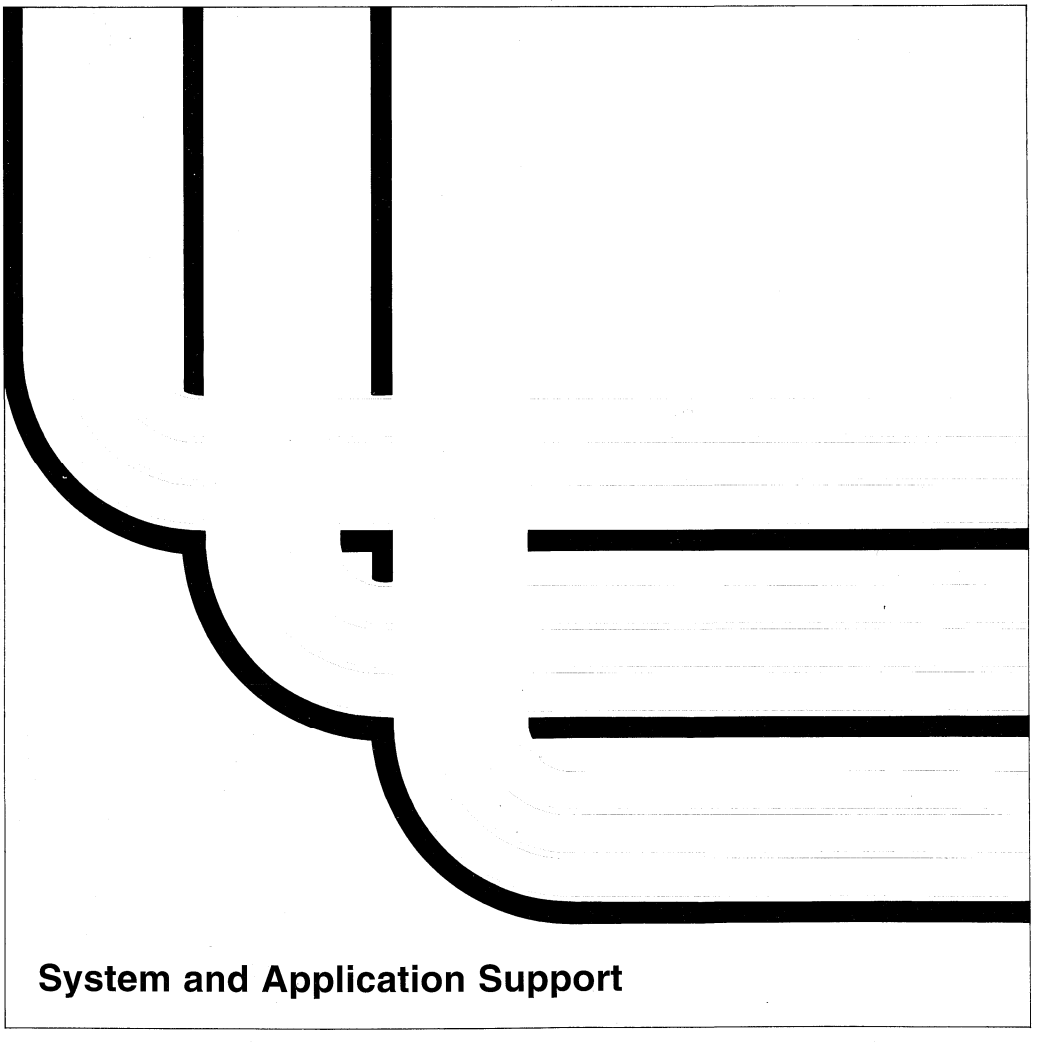
Application System/400

SC41-0036-02

Basic Backup and Recovery Guide

Version 2



System and Application Support

Application System/400

SC41-0036-02

Basic Backup and Recovery Guide

Version 2

Take Note!

Before using this information and the product it supports, be sure to read the general information under "Notices" on page xxi.

Third Edition (November 1993)

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About This Guide

This guide provides information about backup and recovery planning for the system. Backup and recovery planning and implementation is the responsibility of the customer.

This guide provides:

- Information to plan a backup and recovery strategy
- Procedures to implement your backup and recovery strategy
- Procedure to add disk units to an existing auxiliary storage pool (ASP)
- Procedures to recover from disk unit failures
- How to use operational assistant BACKUP menu

This guide is intended for someone who is assigned the responsibilities of backup and recovery planning and recovering the system after a failure. You should be familiar with the information contained in the *Operator's Guide*, and the *New User's Guide*, before using this guide. If you know how to operate the system, you should be ready to use this guide to plan for, and implement, a backup and recovery strategy.

This guide does not describe how to:

1. Recover applications
2. Do journal management and database recovery
3. Use commitment control
4. Start checksum protection
5. Start or stop device parity protection
6. Start mirrored protection
7. Recover from a disk unit failure when checksum or mirrored protection is in effect

The *Advanced Backup and Recovery Guide*, SC41-8079, has information about journal management, database recovery, commitment control, starting checksum, device parity protection, or mirrored protection, and recovering from a disk unit failure when these functions are in effect.

The *Backup Recovery and Media Services/400 Guide*, SC41-0095, has information about using the BRM Services/400 product to provide a comprehensive, easy to use backup, recovery, archive, and media management solution for AS/400 system operations.

When a release is specified in this manual, the short form will be used as shown in the second column.

Version 1 Release 3 Modification 0	V1R3M0
Version 2 Release 1 Modification 0	V2R1M0
Version 2 Release 1 Modification 1	V2R1M1
Version 2 Release 2 Modification 0	V2R2M0
Version 2 Release 3 Modification 0	V2R3M0

You may need to refer to other IBM manuals for more specific information about a particular topic. The *Publications Guide*, GC41-9678, provides information on all the manuals in the AS/400 library.

For a list of related publications, see the "Bibliography."

Summary of Changes

This section lists major changes to the *Basic Backup and Recovery Guide*.

Save and Restore Processes and Procedures

Important!

Please remember:

- Chapter 10, "Working with the Save and Restore Procedures" contains stand-alone procedures to restore only parts of the system. They are not intended to be used for disk recovery or disaster recovery.
- Chapter 13, "Working with Disk Recovery" contains the disk recovery procedures.
- "Total System Restore" on page B-20 is used for recovering from a disaster or performing a total system restore.

- Information about using Operational Assistant was moved from the *Operator's Guide* to Appendix E, "Using Operational Assistant to Back Up Information."
- Index entries that were previously located under *backup* and related headings were moved to the index section under *Operational Assistant* and related headings.
- Considerations for saving and restoring the system with automatic configuration not enabled were added to"Considerations for Saving the System with Automatic Configuration Not Enabled" and "Considerations for Restoring the System with Automatic Configuration Not Enabled."
- User profile considerations were changed in "User Profile Considerations."
- "Restoring the System in Parts" has been updated with the basic steps to perform a partial system recovery. This allows you to restore your critical applications first. Later, you can restore less critical applications.
- Considerations for restoring object audit values was added to "Considerations When Restoring Object Audit Values."
- OUTFILE(*OUTFILE) support for the following commands were added to "Restoring the System in Parts."
  - RSTLIB
  - RSTOBJ
  - RSTCFG
  - RSTDLO
  - RSTUSRPRF
- Information about saving document library objects was changed in the topic "Saving Document Library Objects" on page 7-2.
- The procedure to move data from a previous release to the current release has been changed in "Previous Release-to-Current Release Support" on page 8-5.
- Considerations for output files in using during a save or restore operation were added to the topic "Output Files in Use at the Time of the Save or Restore Operation" on page 9-7.
- Recovering from a media or device error while running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command during a total system restore was added to Chapter 9.
- Information about message queue delivery of *BREAK or *NOTIFY has been added for enhanced unattended backup.
- The procedure for restoring the operating system has been updated with information about restoring the operating system when automatic configuration is turned off or restoring from the distribution tapes.
- Information about restoring user profiles, device configuration, user libraries, and authority has been updated in Chapter 10.
- Disk Recovery procedures have been updated in Chapter 13.

Disaster Recovery

The disaster recovery plan example in Appendix B has been updated.

Save and Restore Performance

Appendix C, "Save and Restore Performance" has been updated with information about tape unit performance during a save and restore operation. This information pertains to Version 2 Release 2.

Miscellaneous

The following was added to Appendix D, "Library QUSRTOOL and Programming Examples."

- More information about tools in library QUSRTOOL.
- An example program for doing an unattended SAVSYS operation.

Part 1. Developing a Backup and Recovery Strategy

Chapter 1. Introduction to Backup and Recovery Strategy Planning

The continued growth in dependence on computers, and on the information from them, has increased the importance of the plans to prevent loss of their availability. It is becoming very difficult, costly, and confusing to revert back to manual systems for any length of time. A backup and recovery strategy is necessary to minimize the effect of unexpected and undesirable situations affecting information services or other parts of the organization's information systems.

The objective of a backup and recovery strategy for information services is to make sufficient preparations and to establish a sufficient set of agreed upon procedures for responding to a disaster or emergency. This will minimize the effect upon the operation of the business.

The purpose of this chapter is to provide an overview of the backup and recovery options available for the AS/400* system.

Backup and Recovery Options Available for the AS/400 System

This topic provides a high-level view of the backup and recovery options available for the AS/400 system. This information provides a base for understanding the backup and recovery options discussed later in Chapter 2, "Planning a Save and Restore Strategy." These options include:

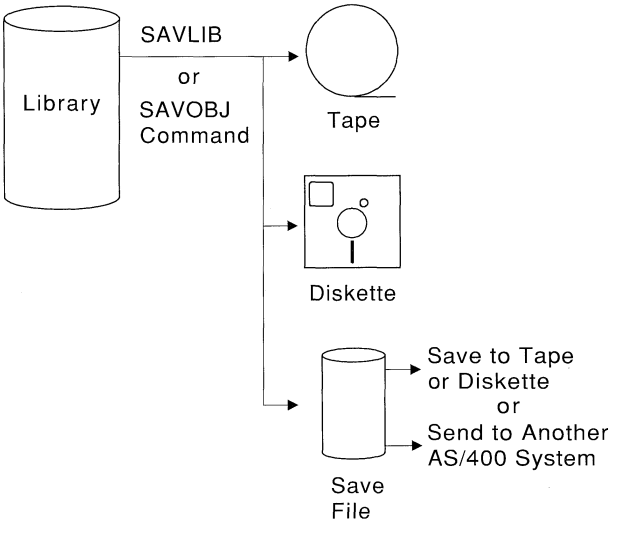
- Save and restore operations of the system, storage, and objects
- Journal management
- Access path journaling
- Commitment control
- Auxiliary storage pools
- Checksum protection
- Device parity protection
- Mirrored protection
- Uninterruptible power supply
- Battery power unit
- Dual systems

Detailed descriptions of some of these methods are discussed later in this guide. More advanced topics are discussed in the *Advanced Backup and Recovery Guide*.

Save and Restore Operations

The save and restore operations provide a means to recover from a program or system failure, save the system storage, exchange information between systems, and store infrequently used objects off-line. Normally, objects are frequently saved and infrequently restored. Objects can be saved and restored using diskette, magnetic tape, or a save file.

The following shows an overview of objects being saved to a diskette, a magnetic tape, and a save file.



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Consider the following when using the save and restore operations:

- When information is saved, a copy of the information in a special format is written onto one or more diskettes, reels of magnetic tape, tape cartridges, or to a save file. The save and restore format does not follow standards for normal data interchange on systems other than the AS/400 system. However, diskettes and tape can be removed and stored for future use on the same system or distributed to another AS/400 system. New tapes and

diskettes must be initialized (INZTAP or INZDKT command) before they can be used.

- A **save file** is allocated in auxiliary storage to store data in a file (without an operator present to change the media). It also allows input and output (I/O) operations from a high-level program, or receives objects sent through the network.

  Save files can be used in two ways:

  - Transmission to another AS/400 system over communications lines.
  - Unattended save operations because an operator does not need to load diskettes or tapes when information is being written to the save file.

- When information is restored, the information is read from diskette, tape, or a save file into storage where it can be accessed by system users. The information restored can be either old information previously saved from the system or new information saved from another AS/400 system.

Journal Management

Two objects unique to journal management are the journal and the journal receiver:

- The **journal receiver** (object type *JRNRCV) is an object that contains entries (called journal entries) written when a change is made to an object (for example, when an update is made to a file being journaled.
- The **journal** (object type *JRN) identifies the journaled objects, the current journal receiver, and all journal receivers that are on the system for the journal.

Using journal management is a way to recover database files. When a change is made to a journaled file, the change is first recorded in the journal receiver and then written to auxiliary storage. If the system ends abnormally before the change for the file is actually written to auxiliary storage, the change is saved in the journal receiver. The next IPL of the system after an abnormal system end ensures that all changes in the journal receiver are also in the files being journaled. If the database file is damaged, you can restore the file from the save media and then apply the journaled changes saved in the journal receiver.

Figure 1-1 on page 1-3 shows journal processing. Files A and B are being journaled, file C is not. Programs PGMX and PGMY use file B. When you make a change to a record in file A or B, the following occurs:

1. The change is written in the active journal receiver.
2. The journal receiver is written to auxiliary storage.
3. The record is written to the file in auxiliary storage.

File C record changes are written directly to the main storage copy of the file because it is not being journaled. Only the changes made to the journal receiver are written immediately to auxiliary storage (disk). Changes against the physical file may stay in main storage until the file is closed.

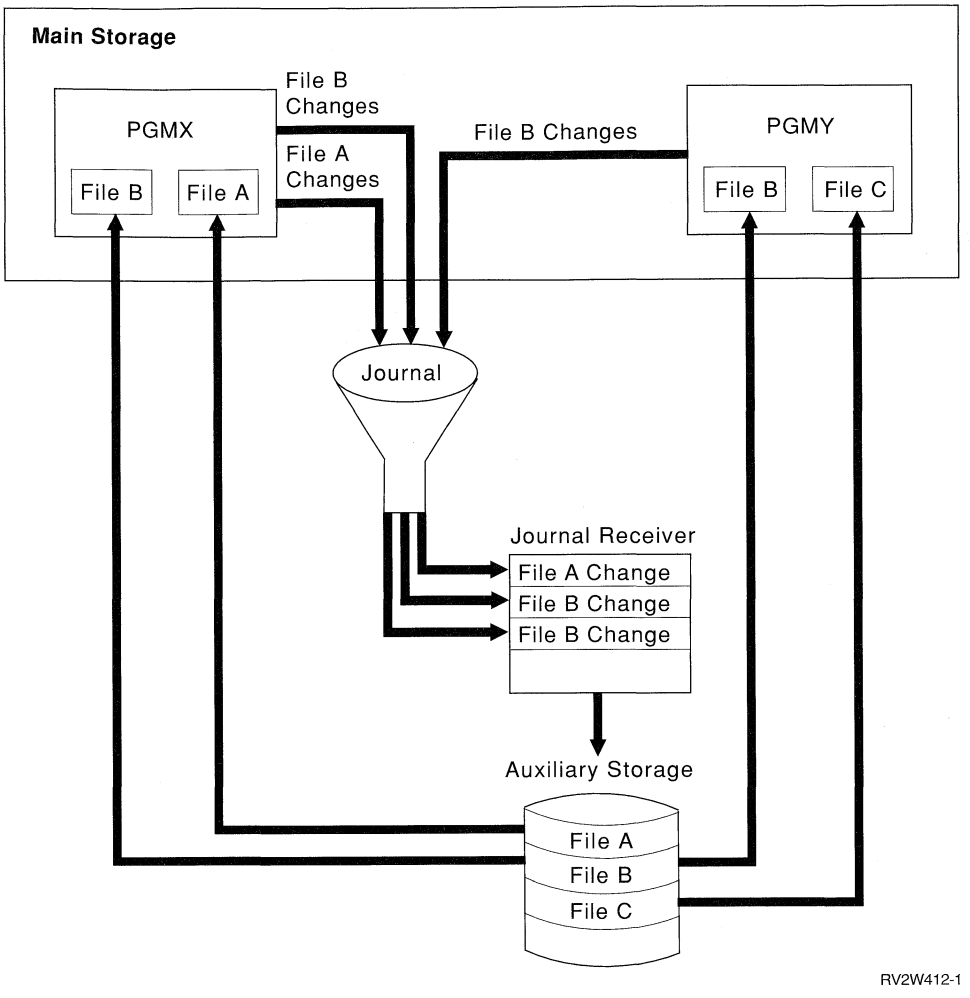


Figure 1-1. Journaling Overview

The system journals some file-level changes, including moving a file and renaming a file. The system also journals member-level changes, such as initializing a physical file member, and system-level changes, such as initial program load (IPL). Users can also add their own entries to a journal receiver to identify significant programming events or to help in the recovery of their programs. These types of entries cannot be applied or removed as entries for database files can.

Access Path Journaling

An **access path** describes to the system the order in which records are read. If access path changes are not journaled in the journal receivers, and a file has been changed and not closed properly, the system can spend a significant amount of time rebuilding the access paths during the IPL following an abnormal system end. If the decision is made to use access path journaling, and the system fails, the system may recover (rather than rebuild) the access paths automatically, using the information in the journal. This can greatly decrease the time required to recover. On the AS/400 system, journaling access paths is the primary method of reducing the time to recover access paths. Rebuilding access paths after an abnormal system end can take several hours. Recovering the access paths from a journal usually takes no more than a few seconds for each access path.

Commitment Control

Commitment control is an extension of the journal function on the AS/400 system. It allows the defining and processing of a number of changes to database files as a single transaction.

Without commitment control, recovering data for a complicated program requires detailed program

knowledge and programs cannot easily be started again. To restore the data to the last completed transaction, the data may need to be adjusted by a user program or data file utility (DFU) that reverses the transactions that are not complete. This becomes more difficult when many users are accessing the files. For example, when the system or a job ends abnormally, journaling assures that all records will exist in the database. Because end-user applications can require multiple changes to files in a transaction, journaling may reflect only a partially completed transaction.

You can use commitment control to ensure:

- All changes within a transaction are completed for all files affected.
- All changes within a transaction that are not complete are removed if processing is interrupted.
- Changes made during a transaction can be removed when the user program determines that it is necessary to do so. This is called a rollback operation.

The commit (COMMIT) and rollback (ROLLBACK) operations are available in several AS/400 programming languages including RPG III, COBOL, PL/I, C/400, control language (CL), and Structured Query Language (SQL).

Auxiliary Storage Pools (ASPs)

An **auxiliary storage pool (ASP)** is a group of units defined from all the disk units that make up auxiliary storage. ASPs provide the means of isolating objects on one or more specific disk units to prevent the loss of data due to a disk media failure on other disk units not included in the ASP.

The system ASP (ASP 1) is created by the system and is always configured. It contains the licensed internal code, licensed programs, and system libraries. The system ASP also contains all other configured disk units that are not assigned to a user ASP.

A user ASP is created by grouping together a physical set of disk units and assigning them a number 2 through 16. ASP 1 is always reserved as the system ASP.

User ASPs can be used to isolate libraries and objects within these libraries from the system ASP. If a library exists in a user ASP, all objects in the library must be in the same ASP as the library. "Object Types Not Allowed in a User ASP" on page 12-14 shows a list of object types that are not allowed in a user ASP.

The exceptions to this rule are journals, journal receivers, and save files. These object types can be created in a user ASP when their libraries are in the system ASP and the selected user ASP contains no libraries. However, this type of ASP usage is **not** recommended because of the complex recovery steps. The recommended way to place these object types in a user ASP is to create the library in the desired ASP first, and then create the objects in that library.

In addition to the recovery advantage, placing libraries and objects in a separate user ASP can improve performance. In a heavy journaling environment, isolating journal receivers to a user ASP can reduce disk arm contention between the files and journal receivers, and improve journaling performance.

Note: If journal receivers and save files are not put in a separate user ASP, consider saving them regularly on tape or diskette to protect them from loss due to disk failure.

Checksum Protection

Checksum protection is a function that protects data stored in an auxiliary storage pool from being lost because of damage or a disk unit media failure. When checksum protection is in effect and a disk unit media failure occurs on a protected unit, the system automatically reconstructs the data after the disk unit is repaired.

Damage to objects can occur because of slight imperfections on a disk surface. If this occurs to objects in the ASP when checksum protection is in effect, the data is automatically re-created. This avoids having the system mark the object as damaged.

When checksum protection is started, the system automatically groups the disk units in the ASP into checksum sets. Space equivalent to approximately one disk unit in each set is used to store checksum data that provides protection for the user data stored on the other units in the set.

The data residing on several disk units (checksum set) is combined onto other units in such a way that, if any one of the units fails, its contents may be recovered by recombining the data on remaining units in the checksum set. The reconstructed data reflects the most up-to-date information that was on the disk at the time of the failure.

When a disk unit fails, checksum protection does not prevent the system from ending abnormally. Rather, its main advantage is that no data is lost and it helps avoid installing the entire system and loading information to disk again if the failed unit must be replaced and the data on it is lost. In contrast, normal save and restore methods allow you to recover only to the point of the last save operation and may result in entering many transactions again.

Any changes made to permanent objects residing in the ASP are automatically updated and maintained in the checksum data (associated with the space allocated to the objects).

Libraries in the system ASP should not have objects in the user ASPs. If the libraries have objects in user ASPs, then the user ASP is of the old type (the type supported before Version 1 Release 3) and contains only journals, journal receivers, and save files. Checksum protection is not recommended for user ASPs that contain only journals, journal receivers, or save files.

Figure 1-2 illustrates a system ASP configuration with checksum protection. In this example, assume that two of the three devices contain user application data, and the other device contains checksum data.

The assignment of units to checksum sets is shown for example purposes only. The actual assignment of checksum sets can vary because the system uses an algorithm to determine the checksum sets. Refer to the *Advanced Backup and Recovery Guide*, for more information about checksum sets.

If the user data on unit 6 is lost, the system automatically reconstructs that data from unit 5 and the checksum data on unit 7 after unit 6 is replaced.

The actual implementation of checksum protection is more complex because there are multiple checksum areas spread across all units in a checksum set to distribute the disk activity more evenly over all units in a checksum set.

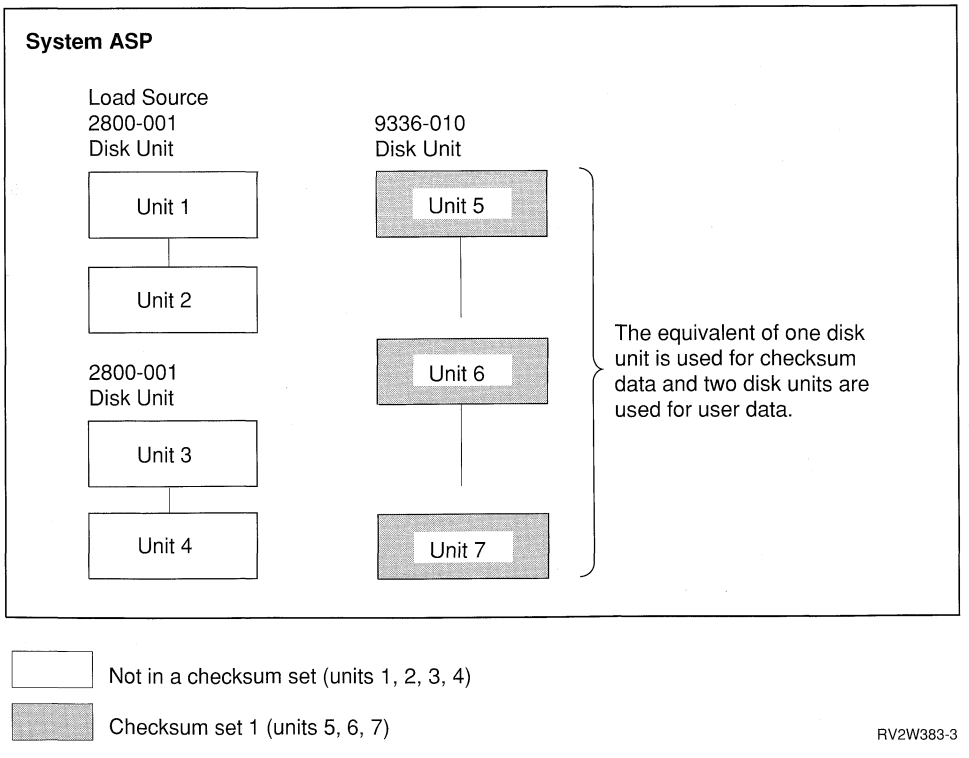


Figure 1-2. Example of Checksum Protection for the System ASP

Checksum protection should not be used as a replacement for system backup procedures. Although checksum protection can fully recover from most disk failures, it is important to be aware that there are situations where checksum protection will not be able to recover some or all of the data. For example, if more than one disk unit within the same checksum set fails and is lost or is damaged by fire, checksum protection will not be able to reconstruct any data. Even though these occurrences are rare, checksum protection should not be used as a substitute for saving the entire system on a regular basis.

Device Parity Protection

Device parity protection improves system availability by providing data protection using technology similar to RAID-5 (Redundant Array of Inexpensive Disks) redundant power, and concurrent maintenance for single disk and power supply failures.

Device parity protection is available for some disk unit subsystems. The models with device parity protection use a data redundancy technique to protect the data. The parity information in the disk unit subsystems with device parity protection is spread across multiple units to improve performance.

When a failure occurs on a disk unit subsystem that has device parity protection, the data is reconstructed. The disk subsystem controller automatically reconstructs the data from the active units in the disk unit subsystem. When a failure occurs on a disk unit subsystem that does not have device parity protection that is in an ASP, the system is unusable. The disk unit that does not have device parity protection has to be repaired or replaced.

An ASP should have device parity protection, mirrored protection, or both to ensure the system remains available after a single disk failure. If you use both in the same ASP, it is recommended that you mirror the internal disk units and use device parity protection for the remaining units in the ASP.

The advantage of device parity protection is that the system remains usable when a single storage unit within a disk unit subsystem with device parity protection fails. However, a decrease in performance is likely because the data on the failed unit must be reconstructed by the disk controller. Mirrored protection is better than device parity protection in this respect because a copy of the data exists on a different storage unit. Another advantage of device parity protection is the automatic recovery of disk errors that otherwise cause damaged objects on the system. Some models of the 9337 disk unit subsystems with device parity protection also contain a write-assist disk unit (WAD). Other models with device parity protection have a write cache. The WAD or the write-cache are used to increase write operation performance.

The WAD has a high-speed buffer storage that contains frequently used access instructions and data used to reduce access time. The WAD is not visible to the system and is not part of the device parity protection mechanism. If the write-assist disk unit fails, write performance decreases. The disk unit can be repaired concurrently.

The write cache is provided by a card that is attached to the controller. This card contains 1MB of memory that provides non-volatile storage within the cache. The card also contains a battery to provide power if the power is turned off during normal operations. This maintains the integrity of the data in the write cache.

The write cache on the 9337 2xx models replaces the write-assist disk unit on the 9337 1xx models. To ensure data integrity, the system is not notified of a write operation until a copy of the data is stored in the controller memory and in the write cache.

If the write cache card fails, the system continues to run. No data is lost because the controller memory contains a copy of the data. If the controller fails, the data in the write cache is preserved. When the controller has been replaced, the data in the write cache is written to the disk.

Device parity protection should not be used as a replacement for system backup procedures. Although device parity protection can fully recover from most disk failures, it is important to be aware that there are situations where device parity protection will not be able to recover some or all of the data. For example, if more than one unit within the 9337 disk unit subsystem fails or is damaged, device parity protection will not be able

to reconstruct any data and the entire ASP must be restored. Even though these occurrences are rare, device parity protection should not be used as a substitute for saving the entire system on a regular basis.

Device parity protection does not protect against system outages that can result from failures in other disk related hardware like a disk controller, I/O processor, or bus. If these types of outages cannot be tolerated, consider mirrored protection. Figure 1-3 illustrates a disk unit with device parity protection.

The *Advanced Backup and Recovery Guide* has more information about capacity planning and considerations.

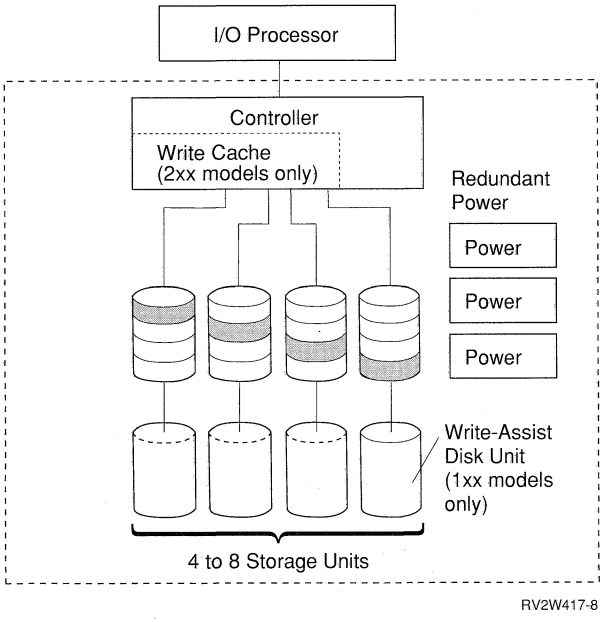


Figure 1-3. Example of Device Parity Protection for User ASPs

Mirrored Protection

Mirrored protection is a function that increases the availability of the AS/400 system in the event of a failure of a disk-related hardware component. It can be used on any model of the AS/400 system and is a part of the licensed internal code. Different levels of mirrored protection are possible, depending on what hardware is duplicated. The system remains available during a failure of a disk-related hardware component such as a disk unit, a disk controller, a disk I/O processor, or a bus, if the failing hardware component and hardware components attached to it are duplicated.

For the 9406 system unit, some failed hardware components can be serviced while the system remains available.

Note: It is not possible to have bus-level protection for unit 1 on a 9406 system unit because both units of the mirrored pair must be on the same bus.

The disk units in an ASP are automatically paired by the system when mirrored protection is started. The system pairs the disk units to provide the maximum level of protection for the current hardware configuration. Because all disk units have at least device-level protection, the system is protected against the failure of a single disk unit.

Figure 1-4 shows a system that has bus-level protection. In this example, if a controller or I/O processor failure occurs, the system continues to run.

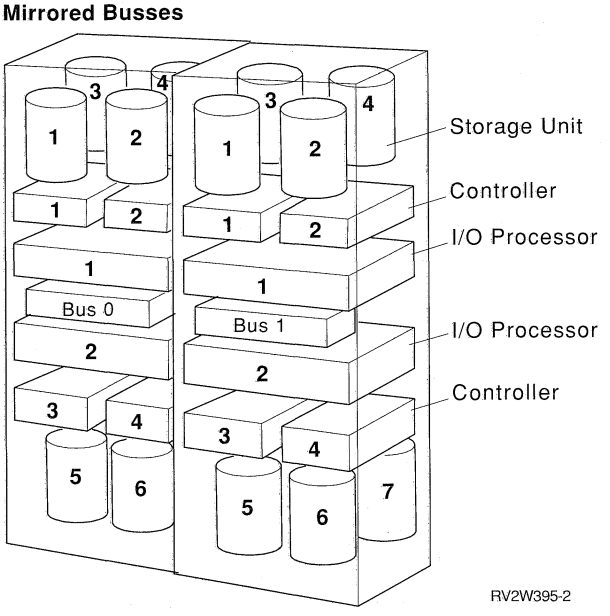


Figure 1-4. Example of Mirrored Buses

Uninterruptible Power Supply

An uninterruptible power supply provides auxiliary power to the processing unit, disk units, and as many other devices on the system as possible.

Normally, an uninterruptible power supply does not provide power to all work stations. You should design your interactive applications to look at error feedback areas and handle any errors indicated. If the application handles the errors and stops, the

system resource is not used to do nonproductive error recovery. Examples of using error feedback areas and error recovery routines can be found in the programming languages reference manuals.

Assuming an uninterruptible power supply is not provided to the work stations if utility power is lost, work station jobs may end abnormally if your user-written programs do not provide for this situation. However, the system remains stable. After utility power is restored, the users can sign on to the work stations. An uninterruptible power supply that provides limited support provides power to the processing unit, unit 1 (load source), and all storage controllers. The system continues to run for a specified number of minutes.

Uninterruptible power supplies vary, but Figure 1-5 on page 1-8 shows a logical view of a typical uninterruptible power supply.

With the AS/400 system, the uninterruptible power supply provides the system with the ability to:

- Continue operations during brief power interruptions.
- Provide normal ending of operations so that the next time the system performs an IPL, there is minimal recovery time. If the system ends abnormally before completing a normal ending of operations, the recovery time can be significant.

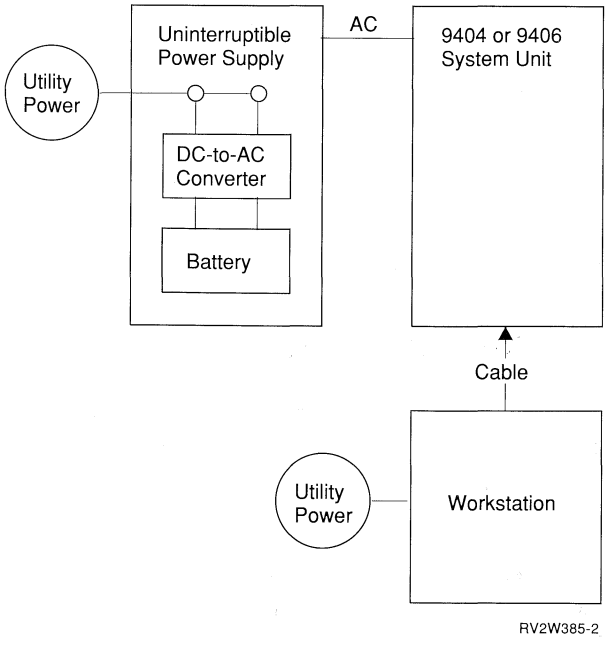


Figure 1-5. Logical View of a Typical Uninterruptible Power Supply

Optional Battery Power Feature

A battery power unit exists as an optional feature for the 9402 and 9404 system units. For the system unit to be protected against temporary power loss, each system unit must have a battery power unit. The Battery Power Unit feature on the 9402 or 9404 system unit supports all disk units in the system unit. The system unit has a battery with sufficient power to keep the processing unit and the disk units powered for a minimum of five minutes in the event of a loss of utility power. For an illustration of the built-in Battery Power Unit feature, see Figure 1-6.

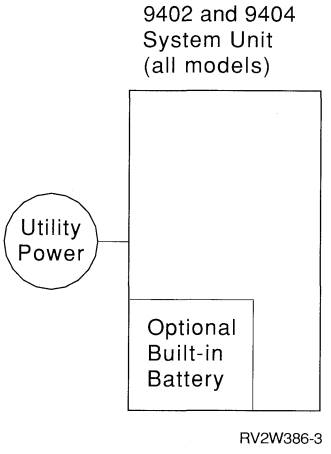


Figure 1-6. Built-in Battery Feature

Standard Battery Power Unit

A battery power unit exists as a standard feature for the 9404 Model E and F system units, the 9404 Server Series Model 135 and 140 system units, and the 9406 Model D, E, F, and G system units. This standard battery provides power to card cages in every rack. All storage controllers have power including storage unit 1.

The system unit has a battery with sufficient power to keep the processing unit powered for a minimum of five minutes in the event of a loss of utility power.

Dual Systems

A dual system approach can be used to record changes on a secondary system as they occur on the primary system. The secondary system can take over critical application programs if the primary system fails. The OS/400 licensed program does not directly support this concept. However, certain functions of the AS/400 system can be used to achieve this.

Chapter 2. Planning a Save and Restore Strategy

The objective is to provide you with the knowledge that will help you develop or revise a backup and recovery plan that will balance the cost of a failure with the cost of protection against the failure.

This chapter does not describe or explain in detail how the backup and recovery options work or how they can be implemented. See the table of contents in this guide and the *Advanced Backup and Recovery Guide* to find more detailed explanations of these options.

Backup and Recovery Guidelines

A comprehensive set of backup procedures is the foundation for any recovery strategy. These backup procedures should be a required part of your normal AS/400 operations. The goal of your strategy should be to ensure that information exists that allows you to recover your system following any type of failure.

Include backing up database files, programs, source code, operating and utility programs, office applications and documents, and end-user applications in your procedures.

Consider the following guidelines when planning your procedures:

- You should be prepared to restore or re-create any object that becomes damaged.
- You should be able to restore the entire system in the event a disaster occurs.
- You should have a plan for how you will recover any changes that have occurred since the time of the last save operation.
- Additional backup procedures can be useful for quarterly or yearly audits to help with business audits.
- A media rotation method provides you with additional backup copies should your most recent set become damaged or unusable. Consider using at least a three-set rotational method for backup copies. For example, use your first set of tapes on Monday, your second set of tapes on Tuesday, and your third set of tapes on Wednesday. On Thursday, start the cycle again by using your first set of tapes.
- Protect your backup media from a site disaster. For example, rotate one of your backup sets to a different location and keep it in a fireproof and waterproof safe. Consider what would happen if your site were destroyed. Would you have a recent copy of your data to load on another system? If not, how long would it take you to manually recover your data and programs?
- Design backup and recovery into your applications. Your design should include as many automatic procedures as possible. Develop error handling routines in your programs for workstations, communications, and database files.
- Provide documentation and test your procedures to make sure they work correctly before you put them into production.
- As a minimum goal, save changes at least once a day. Save the journal receiver or transaction file that contains the latest changes to the production database files. Changes to source files, the document library, and other objects need to be saved at least once a day.
- Periodically (at a minimum, quarterly) save your entire system environment. If significant changes occur, the system environment should be saved more frequently. This backup of the entire system provides a base for recovery if the entire system is lost. The system environment includes:
  - Operating system
  - Device configuration objects
  - User profiles
  - All user objects
  - Private authorities
  - System and network values

  Without this data, you would have to manually re-create your entire device configuration and security environment when building your system again.
- Decide if you want to use some of the functions designed to reduce the save window,

such as saving changed objects or using the save-while-active function.

System Availability

In any business, there are times the system is not available. The availability of the system is impacted by planned outages, such as your system maintenance, save and restore schedules, and on the availability of power.

The shaded portion of Figure 2-1 represents normal operations. Historically, the shaded area continues to grow.

The following describes some terms used when discussing availability and the types of outages that can occur on a system:

- **Scheduled**

  System is down from a planned or predicted condition.

  - System not needed
  - System is dedicated to backup process
  - New equipment or software is being installed or maintained
  - Program temporary fix (PTF) package is being installed.
  - New release is being installed.

- **Unscheduled**

  System is down for some failure or error

  Most of the time is spent waiting or getting the system operational again.

- **High Availability**

  No unscheduled outages

- **Continuous Operations**

  No scheduled outages

- **Continuous Availability**

  No outages

Scheduled and unscheduled outages may often be interrelated. Changes made to decrease unscheduled outage time may increase planned outage time, and vice versa. For example, starting checksum protection requires time for planning and starting. However, recovery from a disk unit failure will be much faster when checksum protection is in effect.

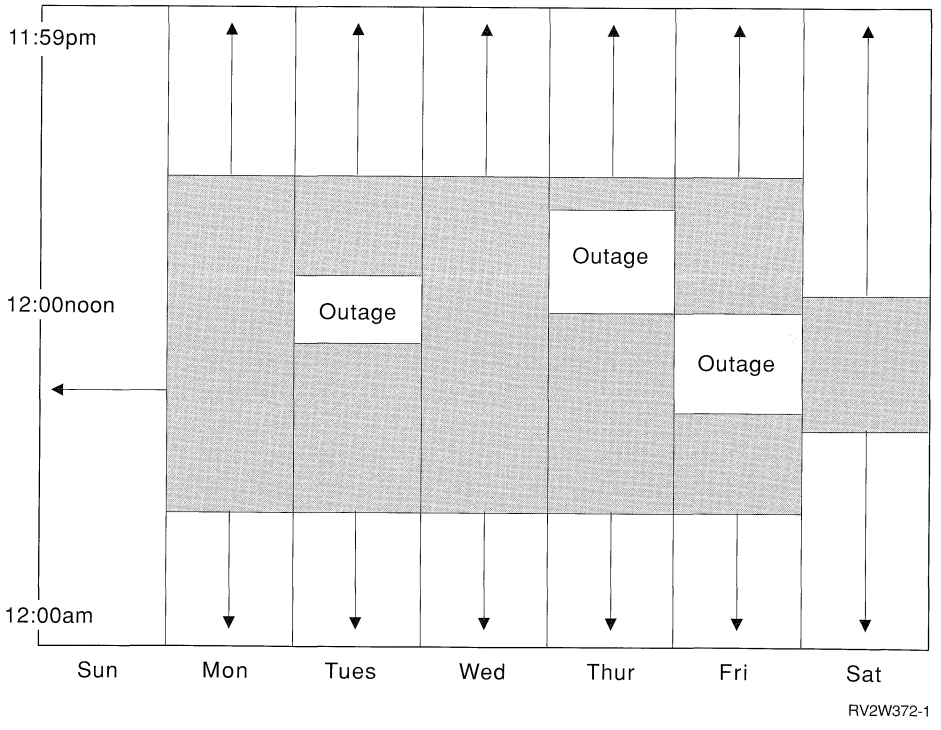


Figure 2-1. Outage Windows

Recovery Design Considerations

This topic discusses two processes: recovery and backup. It makes sense to look at the recovery requirements first because the recovery time generally has the most impact. Establishing what must be recovered and in what period of time usually dictates what must be saved and with what frequency. So the questions to be asked are:

1. What factors make the recovery process longer?
2. What factors or methods can help shorten the recovery?
3. Is it worth the cost of using the appropriate backup or recovery method in order to reduce the recovery time?

See "Failure Types and Associated Data Loss" on page 2-16 for more information about these questions.

Once the recovery process and contingencies have been defined, then the backup procedures necessary to support the recovery requirements can be designed. Because the backup or save methods may require some level of exclusive use of the system, it becomes appropriate to ask the same questions for backup as for recovery.

Cost of Being Down

The first essential step is to analyze the cost of being down. It is not easy to determine the cost of outages. The availability requirements for each application or program can have widely varying effects on the productivity of its users.

Analyze by Major Application: You must start with a reasonable estimate of what each critical application is worth to the business. Some applications are critical throughout major portions of the day, while others can be run any time or on demand.

- The major cost of an outage is the cumulative total of not having the applications available to continue necessary operations.
- Direct costs are the time and revenue lost directly because the system is down. Indirect costs are costs incurred by another department or function as a result of an outage. For example, the production department may absorb the cost of a manufacturing line being shut down because the system is unavailable. This is an indirect cost of the outage, but nonetheless a real cost to the company.
- Tangible costs are direct and indirect costs that can be measured in dollars and cents. Intangible costs are those for which cash never changes hands, such as lost opportunity, good will, and market share.
- Fixed costs are direct, indirect, tangible, or intangible costs that would result from the failure regardless of the length of the outage. Variable costs are those that vary with the duration of the down time, but they are not necessarily directly proportional.

Cost of Doing Backup and Recovery

The second essential step is to know how much it will cost to use the various recovery functions that are available on the AS/400 system. You can then evaluate whether the cost of the function is more expensive than the cost of being down.

The following topics evaluate the backup and recovery functions and what additional costs (if any) the functions can incur.

The manual *So You Want to Estimate the Value of Availability*, GG22-9318, has more information about evaluating the cost of availability.

Save and Restore Operations: The following evaluates the costs of save and restore operations.

- Tape unit with adequate speed and capacity
- Additional disk units for on-line backup
- Operator time (or overtime)
- Programming effort to automate the save and restore processes
- Documentation of save and restore procedures
- Saving objects while they are being changed (save-while-active function)

As the recovery requirements become more critical, the amount of data and the frequency that it must be saved increases. To help reduce the

amount of time spent during the save process, review the following factors that affect save-time performance.

Normal Save Processing: Preprocessing and post-processing are done when a save command is run. Preprocessing builds directories that contain information about the objects. As each directory is completed, it is written to a tape, a diskette, or a save file, followed by the objects.

In some cases, all libraries have been preprocessed and saved to tape when the tape unit unloads. However, the user may not be able to enter data or use the system. This situation occurs when the last library is still under post-processing.

Under most circumstances, this overlap in processing actually decreases the total save time when saving multiple libraries with a single command.

Number and Size of Objects: In most cases, saving many small objects takes more time than saving larger objects that are equal in total size.

System Activity during the Save Operation: Save performance is affected by the current system activity. Increased system activity affects how well the save or restore operations perform. This is especially true for the save-while-active function. You should plan your save window to minimize the effect to users and the system.

You can place the system in a restricted state to limit additional system activity. A **restricted state** (also referred to as a dedicated system) is when all subsystems are ended, including the controlling subsystem. The system is considered in a **non-restricted state** if any or all subsystems are active, regardless of whether there are any active jobs or users at the time.

A restricted system can offer the following benefits:

- Object lock checking can be bypassed.
- Disk contention with other jobs is reduced.
- Sufficient processing unit and main storage resources are available.

Placing the system in a restricted state is required for several functions, such as running the SAVSYS, SAVLIB LIB(*NONSYS), and the SAVSTG commands. Other save functions do not require a restricted system. For example, the following commands do not require a restricted system:

- SAVLIB LIB(*ALLUSR or *IBM),
- SAVCFG, SAVDLO, SAVOBJ,
- SAVCHGOBJ, and SAVSECDTA

However, any objects that are in use at the time the save command is run may not be saved.

In many circumstances, it is not necessary to place the system in a restricted state to obtain good performance. Consider running the save operation in a restricted environment or change the priority of the job if:

- Other active jobs have a noticeable effect on save performance.
- The save operation is affecting active jobs.

Type of Save Operation: When saving large amounts of data, the type and number of save commands used can affect performance. For example, saving multiple libraries using a single SAVLIB command is faster than using separate SAVLIB commands for each library. Saving only the objects that have changed (SAVCHGOBJ command) is much faster than saving the entire library.

Saving access paths (ACCPTH(*YES) on the save commands) can increase the save window. However, restoring access paths can significantly reduce the recovery time. You must decide if a smaller save window is worth the increase in recovery time. If recovery time is more important, consider saving access paths.

User Profile Authority: If the system operator or the user performing the save operation has *SAVSYS or *ALLOBJ special authority specified in their user profile, then security checking of the objects is bypassed. If it is not specified, then the system must check each object to make sure that the user is authorized to save the object. This adds time to the save process.

Data Compression and Data Compaction Methods Being Used: The AS/400 system offers three types of data compression and data compaction to allow you to save more data to the media:

- Software data compression is performed by the OS/400 licensed program.
- Hardware data compression is performed by the AS/400 adapter (attachment feature).
- Hardware data compaction is performed by the tape unit. It is supported on only the 3480 and 3490 tape units if the tape unit has the compaction feature. It is also supported on the 7208 Model 12 when used in 5GB mode.

Software data compression requires central processing unit cycles to perform the compression during the save operation, thus the save time may be increased. The exception is when the central processing unit can process and send data faster than the save device can accept it.

Hardware data compression does not require extra central processing unit cycles. Instead compression occurs within the hardware of the AS/400 tape adapter. In most cases hardware data compression will decrease save time.

Save Device Characteristics: It is important that you understand where save performance problems may occur. Typically, faster or multiple save devices increase save performance. However, if during the save operation you observe the tape drive constantly stopping and starting, then installing a faster tape drive may not significantly increase save performance. Instead this may be indicating that the system is unable to supply data to the tape device fast enough.

Using Save Files: Saving to a save file typically offers good performance; however, there are several considerations. First, saving to a save file is a process of reading from disk and then writing to disk. This can cause disk contention, decreasing save file performance. The contention can be reduced by placing the save file in a user ASP. Contention can be further reduced by placing the disk unit that contains the user ASP on a separate I/O processor (IOP). In addition, optimum save file performance is obtained when:

- The save file is not sharing a user ASP with other objects.
- The activity in that ASP is limited when saving to the save file.

Unattended Saves: By using save files, certain save commands can be run in an unattended environment. The next day, the save files can then be saved to tape at close to maximum speed. Save files can exist in either the system ASP or a user ASP. However, a user ASP can offer better performance.

Any save command that saves multiple libraries cannot save to a save file.

Note: Keep in mind that save files require extra disk space on the system.

Using the Save-While-Active Function: The save-while-active function provided by the AS/400 system allows you to save objects while they are being used by another job. This function can be used along with your other backup procedures to reduce or eliminate the time the system is not available during backup processing.

The *Advanced Backup and Recovery Guide* has more detailed information about using the save-while-active function.

Journaling of Database Files: Journaling of database files is perhaps the cheapest and easiest to use of all the recovery assistance methods. It can be started or stopped for one file at a time. Journaling can be done on all critical or large files, or until the overhead becomes too much for the existing configuration.

Journaling offers a good solution for reducing the save time if you have a large file with few changes. You can significantly reduce the daily save time in most environments by saving the journal receiver daily and the file less frequently. However, journaling can complicate the restore process.

Journaling incurs the following costs:

Disk Space: The volume of database changes that are recorded by a journal directly affects the amount of space the journal receivers use. If the disk space utilization is already high, additional disk units may be necessary to contain the journaled information. However, frequently saving and deleting receivers minimizes the amount of space required.

Disk Write Operations: Journaling is quite efficient in grouping multiple record images when writing to disk. However, it adds to the total number of input/output operations required of the disk configuration. One recommended technique to minimize the impact of the additional write operations is to dedicate an ASP to each journal receiver. This has three advantages:

1. The read/write head dedicated to the receiver can remain positioned over the disk track where the next write operation must take place. Therefore, no time is lost waiting for a read or write operation to the same storage unit.
2. The additional write operations caused by journaling do not have to be absorbed by the disk unit doing the application work.
3. If all of the data in the system ASP is lost, the journal receiver in the user ASP remains intact and can be used to recover the journaled files to a very recent state.

Central Processing Unit Overhead: The amount of processing unit resource required depends on the number of files being journaled and the rate of transactions causing journal entries.

IPL Time: At IPL time all journaled files are synchronized with the latest journal entries for those files. This additional activity is required only if the IPL follows an abnormal termination.

Journal and Receiver Management: Additional steps are needed for the backup and recovery procedures to utilize journaling. It is necessary to include procedures to change, save, and delete the journal receivers as needed. The procedures must be in the appropriate order. The *Advanced Backup and Recovery Guide* has more detailed information about journal management.

Commitment Control: Commitment Control provides for automatic data integrity for transactions involving multiple updates, and it provides for user control of transaction completion or rollback.

There is additional overhead associated with commitment control. Commitment control for files requires both the before-images and after-images to be journaled. If you specified only after-images when you started journaling the files, the system automatically journals the before-images when the files are under commitment control. This implies all of the overhead associated with journaling, in addition to:

- Additional journal write operations for each COMMIT and ROLLBACK operation.
- More system overhead for ROLLBACK operations because they involve writing additional journal entries.
- A commitment definition established by the STRCMTCTL command involves setting up internal control information.
- Locking all changed records within a commit cycle concurrently; the number of records locked within a job increases the overall system resources used for the job. One job holding multiple record locks can have a negative effect on other jobs that need the same resources.
- Changes to application program logic are required to establish the commitment definition and to establish the commitment transaction boundaries. The *Advanced Backup and Recovery Guide* has more detailed information about using the commitment control.

Access Path Journaling: Access path journaling is the most powerful tool available for the prevention of lengthy access path rebuilding during an IPL. One of its strengths is that it can be activated or deactivated one file at a time.

Access path journaling requires that the underlying physical files already be journaled. Before-images of access path pages and records whose keys are changed are also written to the receiver.

The costs of access path journaling are those associated with journaling physical files along with the additional cost of disk space for the before-images of the indexed pages. Very little additional I/O or processing unit overhead is required. This is the result of grouping the index pages and before-images with the other journal entries as they are written to disk.

User Auxiliary Storage Pools (ASPs):

User ASPs can be used to isolate libraries and objects within these libraries from the system ASP. If a library exists in a user ASP, all objects in the library must be in the same ASP as the library.

Isolating objects provides media for holding temporary online backup copies using save files. By isolating objects, you also isolate the read and write activity necessary for journaling. When journal receivers are placed in a user ASP, the separation provides protection from failures in the system ASP.

To minimally disrupt the existing configuration, you can create user ASPs in one of the following ways:

- Adding new disk units.
- Moving disk units from an existing ASP that has excess storage.

Recovery procedures must ensure that journals, journal receivers, and save files are loaded or created again in the correct sequence, to the correct ASP.

Checksum Protection: Checksum protection provides a means of reconstructing information on a disk unit if the unit fails and is replaced.

The system divides all of the disk space in the ASP into checksum sets, each of which contains from two to eight storage units. Space equivalent to the size of one storage unit in each set is used to store checksum data. In a checksum set of two units, half of the disk space is used for checksum data and the other half is used for user data. In a checksum set of eight units, one eighth of the disk space contains checksum (or redundancy) data and seven eighths contains user data.

Any time a piece of data on any disk unit in a checksum set is updated, the corresponding sector in the checksum data for that location must also be updated. This requires an extra read of the original page that is about to change, a read of the checksum page, and then a write of the checksum page. A typical update operation of one read and one write operation increases to three read and two write operations. This additional workload on the disk configuration may require additional disk units or controllers and adaptors to handle the increase.

The machine pool size should be increased by approximately 5% to hold the extra disk pages in memory while the checksum calculation is performed.

Performing the actual checksum algorithm can increase the central processing unit utilization by approximately 10%, depending on the number of updates.

Part of each disk unit in a checksum set is used to store the redundancy (or checksum) data. During an abnormal end of the system, it is possible that the checksum calculation and update process could be interrupted. Checksum information may not be synchronized. Therefore, the IPL process following an abnormal system end validates the checksum data. If a copy of main storage was not saved to unit 1 during the abnormal system end, this validation may lengthen the IPL time considerably.

Device Parity Protection: Device parity protection provides a means of reconstructing information on some models of disk unit subsystems if a storage unit fails and is replaced. A data redundancy technique is used to protect the data. The technique is similar to the RAID-5 technology and is implemented similar to checksum protection. However, protection is provided by the disk unit subsystem, not by the system software.

Device parity protection can not be turned on or off using a function provided by the system software. Device parity protection can be started and stopped at the controller level of the disk unit subsystem using dedicated service tools (DST) options.

Disk unit subsystems can be in an ASP that has mirrored protection. However, the units in the disk unit subsystem do not participate in the mirrored pair configuration. Protection for the units is provided by the disk unit subsystem.

A disk unit subsystem with device parity protection can have four to eight disk units. Parity information is distributed on four disk units in the disk unit subsystem. The remaining units are protected by the parity information in the four disk units.

When a failure occurs on a disk unit that has device parity protection, the disk controller automatically reconstructs the data from the other storage units in the disk unit subsystem. If a disk unit without device parity protection fails in an unprotected ASP that has disk units with device parity protection, then the system is unusable until the disk unit has been repaired or replaced.

Unlike checksum protection, the system remains usable if a storage unit fails in a 9337 disk unit that has parity protection. However, a decrease in performance usually occurs because the data must be reconstructed by the disk controller.

Device parity protection does not protect the system from failure in disk-related hardware, such as a controller, an I/O processor, or a bus.

Device parity protection is not a replacement for normal save procedures. Also, it cannot be used in an ASP with checksum protection.

Mirrored Protection: Mirrored protection provides a way of writing data to two disk units at the same time. The information on one disk unit is duplicated on the other. The information can be read from either disk unit. You start mirrored protection by specifying an auxiliary storage pool (ASP) number. You can mirror one or more ASPs on the system. However, all ASPs should have mirrored protection to provide for maximum protection.

The main cost of using mirrored protection is in additional hardware. To achieve high availability and prevent data loss when a disk unit fails, you need mirrored protection for all the ASPs. This normally requires twice as many disk units.

If you want continuous operation and prevention of data loss when a disk unit, controller, or I/O processor fails, you need duplicate disk controllers and I/O processors. A model upgrade can be done to get nearly continuous operation and to prevent data loss when any of these failures or a failure of bus 1 occurs. If bus 0 fails, the system cannot continue to operate. Because bus failures are rare, and bus-level protection is not significantly greater than I/O processor-level protection, you may not find a model upgrade to be cost-effective for your protection needs.

Note: Bus-level protection is not possible for unit 1 on a 9406 system unit because both units in the mirrored pair must be on Bus 0.

Mirrored protection has a minimal effect on performance. The performance of the mirrored system should be approximately the same if the busses, I/O processors, and controllers are loaded no more heavily than the original system.

In deciding whether or not to use mirrored protection on your system, you must evaluate the cost of potential downtime against the cost of additional hardware over the life of the system. The additional cost in performance or system complexity is usually negligible.

Uninterruptible Power Supply: The operating system and an uninterruptible power supply provide functions that allow you to develop a strategy that meets your needs when a utility power failure occurs. If power outages occur often, it is wise to consider installing an uninterruptible power supply in order to increase the chances that a copy of main storage is saved. If a copy of main storage is saved, rebuilding access paths and checksum recovery time can be reduced.

Installing an uninterruptible power supply involves two major investments:

1. The initial cost of the uninterruptible power supply and the space to install it.
2. The initial cost to automate an orderly shutdown without operator intervention. This requires some thought and some CL programming effort to accomplish.

When using an uninterruptible power supply, there are a variety of ways to control what happens when the utility power fails. The *Advanced Backup and Recovery Guide*, SC41-8079, has more information about programming considerations when using an uninterruptible power supply.

Before designing a utility power failure strategy, consider the following:

- Interruption times vary when power is lost.
- Power can be provided for continuous operations or for stopping all jobs and powering down the system.
- Power can be provided to workstations.

- The system can operate in attended or unattended mode.

The system values QDEVRCYACN and QDSCJOBITV can be used to prevent ending interactive jobs when power to the system is maintained with an uninterruptible power supply. However, the workstation power is lost. This also handles the situation where only the line or connection ended unexpectedly.

Battery Feature: An internal battery is supplied as an optional feature with some models of the 9402 and 9404 system units. The battery feature is a standard feature for the 9404 Models E and F and for the 9406 Models D, E and F. This feature allows the system to perform a normal power-down sequence if a power failure should occur.

The optional or standard battery features on the 9402, 9404, and 9406 system units have internal battery backup that provides power for a minimum of 5 minutes.

Dual Systems: Using two parallel systems will achieve the highest availability. The costs of implementing a dual system approach includes the following:

- Cost of the duplicate or secondary system. In many situations the second system may not need to be a complete duplicate of the primary system because all applications may not need to be available while running on the backup system. It may not require as much disk space or as large of a central processing unit. The cost of the second system may be partially offset if it can be used to run additional applications, as well as for emergency use.
- There must be a communications link between the two systems across which journal entries can be sent if nearly immediate transaction duplication is required. An alternative is to log the journal entries to tape as they occur. Periodically, and upon failure of the first system, the tape can be taken to the backup system and the changes applied to the duplicate files.
- Programs will need to be developed to save the journal entries on the primary system and either transmit them to the secondary system or write them to a tape. On the secondary system, programs will need to receive the transmitted or transferred journal images and update the duplicate files accordingly. There are vendor-provided packages available that address this type of program.
- An automatic or manual procedure must be used to switch the on-line devices from the primary to the secondary system. This includes personal computers if they are the primary workstations. If all or most are personal computers using PC Support on a local area network (LAN), they can have a session attached to each system.
- Uninterruptible power supply on one or both systems further raises the total availability.
- Journaling is used to save the transactions for transmittal to the secondary system.

IBM Business Recovery Services, Fully Operational Recovery Centers: IBM Business Recovery Services in the United States offers a very flexible solution for customers who require a high degree of availability within their computer network. Business Recovery Services offers:

- On-site and remote testing capabilities
- A single point of contact
- Immediate response to your declared disaster
- An IBM recovery team at your location

For more information, contact your local IBM marketing representative.

Job Recovery Considerations

Job recovery and starting again should be a basic part of application design. Applications should be designed to handle:

- Unexpected data problems, such as alphabetic data occurring where numeric data is expected
- Operator problems, such as operators taking the wrong option or canceling the job
- Equipment problems, such as workstation, disk unit, and communication line failures

Job recovery procedures should ensure the integrity of the user's data and allow for easy starting of the interrupted application. Journaling and commitment control can be used in application

design to help in job recovery. Recovery procedures should be transparent to the end users.

Interactive Job Recovery: If you are running a data entry job or one that updates a single file, it is unlikely that you may need to plan an extensive recovery strategy. The operators can inquire against the file to determine which record was last updated and then continue from that point.

To recover from inquire-only jobs, the workstation operators simply start where they left off. When using update transactions for many files, consider using a journal or commitment control. The system automatically recovers journaled files during the initial program load (IPL) following an abnormal end of the system. In addition, the journal can be used for user-controlled forward or backward file recovery. Commitment control, using the file changes recorded in the journal, provides automatic transaction and file synchronization. During job end, the system automatically rolls back file updates to the beginning of the transaction. In addition, the commitment control notify object can assist you in restarting the transaction.

When designing an interactive application, consider the possibility that you can experience equipment problems with your workstations and communications lines. For example, suppose your computer system loses power. If you have an uninterruptible power supply installed to maintain power to the processing unit and disk units, your system remains active. However, in this example, your workstations lost power. When your programs attempt to read or write to the workstations, an error indication is returned to the program. If the application is not designed to handle these errors, the system can spend all its time in workstation error recovery.

You should design your interactive applications to look at error feedback areas and handle any errors indicated. If the application handles the errors and stops, the system resource is not used to do nonproductive error recovery. Examples of using error feedback areas and error recovery routines can be found in the programming languages reference manuals.

Batch Job Recovery: Print-only batch jobs normally do not need special recovery to start again. Running the program again may be adequate.

Batch jobs that perform file updates (add, change, or delete actions) present additional considerations for starting again and recovery. One approach to starting again is to use an update code within the record. As a record is updated, the code for that record can also be updated to show that processing for that record is complete. If the job is started again, the batch program positions itself (as a result of the update code) to the first record that it had not processed. The program then continues processing from that point in the file.

Another way to start batch processing again is to save or copy the file before starting the job. You can use one of the following commands to save or copy the file:

- Save Object (SAVOBJ)
- Copy File (CPYF)

Then, if you have to start again, restore or copy the file to its original condition and run the job again. With this approach, you need to ensure that no other job is changing the files. One way to ensure this is to get an exclusive lock on the file while the job is running. A variation of this approach is to use the journal. For example, if starting again is required, you could issue the Remove Journal Change (RMVJRNCHG) command to remove changes to the files. Then, run the job again against the files.

If your batch job consists of a complex input stream, you probably want to design a strategy for starting again into the input stream. Then, if the batch job needs to be started again, the job determines from what point the stream continues.

Commitment control also can be used for batch job recovery. However, if you plan to use commitment control for batch jobs, consider that the maximum number of record locks allowed in a commit cycle is 32 768. Therefore, you may need to divide the batch job into logical transactions. For example, if your batch program updates a master file record followed by several detail records in another file, each of those sets of updates can represent a logical transaction and

can be committed separately. Locks are held on all records changed within a commit cycle. Therefore, changed data is made available more quickly if your batch job is divided into small, logical transactions.

Objects That Make Up the AS/400 System

Figure 2-2 breaks the system into its basic parts. The following section shows how different parts of the system are saved or restored.

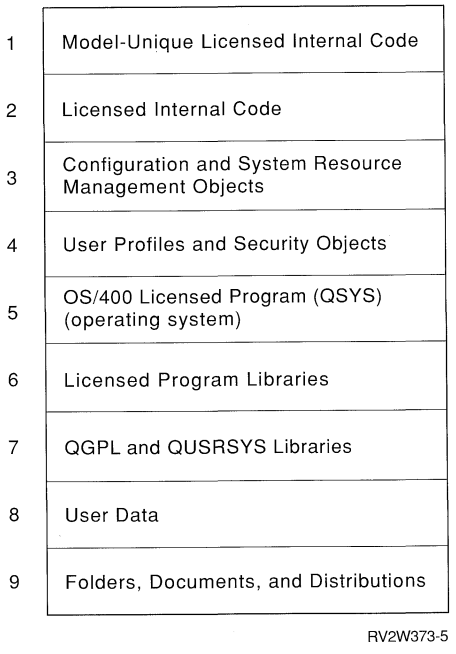


Figure 2-2. Objects That Make Up the AS/400 System

1. Model-Unique Licensed Internal Code:

   The Model-Unique Licensed Internal Code is considered a piece of the processing unit hardware and is not the same thing as licensed internal code.

   Model-Unique Licensed Internal Code is unique to each model type of the AS/400 system. The tapes are not interchangeable among model types; they each have their own part numbers. Every system except the 9402 Models C02, C04, D02, D04, E02, and F02 receives a Model-Unique Licensed Internal Code tape, just as every system receives a central processing unit card.

   Model-Unique Licensed Internal Code is not shipped on the same tape as the OS/400 licensed program and IBM licensed programs. Instead, it is shipped on a separate tape. This is true, whether:

   - The system was ordered as a total system package system.
   - The system was bought directly from IBM or a business partner.
   - The OS/400 licensed program was obtained directly from IBM or obtained by a DSLO agreement.

   For the 9402 system unit, the tape is located in a pouch on the side of the system unit. For the 9404 or 9406 system unit, it is located inside the back cover.

   Model-Unique Licensed Internal Code is not saved by any save command. If Model-Unique Licensed Internal Code ever becomes damaged or must be restored, the system will display an SRC (system reference code) on the operator panel, indicating that you need to place the Model-Unique Licensed Internal Code tape in the tape unit. Additionally, if you distribute software, the Model-Unique Licensed Internal Code can never be distributed. If the Model-Unique Licensed Internal Code tape is ever lost or damaged, your local IBM branch office will help you obtain a new one. Since the Model-Unique Licensed Internal Code may be required in a recovery situation, you should store this tape in a safe and accessible place. Figure 2-3 shows an example of the label for the Model-Unique Licensed Internal Code.

```
                        P/N 1234567

(C) COPYRIGHT IBM CORP.   19XX
ALL RIGHTS RESERVED
MODEL UNIQUE LIC-Property of IBM

LICENSED FOR INDICATED SPECIFIC SERIAL NUMBER SYSTEM.
NOT LICENSED FOR ANY OTHER USE, REPRODUCTION, ADAPTATION
OR DISTRIBUTION.

TYPE 940X     S/N XX-XXXXX          MODEL BXX
```

Figure 2-3. AS/400 Model-Unique Licensed Internal Code Tape or Cartridge Sample Label.

2. Licensed Internal Code

   The Licensed Internal Code is shipped on IBM tape and is the file labeled QFILEMCD, located ahead of the OS/400 licensed program. Unlike the Model-Unique Licensed Internal Code, Licensed Internal Code is located on the IBM-supplied OS/400 tapes

and is the same for all models of the AS/400 system.

3. Device Configuration Objects

   The device configuration objects include:

   - Line descriptions
   - Controller descriptions
   - Device descriptions
   - Connection lists
   - System resource management objects
   - Configuration objects required for communications

4. User Profiles and Security Objects

   These are any IBM-supplied or user-created user profiles. Security objects consist of authority holders (*AUTHLR) and authorization lists (*AUTL) object types.

5. OS/400 Licensed Program (library QSYS)

   The IBM-supplied library QSYS contains the majority of operating system objects, such as files, programs, and internal objects.

6. Licensed Program Libraries

   These are installed licensed programs, such as RPG, OfficeVision, and PC Support. The majority of the licensed programs are stored in one or more of the program's libraries. RPG is stored in library QRPG; PC Support is stored in library QIWS. However, during the software installation process, objects related to licensed programs may be placed in libraries QSYS, QUSRSYS, and QGPL.

   In addition to licensed programs, there are software functions referred to as optional parts of a licensed program. These optional parts can be deleted if they are not needed.

   For example, if you do not use the OS/2 operating system and DBCS, then you can delete:

   - PC DOS-based programs
   - DBCS-(DOS)
   - OS/2 programs
   - DBCS-(OS/2)

7. QGPL and QUSRSYS Libraries

   The two IBM-supplied libraries can contain both IBM-supplied objects as well as user-created objects. QUSRSYS contains IBM-supplied journals and journal receivers, output queues, message queues, translation tables, and office objects, such as files for office enrollments and user calendars.

8. User Data

   User data is any object that you have created and placed in either an IBM-supplied library or a library you created.

9. Folders, Documents, and Distributions

   Documents and folders consist of object types *DOC (document) and *FLR (folder). Documents and folders can only be stored in the IBM-supplied library QDOC. Distribution objects are stored in library QUSRSYS.

Commands Used to Save Objects on the AS/400 System

Now that the object types that make up an AS/400 system have been identified, we can look at the save commands available for use in a backup strategy (see Figure 2-4 on page 2-14 and Figure 2-5 on page 2-15).

The intent of this information is to provide you with an overview of what the command saves and where it fits in the overall strategies.

Save Storage Command: The Save Storage (SAVSTG) command produces a tape that is a sector-by-sector copy of all permanent data stored on the disk units, including the Licensed Internal Code. The save storage operation makes an image copy of all permanent data that resides on the configured disk units on the AS/400 system.

Save System Command: The Save System (SAVSYS) command is part of a complete system save operation. It saves the Licensed Internal Code, OS/400 licensed program, configuration and system resource management objects, user profiles, and security objects, and all permanent and temporarily applied program temporary fixes (PTFs).

The SAVSYS command does not save IBM licensed programs (such as RPG, OfficeVision, or PC Support), optional parts of the OS/400 licensed program, documents or folders, libraries QGPL and QUSRSYS, or user libraries.

Save Configuration Command: The Save Configuration (SAVCFG) command is a subset of the SAVSYS command. The SAVCFG command saves all configuration and system resource management information without requiring a restricted system. SAVCFG offers an advantage in that it can eliminate the need to perform frequent save system (SAVSYS command) operations when changes are made to the configuration objects.

Because the SAVSYS command saves the same configuration data as SAVCFG, it is not necessary to run SAVCFG after a SAVSYS command. A SAVSYS operation may only be needed for a release upgrade or after applying a cumulative PTF package.

The information saved includes the following:

- Line descriptions
- Controller descriptions
- Device descriptions
- Mode descriptions
- Class-of-service descriptions
- Network interface descriptions
- Connection lists
- Configuration lists
- System resource management information
  - Hardware resource data
  - Token-ring adapter data

The information can be restored with the Restore Configuration (RSTCFG) command.

Save Security Data Command: The Save Security Data (SAVSECDTA) command is a subset of the SAVSYS command. The SAVSECDTA command saves user profiles and security objects. Information saved includes the following:

- User profiles
- Private authority to objects owned by others
- Authorization lists
- Authority holders

SAVSECDTA offers an advantage in that it can eliminate the need to perform frequent save system (SAVSYS) operations when changes are made to the security data. Since the SAVSYS command saves the same security data as SAVSECDTA, it is not necessary to run SAVSECDTA after a SAVSYS. A SAVSYS operation may only be needed for a release upgrade, after applying a cumulative PTF package.

Save Library and Save Object Commands: The SAVLIB LIB(*NONSYS), SAVLIB LIB(*ALLUSR or *IBM), SAVOBJ, or any combination of these commands, are used to save:

- IBM licensed program libraries
- All permanently and temporarily applied PTFs for licensed programs
- QGPL and QUSRSYS libraries
- Any other user-created libraries

SAVLIB LIB(*NONSYS) saves all libraries on the system in alphabetic order. SAVLIB LIB(*NONSYS) requires that the system be placed in a restricted state (all subsystems ended).

The following libraries cannot be saved with the SAVLIB command:

QSYS
QDOC
QSPL
QRPLOBJ
QTEMP
QSRV
QRECOVERY

Save Library (SAVLIB) Command: Using this command, you can save:

- SAVLIB saves from 1 to 300 libraries in the order specified on the command.
- All user libraries (including library QGPL and QUSRSYS) to diskette or tape using SAVLIB LIB(*ALLUSR). User libraries are defined as libraries that the user creates, or IBM-supplied libraries that contain user data. IBM-supplied libraries that do not contain user data are not saved. The *ALLUSR value reduces the amount of data saved because the IBM libraries are not included. For a list of the libraries that are saved when *ALLUSR is specified on the SAVLIB command, see Table 5-1 on page 5-4.
- All IBM-supplied libraries (not including libraries QGPL and QUSRSYS) to tape or diskette using SAVLIB LIB(*IBM). Only IBM-supplied libraries that contain IBM objects are saved. The *IBM value on the LIB parameter allows the user to save IBM supplied-

libraries less frequently, such as after installing a new cumulative PTF package. For a list of the libraries that are saved when *IBM is specified on the SAVLIB command, see Table 5-1 on page 5-4.

Note: You can use the OMITLIB parameter to exclude up to 300 libraries when *ALLUSR, *IBM, or *NONSYS is specified on the SAVLIB command. The default for the OMITLIB parameter is *NONE.

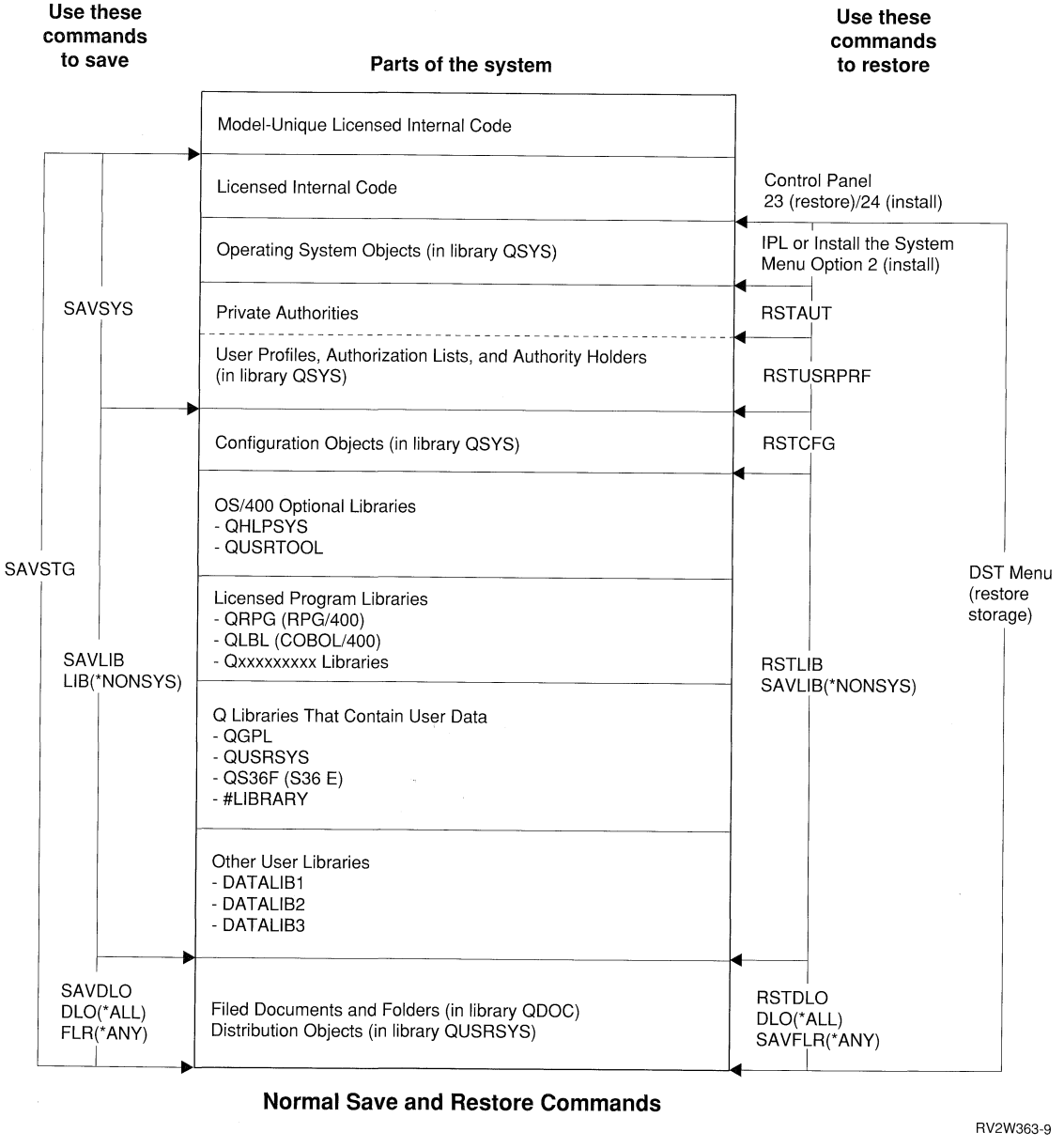


Figure 2-4. Save and Restore Commands That Can Be Used

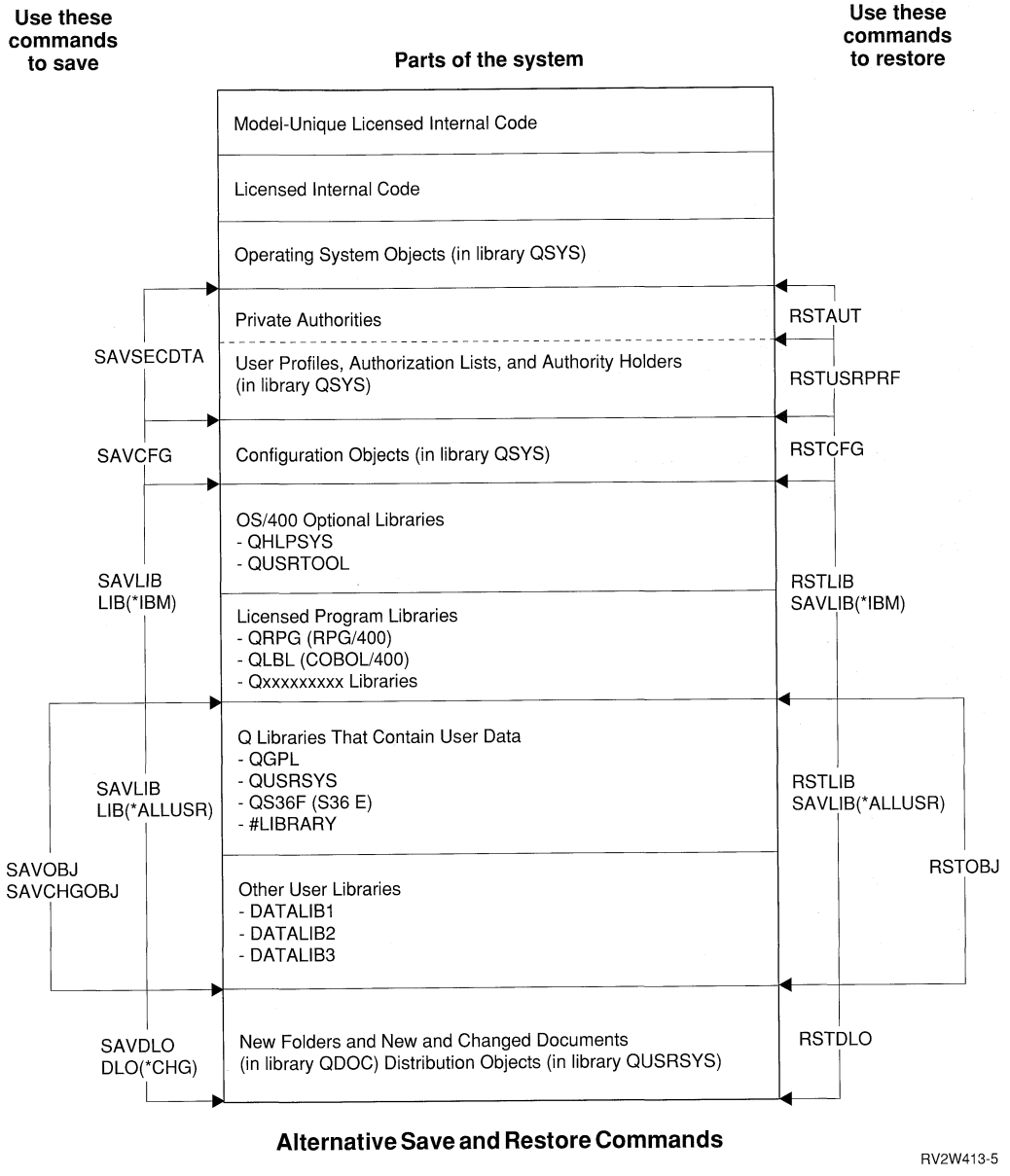


Figure 2-5. Alternative Save and Restore Commands That Can Be Used

Save Changed Object Command: The Save Changed Object (SAVCHGOBJ) command allows you to save all changed objects (except for office objects) from one or more user libraries. If the value for the LIB parameter is specified as *ALLUSR, changed objects from all user libraries are saved. User libraries are defined as libraries created by the user or any IBM-supplied library that contains user data. The *ALLUSR value allows you to save all of the changed objects (with the exception of office objects) including libraries QGPL and QUSRSYS in a single operation.

Note: You can use the OMITLIB parameter to exclude up to 300 libraries when the value *ALLUSR is specified on the SAVCHGOBJ command. The default for the OMITLIB parameter is *NONE. Do not use the SAVCHGOBJ command to save IBM licensed program libraries. For backup and recovery purposes, SAVLIB LIB(*NONSYS) or SAVLIB LIB(*IBM) is the intended method for saving IBM licensed programs.

Save Document Library Object Command:

The Save Document Library Object (SAVDLO) command saves specified documents or folders located in library QDOC and distribution documents (mail) in library QUSRSYS. The SAVDLO command does not save office user data, such as calendars and search files. These

are saved when library QUSRSYS is saved. Documents and folders that have changed since the last complete save can be saved using SAVDLO DLO(*CHG).

Failure Types and Associated Data Loss

The discussion of the recovery design process will structure a walk-through of recovery events and considerations for each of the following failure types:

- Site failure (flood, tornado, fire, and so on)
- System failure due to:
  1. Power failure
  2. Disk failure with data loss
  3. Non-disk failure (such as processing unit and OS/400 program damage)
- Object failure (program bug causes logical damage to files)

Site Failure: The failure or loss of the site can be caused by fire, flood, explosions, or sabotage. Although the possibility of such disasters is remote, recovery from these events must be planned. If you are not prepared for this type of disaster and it occurs, you may not be able to recover the information. As part of your plan, it is a good idea to keep backup tapes and critical supplies at a separate location.

System Failure: The failure of the system itself can be caused by:

- *Power failure.* This causes the system to end abnormally. Normally, an initial program load (IPL) of the system can correct these errors.
- *Disk failure with data loss.* If the disk unit cannot be recovered, the source data must be restored. If a disk unit is lost, you may have to restore the operating system, licensed programs, application programs, and user data.
- *Non-disk failures.* Most failures will not cause the system to end abnormally. If a severe hardware failure causes the system to end abnormally, the hardware must normally be repaired before the system can perform an IPL.

Object Failure: The most common type of failure is the loss of an object or group of objects, such as files, libraries, or programs.

An object can be lost or damaged due to several factors, including equipment errors, programming errors, or operator errors. Any of these occurrences can cause program processing to end abnormally. For example, if an operator selects the wrong tape, data that is not current can be loaded and cause out-of-date databases. Files will need to be brought up to date.

Questions You Should Ask About Recovery

For each type of failure, there are basic questions that need to be answered during the recovery planning process:

1. What is likely to be lost during this type of failure?
2. What is the basic sequence and extent of the recovery process?
3. How long is the recovery likely to take?
4. Are there methods that can be used to avoid the failure or reduce the recovery time?

The cost of implementing the recovery methods, the cost of the recovery time, and other dependencies are determined by your business requirements.

Site Failure

The shaded portion of Figure 2-6 on page 2-17 represents what can be lost during this type of failure.

1. What is likely to be lost during this type of failure?
   - Everything except what is stored off-site or in a vault.
2. What is the basic sequence and extent of the recovery process?
   - Restore the system from the last off-site backup copy.
   - If any recent on-site backups are valid, use them to update as possible.
   - Other transactions since last good backup must be manually entered again.

3. How long is the recovery likely to take?
   - Several days
4. Are there methods that can be used to avoid the failure or reduce the recovery time?
   - The more frequently an off-site or protected backup copy is made, the less data needs to be entered again.
   - If a dual system approach is used and the secondary system is at a location not affected by the disaster, hardware replacement can take some time but very few transactions are lost. The backup system can become the primary one in a matter of minutes or seconds.
   - It may be advisable to have an arrangement with IBM's Business Recovery Services to provide a backup system that could be used until the necessary hardware is replaced.

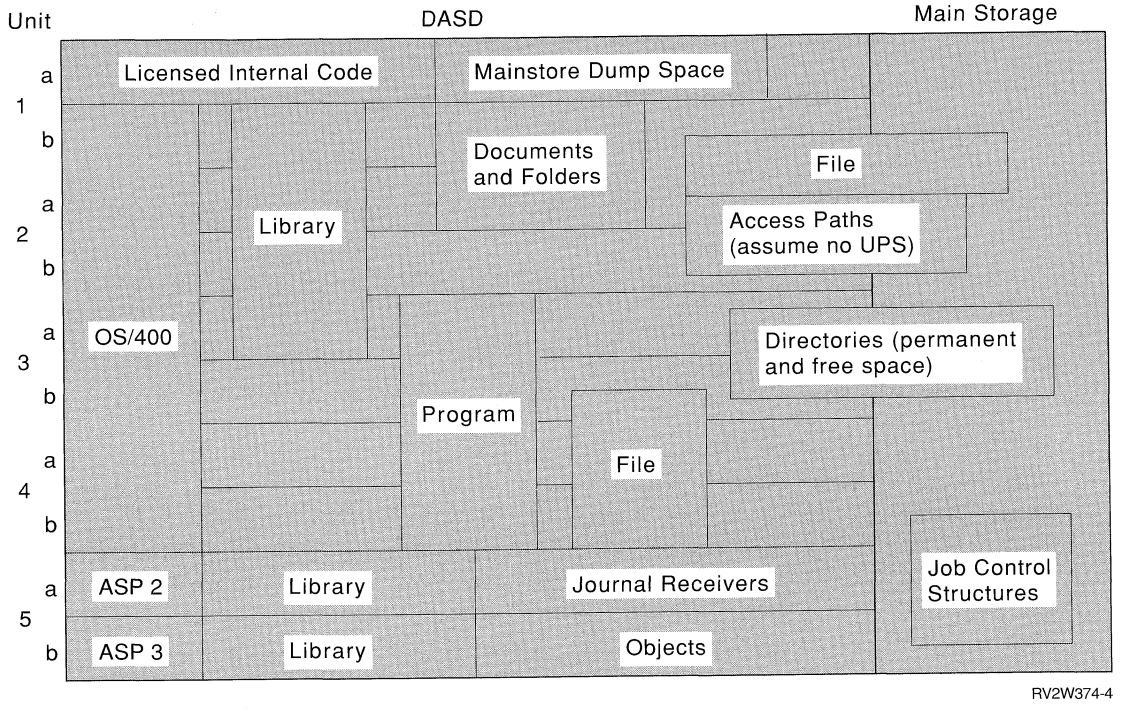


Figure 2-6. What Can Be Lost with a Site Failure

Power Failure

The shaded portion of Figure 2-7 represents what can be lost during this type of failure.

1. What is likely to be lost or damaged during this type of failure?
   - High probability of loss:
     - Access paths of files opened for update
     - Transactions in process
     - Permanent and free space directories
     - Checksum redundancy data (if used)
   - Possible damage to objects being used when the failure occurred, such as message queues and files.
2. What is the basic sequence and extent of the recovery process?
   - When power is restored, an IPL closes in-use files and initiates rebuilding of access paths as required.
   - On-line users must start applications again and enter in-process transactions again.
3. How long is the recovery likely to take?
   - Depends on the size of the system and the number and size of the access paths that must be rebuilt.
   - IPL of the system is longer if main storage was lost and checksum protection was used.
4. Are there methods that can be used to avoid the failure or reduce the recovery time?
   - Uninterruptible power supply (UPS).
   - Journaling files and access paths.
   - Commitment control.
   - If commitment control is being used, it may be used to help restart application programs at application transaction boundaries.
   - Journaling provides application restart with some user programming.

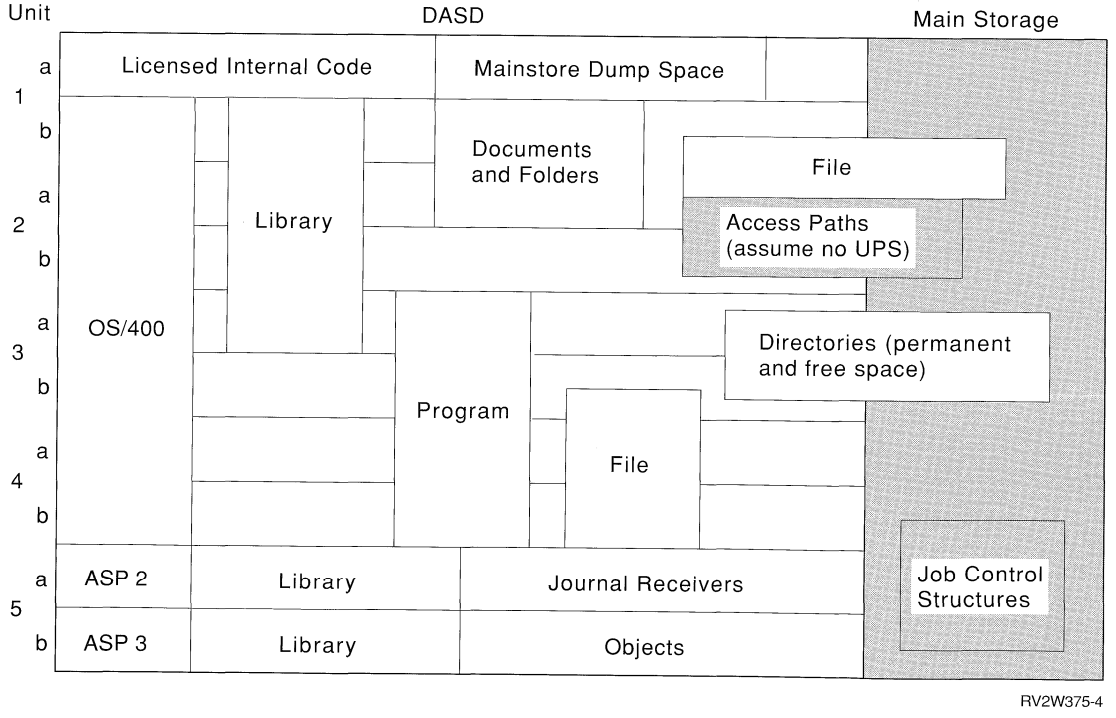


Figure 2-7. What Can Be Lost Due to a Power Failure

Disk Unit Failure (Data Loss)

The shaded portion of Figure 2-8 on page 2-20 represents what can be lost during this type of failure.

1. What is likely to be lost during this type of failure?

   One or more of the following:

   - High Probability:
     - Licensed internal code (only if unit 1 fails)
     - OS/400 licensed program
     - Security information
     - Device configuration data
     - User data (files, access paths, programs, journals, and journal receivers)
     - Current transactions
     - Documents
     - Journals and receivers

2. What is the basic sequence and extent of the recovery process?

   a. Replacing the damaged disk.

   b. Restoring the Licensed Internal Code.

   c. Restoring the OS/400 Licensed Program.

   d. Restoring user profiles, configuration objects, user libraries, documents and folders, and authority.

   e. Capturing and entering all transactions again since the last save operation.

3. How long is the recovery likely to take?

   - Hours, possibly days on a large system.

4. Are there methods that can be used to avoid the failure or reduce the recovery time?

   - Journal access paths. Checksum protection does not guarantee integrity of access paths. Rebuilding many large access paths can take longer than the checksum rebuild. It is recommended that access path journaling to user ASPs be considered with checksum protection to minimize recovery time.
   - Journaling to a user ASP. If the failing disk unit is in the system ASP containing libraries for objects in a user ASP, then the system ASP must be restored. The Reclaim Storage (RCLSTG) command must also be run to recover the objects in the user ASP.

     It is strongly recommended that the library for the journal and the files being journaled are in the same ASP. If a disk unit fails in the system ASP, the data in the user ASP is not lost. However, the Reclaim Storage (RCLSTG) command must be run to restore ownership and addressability to the objects in the user ASP.
   - Checksum protection. The entire system does not need to be reloaded. This reduces the number of transactions that must be recaptured.

     It is recommended that an uninterruptible power supply be installed when checksum protection is used. This avoids checksum validation following abnormal system ends caused by power failures.
   - Device parity protection. The system continues to run until the disk-related hardware can be repaired or replaced if the entire ASP had device parity protection.
   - Mirrored protection. The system continues to run until the disk related hardware can be repaired or replaced.
   - User ASPs. Only the data in the failed ASPs needs to be restored. Data in other ASPs does not need to be restored.
   - Dual systems. Transaction processing can continue on the backup system during the recovery. This does not eliminate the need for the recovery process on the primary system.

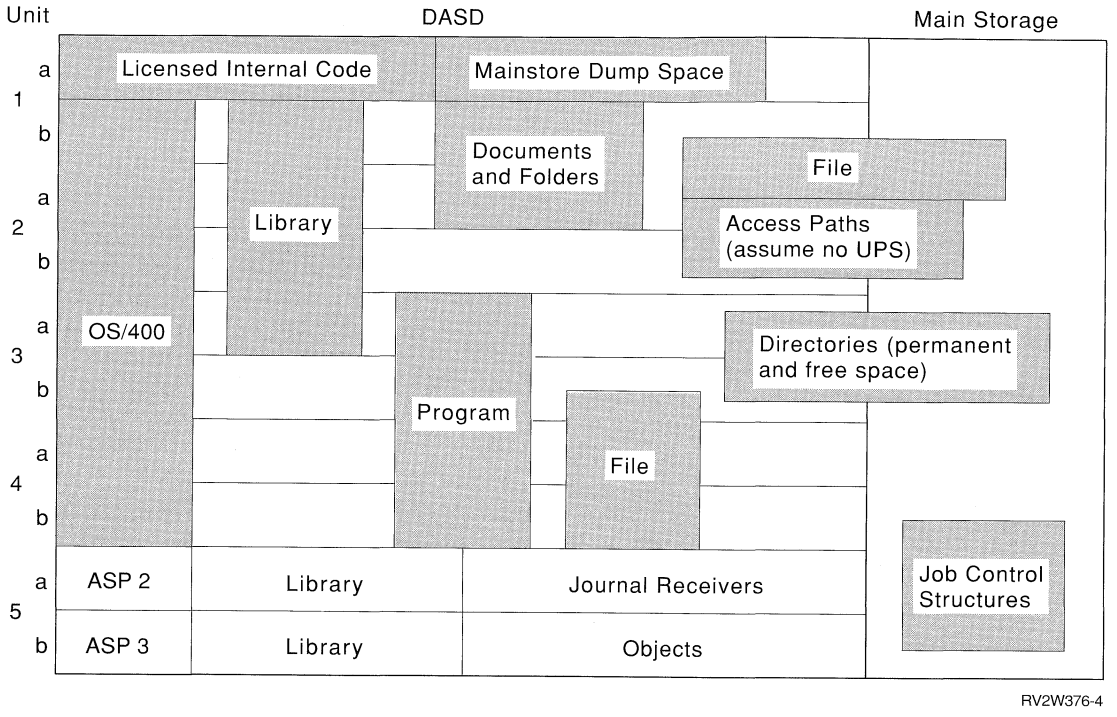


Figure 2-8. What Can Be Lost Due to a Disk Unit Failure

Non-Disk Failure

This category is intended to include a variety of failures which are quite rare, such as:

- Damage to the processing unit or memory card
- Failure of the power supply unit
- Damage to the operating system
- Operating system error

The shaded portion of Figure 2-9 represents what can be lost during this type of failure.

1. What is likely to be lost or damaged during this type of failure?
   - OS/400 licensed program
   - Damage to objects in use, such as user files or documents
   - Access paths
   - Current transactions
2. What is the basic sequence and extent of the recovery process?

   Varies with the specific nature of failure, but may include the following:
   - IPL
   - Reclaim storage operation
   - Clear job queues and output queues
   - Restore the OS/400 licensed program
   - Restore the Licensed Internal Code
3. How long is recovery likely to take?
   - A few minutes or several hours
4. Are there methods that can be used to avoid the failure or reduce the recovery time?
   - Journaling files and access paths
   - Commitment control
   - Dual systems (if damage is not concurrent to both systems)

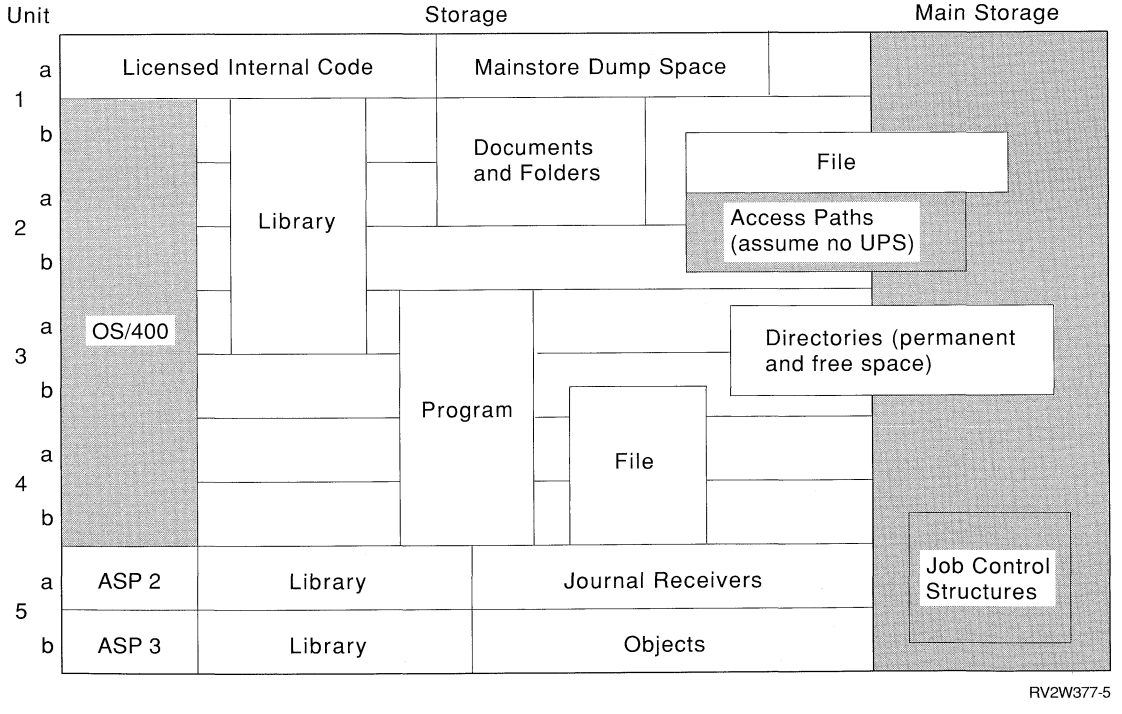


Figure 2-9. What Can Be Lost Due to a Non-Disk Related Failure

Object Failure (Program or Operator Error)

The shaded portion of Figure 2-10 represents what can be lost during this type of failure.

1. What is likely to be lost during this type of failure?
   - Data integrity
   - Access paths
   - Transactions
2. What is the basic sequence and extent of the recovery process?
   - Recover effect of program error
   - Restore the last good copy of the object, or re-create the object, and re-run transactions
3. How long is the recovery likely to take?
   - Depends on the extent of damage.
4. Are there methods that can be used to avoid the failure or reduce the recovery time?
   - Journaling for files and access paths
   - Commitment control
   - Multiple levels of backup
   - Dual systems

     In a dual system approach, the problem can be compounded if the defect has been introduced on both systems and files are not valid on both systems.
   - Procedures should be automated as much as possible.

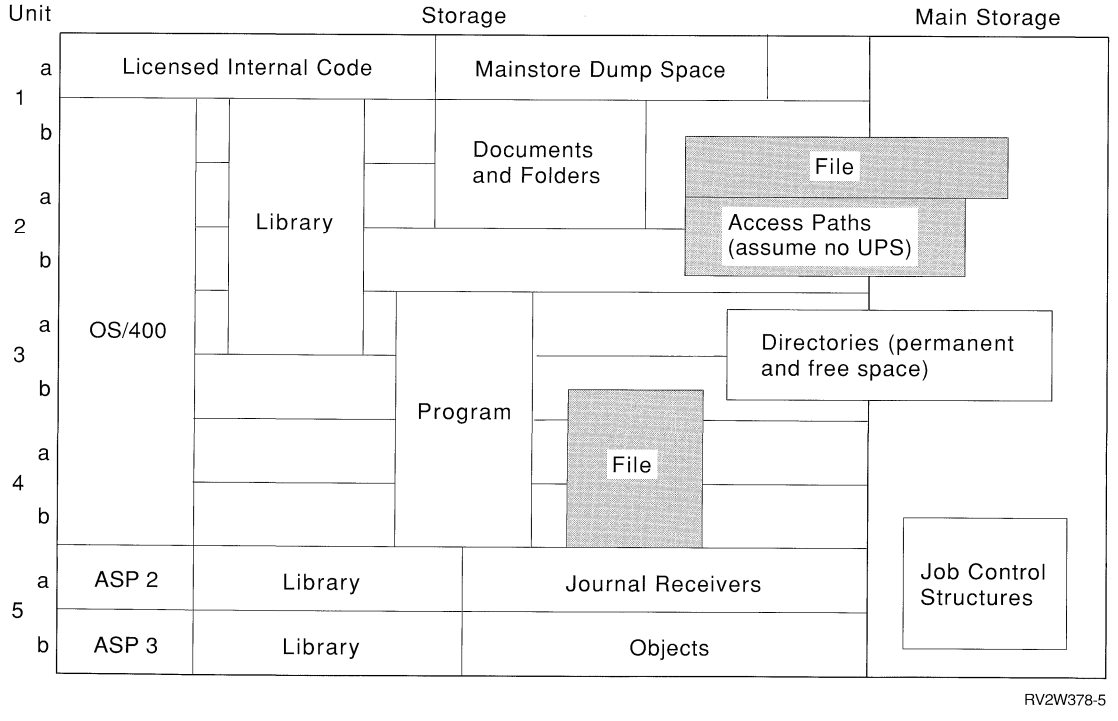


Figure 2-10. What Can Be Lost Due to Object Failure

System Availability and Recovery Strategies

System **availability** is defined as the condition where end users can access and use their applications and data. Obviously, the reliability of your equipment affects the availability of the system. The strength of your applications (how error-free they are, how they handle errors, and so on) also affects the availability of your applications. Another aspect of availability is recoverability.

Recoverability can be defined as the degree or extent to which your system can be restored to an operational condition after a system failure. It also includes ensuring that your database files are not damaged, that they can be accessed, and that they are as current as possible.

The AS/400 recovery tools help reduce the time your system is not available. Although these functions can significantly improve availability, they are not an alternative to a backup or application recovery strategy. These tools should be used in addition to backing up your system, not in place of it.

To simplify the selection of these tools, several examples are described. One may fit your specific requirements, or you may discover a different combination that fits better. Before you select any of these tools, read this manual completely.

Level 1 Availability and Recovery

This combination of save and restore recovery tools provides basic backup and recoverability. The tools include:

- Using save and restore operations
- Using an uninterruptible power supply (optional) to prevent loss of power

Using this combination, a small AS/400 system can take less than a day to recover from a failure with no disk unit failure. The time to recover from a disk unit failure may exceed one day.

If you experience frequent power outages or fluctuations, it is recommended that you install an uninterruptible power supply.

Level 2 Availability and Recovery

This combination of recovery tools provides higher system recoverability in the event of a system failure with no disk unit failure. This combination also provides a good level of recoverability, in many instances, when the system fails with disk unit failure. The tools include:

- Using save and restore operations
- Using journals to recover physical files
- Using an uninterruptible power supply (optional) to prevent loss of power

Because journaling is used, the system automatically synchronizes the database files using the journal receivers. Journaled access paths are recovered rather than rebuilt. Even if you experience a disk unit failure, your database files can be brought up to date because your receivers are isolated in user ASPs. At most, only the last transaction would have to be retyped.

If you experience frequent power outages or fluctuations, it is recommended that you install an uninterruptible power supply.

Some costs to consider with this set of tools include additional disk devices for user ASPs and possibly slower performance when journaling files and access paths.

Level 3 Availability and Recovery

This combination of recovery tools provides basic backup and job recoverability. The tools include:

- Using save and restore operations
- Using journals to recover physical files
- Using commitment control for transaction recovery
- Using an uninterruptible power supply (optional) to prevent loss of power

Using this combination, an intermediate to large AS/400 system can take less than a day to recover from a failure with no disk unit failure. The time to recover from a disk unit failure may exceed one day.

Because journaling and commitment control are used, the system automatically synchronizes

(brings up to date) the database files to a commitment boundary. However, if you experience a disk loss you may have to retype all the data and transactions entered since the last backup operation.

If you experience frequent power outages or fluctuations, it is recommended that you install an uninterruptible power supply.

With this set of tools, consider the additional cost if performance is slower when journaling files.

Level 4 Availability and Recovery

This combination of recovery tools provides the highest availability for a single AS/400 system. The tools include:

- Using save and restore operations
- Using journals to recover physical files
- Using commitment control for transaction recovery
- Using journals to recover access paths
- Using user ASPs to limit data loss and to speed recovery
- Using an uninterruptible power supply to prevent loss of power
- Using one of the following:
  - Checksum protection to protect the ASPs
  - Device parity protection to protect all user ASPs
  - Mirrored protection to protect all ASPs
  - Mirrored protection and device parity protection to protect the system ASP

Because journaling and commitment control are used, the system automatically synchronizes the database files to the last transaction boundary. Even if you experience a disk unit failure, the contents of the lost disk unit is reconstructed by checksum protection or device parity protection. If you are using mirrored protection and experience a disk failure, no data is lost and the system continues to run.

Some costs to consider with this set of tools include:

- The cost of additional resources that may be necessary for checksum or mirrored protection:
  - Disk
  - Main storage
  - Processing unit speed
- The cost of an uninterruptible power supply.

Level 5 Availability and Recovery

This combination of recovery tools provides the highest availability for the AS/400 system and a second system. This combination assumes you have a second system backing up your primary system. The tools include:

- Using two systems
- Using save and restore operations
- Using journals to recover physical files
- Using commitment control for transaction recovery
- Using journals to recover access paths (optional)
- Using user ASPs to limit data loss and to speed recovery
- Using an uninterruptible power supply to prevent loss of power
- Using one of the following (optional):
  - Checksum protection to protect the ASPs
  - Device parity protection to protect all user ASPs
  - Mirrored protection to protect all ASPs
  - Mirrored protection and device parity protection to protect the system ASP

The database on the backup system may not reflect current information on the primary system. For example, if you are updating the backup system for every transaction, then the backup system data could be one transaction behind the primary system.

Some costs to consider with this set of tools include:

- The cost of the backup system. This cost can be offset to some extent by using the backup system for other applications.
- The cost of connection between the primary and backup systems.
- The cost of an uninterruptible power supply.

- The cost of additional resources that may be needed for checksum or mirrored protection.

Strategies Summary

Table 2-1 summarizes these recovery tools. An X indicates the tool is used; an O indicates it is optional.

Table 2-1. Summary of Strategies

Recovery Tool	Level 2	Level 3	Level 4 (Single System)	Level 5 (Dual System)
Save and restore	X	X	X	X
Uninterruptible power supply	O	O	X	X
Journal files	X	X	X	X
Commitment control	X	X	X	X
Journal access path		X	X	O
User ASPs		X	X	X
Checksum protection			X	O
Device parity protection			X	O
Mirrored protection			X	O
Two systems				X

Table 2-2 illustrates estimated recovery time and whether or not the data is current for the specified recovery tools.

Table 2-2. Estimated Recovery Time and Current Data for Recovery Tools

Recovery Time/Current Data	Level 2	Level 3	Level 4 (Single System)	Level 5 (Dual System)
Estimated recovery:				
No disk loss	Long	Medium	Medium	Short
Disk loss	Long	Long	Medium	Short
Is data current for:				
No disk loss	Yes	Yes	Yes	Yes
Disk loss	No	Yes	Yes	Yes

Note: With mirrored protection, there is no data loss. The system continues to run.

Backup and Recovery Summary

Table 2-3 on page 2-26 illustrates the benefits and limitations of each of the backup and recovery functions. Carefully examine each of these functions to determine the best protection for you.

Note: There are generally two types of disk device failures. The most common type involves no data loss. For example, a cable may be damaged. The second type of disk device failure involves media failure where data loss occurs. For the latter type of disk device failure, checksum protection, mirrored protection, device parity protection, and user auxiliary storage pools provide you with improved protection from the failure.

Table 2-3. Benefits and Limitations of Optional Disk Recovery Functions

Function	Benefits	Limitations
Journaling Files	• Reduces the frequency and amount of data saved when used in conjunction with user ASPs.	• Increase in storage requirements. • May impact performance due to increased I/O and processing unit activity.
Access Path Journaling	• Avoids rebuilding access paths after most abnormal system ends. • Successful even if main storage cannot be copied to storage unit 1 of the system ASP during an abnormal system end. • Generally faster and more dependable.	• Same limitations as journaling files, in addition to: • Normally requires a significant increase in the storage requirements for journaling files. The additional processing time is normally minor.
Auxiliary Storage Pools	• Reduces amount of data loss if a disk unit failure occurs. • Libraries can be placed in user ASPs. This allows for separation of critical or highly used objects. • Performance improvement. If you do extensive journaling, you can place a journal receiver in a user ASP that can be used exclusively for journaling. • Can significantly reduce the number of transactions lost since you last saved the system. ASPs allow you to separate your files and journals receivers; your files can be placed in the system ASP or a user ASP and your journal receivers in another user ASP, reducing the chances that both will be lost.	• System cannot directly recover lost data from a disk unit media failure; requires operations by user to recover. • You must place libraries or objects in a user ASP with a parameter on the create or restore command. • Can require additional disk devices. • System must clear system ASP during the initial configuration unless you install new disk devices.
Checksum Protection	• Lost data is automatically reconstructed after a disk failure in the ASP. • Reduces the number of objects that are damaged.	• Requires additional processing unit resources. • Requires additional main storage. • Can require additional disk devices to prevent slower performance.
Device parity protection	• Lost data is automatically reconstructed by the disk controller after a disk failure in the ASP. • Reduces the number of objects that are damaged.	• Can require additional disk devices to prevent slower performance.
Mirrored Protection	• System continues to operate with disk unit failures. • On the 9406 system unit, most failed disk units can be replaced while the system continues to run.	• Requires additional disk units.

Chapter 3. System Save Strategies

A save strategy is the plan you put in place to save your data. The methods you choose to use in your plan can vary depending on your business requirements. This topic discusses several approaches to save strategies and the methods used for each approach.

Complete System Save Strategy: A complete system save strategy is one that ends up saving all possible data on the system over a set period of time. A complete system save strategy can be done in two ways: saving the entire system daily or saving the system in parts. When you save the system in parts, some objects are only saved weekly, monthly, or more.

You can use several approaches:

- Basic Strategy
  - Method 1. Save Storage
  - Method 2. SAVSYS, SAVLIB LIB(*NONSYS) and SAVDLO

  See "Basic Save Strategies" for more information about these methods.
- Complex Approach
  - After install–complete save
  - Quarterly–SAVSYS, SAVLIB LIB(*IBM) and LIB(*ALLUSR), and SAVDLO DLO(*ALL) FLR(*ANY)
  - Weekly–SAVLIB LIB(*ALLUSR), SAVCFG, SAVSECDTA, and SAVDLO DLO(*ALL) FLR(*ANY)
  - Daily–save changed objects (SAVCHGOBJ and SAVDLO DLO(*CHG))

    See "A More Complete Method for Saving the Entire System" on page 3-4 for more information about this method.

Incomplete System Saves: An incomplete system save strategy is one that does not save the licensed internal code, IBM software, configuration data, or distribution objects. It may or may not save user profiles, security objects, QUSRSYS and QGPL, office data, folders and documents, and user data.

Note: The save-while-active function can be used with the complete system save strategy or the incomplete save strategy. The save-while-active function allows you to perform a save operation when there are active jobs making changes to the objects being saved. However, it should be used when system activity is low.

The *Advanced Backup and Recovery Guide* has more information about special considerations when using the save-while-active function.

Basic Save Strategies

The following topics discuss basic save strategies. The two methods save all the data on the system.

Method 1. Save Storage

A basic save method on the AS/400 system would be a **daily** save storage (SAVSTG command) operation as shown in Figure 3-1 on page 3-2. By design, saving storage is an efficient way of saving data from disk to tape. For systems with smaller amounts of disk space, saving storage is the fastest way of backing up the entire system. In all cases, saving storage is the simplest method.

The save storage operation has a disadvantage because it does not allow for restoring of individual objects or libraries, such as the recovery of a data file due to programmer or system operator error. Because most data files are changed frequently, you should have copies of the files on one of the daily save operation media to allow for the restoring of individual objects.

- Advantages
  - Simple, one command saves all
  - Usually fast for small system
- Disadvantages
  - Cannot restore individual objects
  - Requires IPL after complete save
  - Requires a restricted system
  - Cannot restore to a different configuration

- Must use the previous save storage media if a media error occurs on the current save storage media.

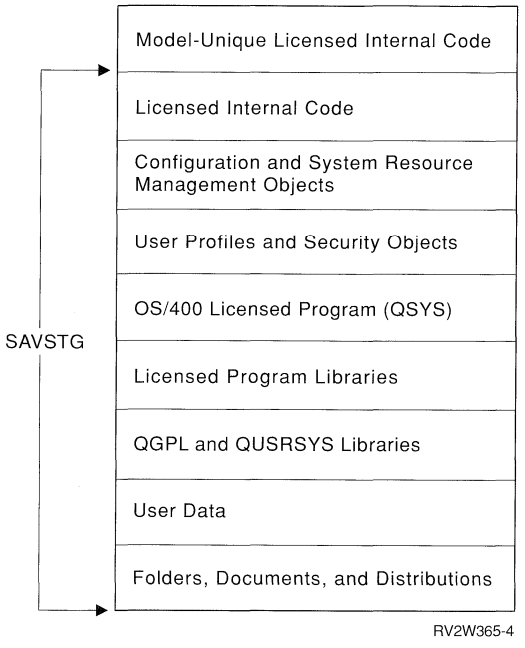


Figure 3-1. Save Storage

The basic steps used for disaster recovery using the SAVSTG media are:

1. Restore the licensed internal code from the SAVSTG media.
2. Restore the model-unique licensed internal code from the tape provided in the service kit (if prompted).
3. Restore the operating system, other licensed programs, and user libraries using the SAVSTG media.

If you must recover a file, program, or document that has not changed for several months, you will probably need to use the media from the last complete save operation. Therefore, an infrequent (quarterly) complete save operation should be done using method 2 commands to allow for recovery of objects that have not changed. If you have objects that change frequently, you should use method 2 monthly or weekly, or consider saving frequently changed objects daily.

Recovery of the licensed internal code must also be considered. In some situations where damage occurs, it may be necessary to restore the licensed internal code. This can be done by using the save storage media.

The recovery of optional IBM licensed programs, such as the RPG/400* program, must also be performed in certain damage situations. These licensed programs are in libraries that have names beginning with Q, such as QRPG. A typical solution is to back up these libraries as part of the periodic save operation.

It is recommended that the latest program temporary fix (PTF) package be applied before performing the complete save operation using the other save commands.

Providing for Object Recovery: To provide for the recovery of an individual object, run an accumulative daily save operation (SAVCHGOBJ and SAVDLO commands) just before running the SAVSTG command. If you need to recover a specific object from the previous cycle, use the last daily save operation media.

Doing daily save operations just before running the Save Storage command allows for maximum object recovery even if the complete save operation media cannot be used.

The daily save media, used along with the save storage media, allows recovery in case the current complete save media cannot be used. If you need to recover from a disaster, you would normally use the save storage media from that week and then use the daily save operation media. If the save storage media from that week cannot be used, you would:

1. Restore the save storage media from the previous week.
2. Restore the daily save media from the current week.

Notice that when the restore operation of the save storage media occurs, the system is brought back to the point of the save storage operation of the previous week. This includes spooled files, messages, and so on, which cannot be saved with the other save commands.

If journaling is used, there are some additional considerations. It is important to note that even if you are not journaling objects, the system may be journaling for particular system functions and the recovery may involve applying journal entries from several receivers. This is true if you are using

Office functions, PC Support, or SNA distribution services. Normally, you would want to detach the journal receiver using the CHGJRN command before saving it to the media. Restoring a journal receiver from the save media that was attached at the time of the save operation marks the restored copy as PARTIAL. The *Advanced Backup and Recovery Guide* has information about limitations when using journal receivers with a status of PARTIAL. After the journal receiver is detached from the journal and saved to the media, it can be deleted from the system.

In the save storage approach for daily save operations, the default for the Save Changed Objects (SAVCHGOBJ) command is that the files being journaled are not saved. The files are not saved until the complete save operation is done (quarterly) using other save commands. The quarterly save operation may be too infrequent. After restoring from a quarterly save media, you may need to apply journal entries from several journal receivers. Therefore, you may want to ensure that the files being journaled are saved more frequently.

Method 2. SAVSYS, SAVLIB LIB(*NONSYS) and SAVDLO

Systems with large amounts of data to be saved may not find the basic save Method 1 adequate for their recovery requirements. (See Figure 3-2 on page 3-4.) Method 2 saves all the data on the system, except the Model-Unique Licensed Internal Code. For this method, use these commands monthly or weekly: SAVSYS, SAVLIB LIB(*NONSYS), and SAVDLO. Use these commands daily: SAVCHGOBJ and SAVDLO DLO(*CHG). This method creates a base starting point for recovery.

- Advantages
  - Can restore an individual object
  - An IPL is not required
- Disadvantages
  - Requires a restricted system
  - Slower than the save storage method

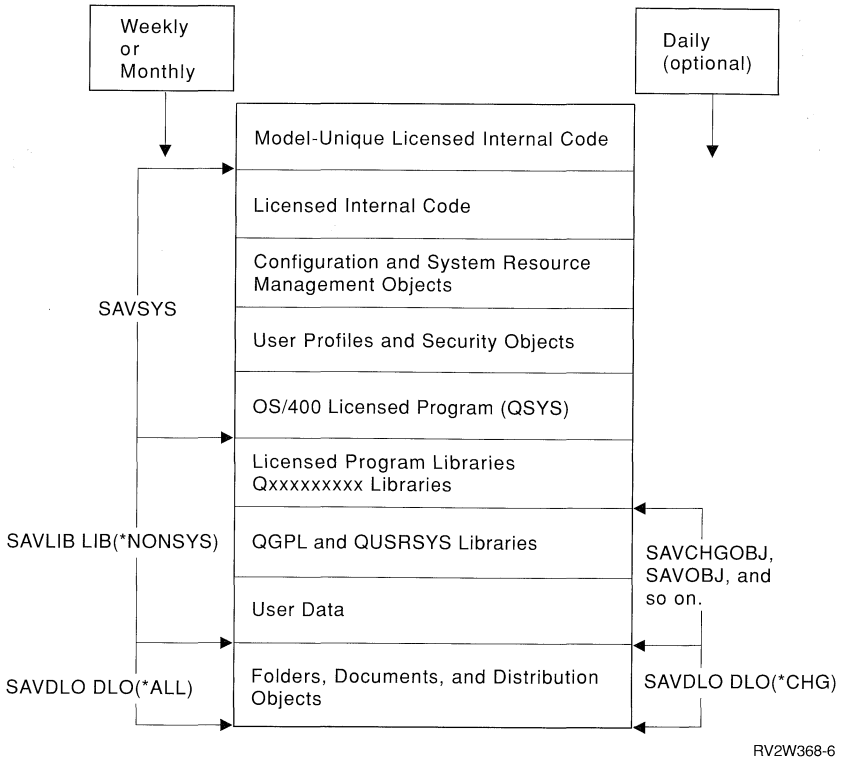


Figure 3-2. Basic Save Method 2

The basic recovery steps are:

1. Restore the Licensed Internal Code from the SAVSYS media.
2. Restore the Model-Unique Licensed Internal Code from the tape provided with the system, if necessary.
3. Restore the OS/400 licensed program from the SAVSYS media.
4. Restore the user profiles from the current SAVSYS media.
5. Restore the configuration objects and system resource management information (the RSTCFG command) from the SAVSYS.
6. Restore all user libraries (RSTLIB SAVLIB(*NONSYS)) from the last SAVLIB LIB(*NONSYS) media.
7. Restore the SAVDLO DLO(*ALL) FLR(*ANY) media.
8. Restore user authority (RSTAUT).

A More Complete Method for Saving the Entire System

A more complex, complete system save method (see Figure 3-3 on page 3-5) is very similar to the previous basic methods. The only difference is the greatly expanded time between a complete save and the more frequent daily and weekly saves.

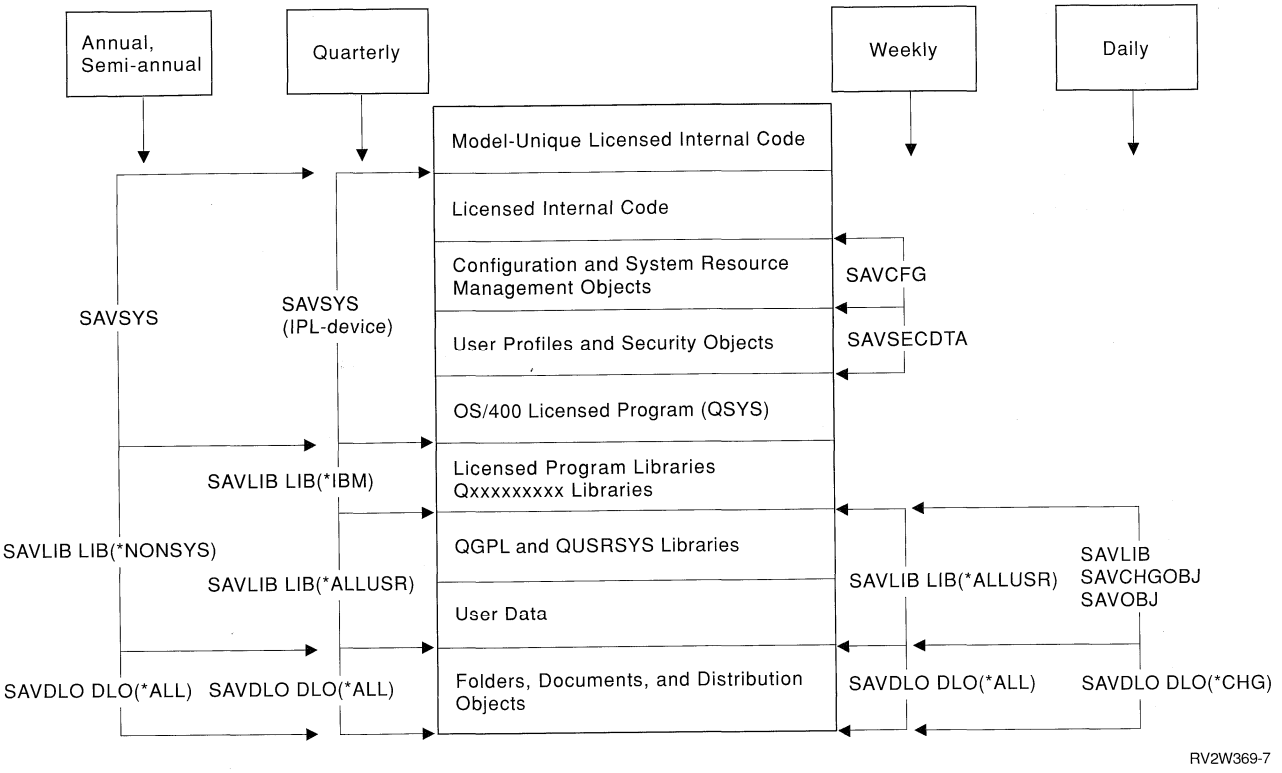


Figure 3-3. Complex Save Method

Once the starting point has been established, periodic save operations of changed and new data are done using the following commands:

- Save Library (SAVLIB)
- Save Configuration (SAVCFG)
- Save Object (SAVOBJ)
- Save Changed Object (SAVCHGOBJ)
- Save Document Library Objects (SAVDLO)
- Save Security Data (SAVSECDTA)

If you must recover by restoring the entire system, restore the base save media onto the the system and bring it up to date. To bring the base save media up to date, restore the more recent save media of changed and new objects.

Notes:

1. The system must be in a restricted state to ensure a complete save of all libraries.
2. Generally, objects that are in use in a library are not saved. The library should be saved at a later time when the objects are not being used.

Only one of the basic save methods needs to be performed after a new AS/400 system is installed or upgraded to a new release. When IBM licensed program libraries are updated, the data can be saved using the SAVSYS and SAVLIB LIB(*IBM) commands. This is necessary after a program temporary fix (PTF) package is installed and is usually done on a quarterly basis. All user data should be saved on a weekly basis using SAVLIB LIB(*ALLUSR), SAVSECDTA, SAVCFG, and SAVDLO DLO(*ALL). Daily changes can be saved using the SAVCHGOBJ, and SAVDLO DLO(*CHG) commands. If your configuration objects change, run the SAVCFG command.

- Advantages
  - Shorter backup time
  - Less data is saved, allowing for unattended backup
  - A restricted system is not required for daily and weekly save operations
- Disadvantages
  - Complex recovery procedures

The basic recovery steps are as follows:

1. Restore the Licensed Internal Code from the SAVSYS media.
2. Restore the Model-Unique Licensed Internal Code from the tape provided with the system, if necessary.
3. Restore the OS/400 licensed program from the SAVSYS media.
4. Restore the user profiles (RSTUSRPRF command) from the most current SAVSYS or SAVSECDTA media.
5. Restore the configuration objects and system resource management information (RSTCFG command) from the most current SAVSYS or SAVCFG media.
6. Restore all IBM libraries (RSTLIB SAVLIB LIB(*IBM)) from the last SAVLIB LIB(*IBM) media.
7. Restore all user libraries (RSTLIB SAVLIB LIB(*ALLUSR)) from the last SAVLIB LIB(*ALLUSR) media.
8. Restore all documents and folders (RSTDLO DLO(*ALL)) from the SAVDLO DLO(*ALL) media.
9. Restore the last saved changes from the SAVCHGOBJ and the daily SAVDLO DLO(*CHG) media.
10. Restore user authority (RSTAUT command).
11. If the save-while-active function was used, perform any restore recovery procedures that are needed. The *Advanced Backup and Recovery Guide* has more information about recovery using the save-while-active media.

In addition to these steps, there are several conditions that need to be handled manually.

- Programs that adopt the owner's authority can be restored. However, the user performing the restore operation must be the owner of the program, or have all object (*ALLOBJ) special authority (for example, QSECOFR). If not, the program is restored, all private authorities are revoked, and only the owner can run the program. For this reason, it is recommended that the restore operation be performed using the QSECOFR user profile.
- When a physical file is saved, you can request that the access paths for the dependent logical files be saved by specifying ACCPTH(*YES) on the save command; the access paths are saved with the physical file.

  If the access path for a logical file is saved with the physical file, the access path is automatically restored when **all** of the following conditions that apply for the logical file for in Table 3-1 on page 3-7 are true at restore time:

Table 3-1. Saving and Restoring Access Paths

Save	**Restore**
Access paths are saved if **all** of the following are true: • ACCPTH(*YES) is specified on the save command. • All based-on physical files under the logical file are in the same library and are being saved at the same time on the same save command. • The logical file is MAINT(*IMMED) or MAINT(*DLY). **Other Considerations** If the based-on physical files and the logical files are in different libraries, the access path is saved.	Access paths are restored if **all** of the following are true: • ACCPTH(*YES) was specified on the save command. • All based-on physical files under the logical file are in the same library and are being restored at the same time on the same restore command. • The logical file has not been changed to MAINT(*REBLD) since the save operation. • The logical file owned the access path at the time of the save operation. • If the logical file is created again by the restore operation, the key length for the access path must be equal to the maximum key length of the logical file. **Other Considerations** If the based-on physical files and the logical file are in different libraries and the logical file or physical files do not exist at restore time, (file was deleted or the system re-installed) the access paths are not restored. They are rebuilt.

If the physical and dependent logical files exist in different libraries, the following occurs:

  - If the based-on physical file is restored first, then the logical file can be restored. The system may start rebuilding the access paths. If you restore the physical file again, the access path is restored because the logical file now exists.
  - If an attempt is made to restore the logical file first, the request fails because the logical file is dependent on the physical file that has not yet been restored.

- The journals must be restored before the files being journaled. If they are not, journaling is not started for the files.

  If the journal is in the same library as the objects being journaled, then the system restores the journal first. If the journal is in a different library, you must restore it before you restore the objects being journaled.

- If you are using the save-while-active function, then restore recovery may need to be performed after objects from the save-while-active media are restored.

  Recovery procedures vary, depending on the application environments. Journal and commitment control environments require procedures different than those required for a system operating with an unprotected database. The *Advanced Backup and Recovery Guide* has more information about the save-while-active function.

Library QSYS (OS/400) and licensed program libraries do not change very often. Generally, library QSYS is updated only when changes or additions have occurred to: user profile and security information, configuration data, or when there has been a release upgrade or program temporary fix (PTF) activity. Licensed program libraries (such as QRPG and QIWS) generally change only when a release upgrade or PTF activity has occurred.

Because you can control when a new release is installed or when PTFs are applied, you can determine how often you completely save the system. What is important is how well you have planned. For example, a release upgrade is a fairly easy activity to plan for and work around. Installing a PTF cumulative package is a major activity. Because a PTF cumulative tape tends to affect more than the licensed programs, it is best to save the IBM libraries using SAVSYS or SAVLIB LIB(*IBM) after the package has been installed. This offers two benefits:

1. Your backup media will already be at the proper PTF level. This will eliminate the need to install the cumulative PTF package again in the event a full system recovery is required.
2. If you have to restore an individual object from your backup media, it will be at the proper level and match other objects already on your system.

Minor PTF activity is installing individual PTFs that are available in between the cumulative packages and offers a fix or an enhancement you need. How minor PTF activity affects your save strategy depends on how well you have planned and written your save strategy. By maintaining an accurate log of save activity and PTF activity, you may decide not to save the entire system when a single PTF fix has been applied. Instead, your save media and PTF log will tell you what PTFs are not contained in the set of save tapes and must be re-applied. Again, the important part is to fully plan for and write down your save and restore strategy.

A Limited Method for Saving Only Certain Parts of the System

A limited, incomplete system save method is one that periodically saves user profiles and security objects, QUSRSYS and QGPL, and all user data (programs, files, and so forth). It may or may not include a method of saving configuration and system resource management information (SAVCFG command). All user data can be saved using SAVLIB LIB(*ALLUSR), SAVSECDTA, and SAVDLO commands.

Note: This method allows you to perform save operations while the system is in a non-restricted state. If you are saving objects while the system is in a non-restricted state, any object that is in use at the time of the save operation will not be saved. After the save operation is complete, you need to identify and save those objects that were not saved. For example, any object associated with the QSNADS environment is not saved if QSNADS is active at the time of the save.

Because the method shown in Figure 3-4 does not save IBM software, program temporary fixes (PTFs) are not saved. In the event the entire system must be restored, IBM-supplied software must be installed again, just as if it were a new system. All PTFs must be applied again. If the Save Security Data (SAVSECDTA) command is not used, user-created user profiles will have to be created and authority granted again as necessary. This save strategy is sufficient as long as you anticipate longer recovery times and are willing to accept them.

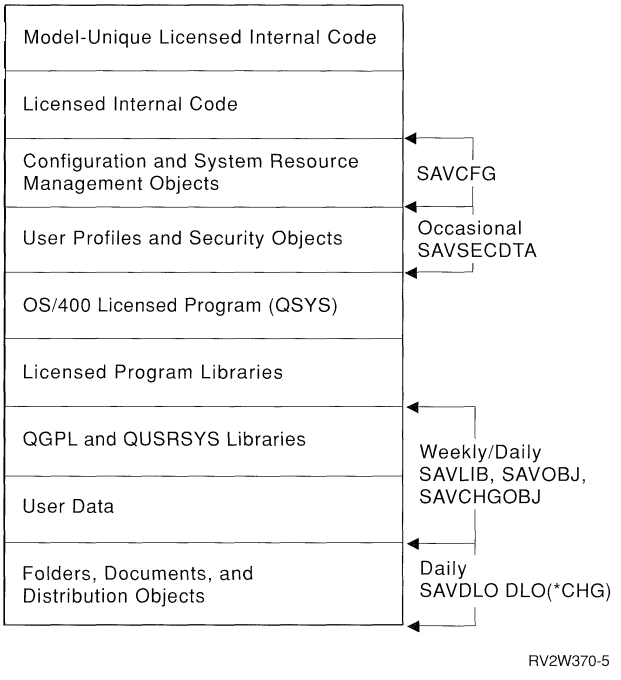


Figure 3-4. Incomplete Save Method

The basic recovery steps are:

1. Install the licensed internal code from the IBM distribution tape.
2. Install OS/400 licensed program, IBM-supplied libraries (QGPL and QUSRSYS), and IBM licensed programs from the distribution tape. Use the instructions "Installing a New Release of AS/400 Without the Operating System Installed" in the *Licensed Programs and New Release Installation Guide*, SC41-9878. This step includes installing the latest cumulative PTF package.
3. Restore the user profiles from the most current SAVSECDTA media, or re-create the user profiles if no save operation was done.
4. Restore the configuration and system resource management information from the most current SAVCFG media or recreate configuration information if a SAVCFG operations was not run.

5. Restore all user libraries from the last SAVLIB LIB(*ALLUSR) media.
6. Restore all documents and folders from the last SAVDLO DLO(*ALL) media.
7. Restore private authorities using the RSTAUT command if a RSTUSRPRF command was run, or manually grant desired authorities using the EDTOBJAUT command.

Summary of Save Strategies

Table 3-2. Summary of Save Strategies

TYPE	COST	BENEFIT
BASIC Method 1	• No partial recovery. • No individual object recovery.	• Fast save and recovery. • Very simple to use.
BASIC Method 2	• More complex than BASIC method 1. • Multiple commands.	• Individual object recovery. • Flexibility. • Partial recovery.
COMPLEX	• Extra planning required. • Operator training. • More complex recovery. • Multiple commands. • CL programming.	• Medium to fast save and recovery. • Individual object recovery. • Partial recovery. • Flexibility.
INCOMPLETE	• Long recovery. • Requires manual recovery and rebuild. • Limited individual object recovery. • PTFs are lost.	• Fast save (user data only).

The *Advanced Backup and Recovery Guide* has more information about using the save-while-active function in your save strategy.

Save Strategies for Office Data

The purpose of this topic is to provide save strategies for office data. If you are not using OfficeVision/400 or documents and folders, you do not need to read this topic.

A complete save operation of office services data means all objects on the system used by office services are saved to off-line storage.

Saving office services data daily means saving only those objects used by office services that have been changed or created since the last complete save. These objects are saved to an off-line storage media. You should use a **cumulative save changed data** strategy for daily save operations. All office services objects changed since the last complete save operation are saved during each daily save operation. This strategy makes restoring your entire system in the event of a disaster (fire, flood, power outage, and so on) much easier.

You choose the frequency for both save operations. You should do a complete save operation of office services data once a week, in addition to a daily save operation of office services data. You can adjust this schedule to fit your system activity level. Do not allow too much time between complete save operations, because outdated complete save data makes it more difficult to restore your entire system.

Complete Save Operation

The specific types of objects saved during a complete save operation of office services data include office database files, the office services journal (QAOSDIAJRN), journal receivers, distribution objects, documents, and folders. Figure 3-5 on page 3-10 illustrates a complete save operation.

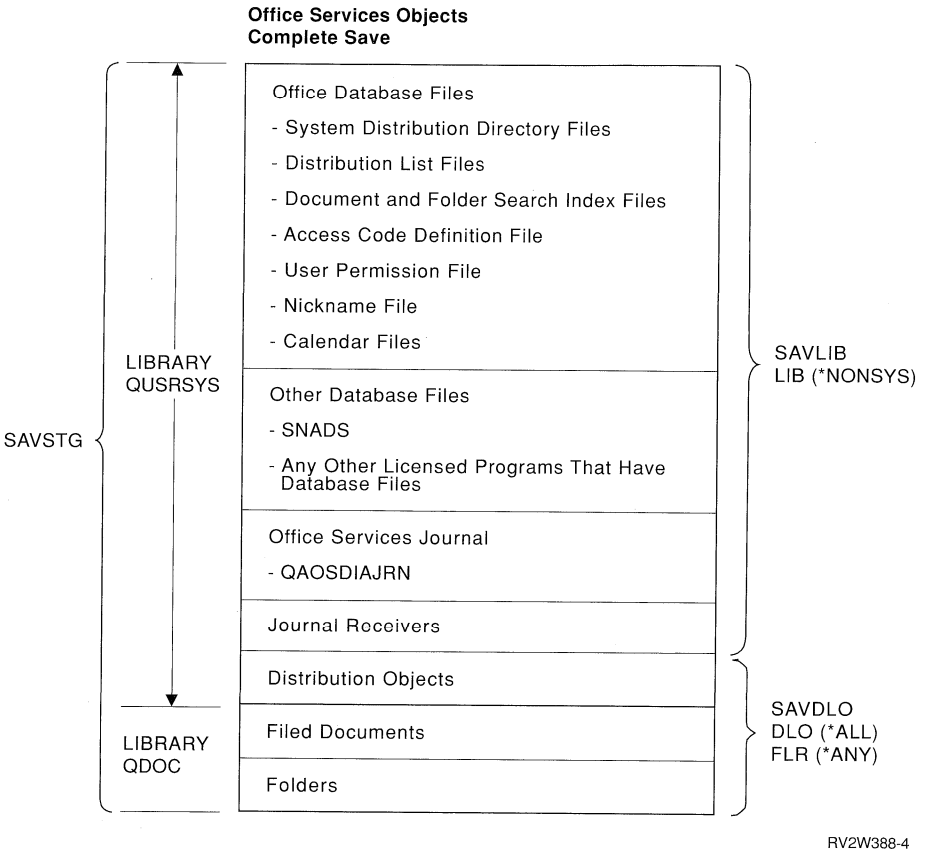


Figure 3-5. Complete Save of Office Services Objects

There are two methods that can be used for a complete save:

Method 1: The Save Storage (SAVSTG) command only. The SAVSTG command saves all licensed internal code and all disk unit data to tape. All office services data is included when saving storage is done. This command is intended for disaster recovery. Individual objects cannot be restored from the SAVSTG tapes.

Method 2: A combination of the Save Library (SAVLIB), and Save Document Library Object (SAVDLO) commands. The SAVLIB commands save data in addition to office services data. The following commands ensure office services data is saved:

1. SAVLIB LIB(*NONSYS)

   The *NONSYS option results in the save of the entire QUSRSYS library. The office services data saved by saving library QUSRSYS includes:

   - The database files for directory, distribution, document library, and calendar services.
   - The office services journal (QAOSDIAJRN)
   - Journal receivers

2. SAVDLO DLO(*ALL) FLR(*ANY)

   Saves all filed documents in QDOC library, all folders, and all distributions in library QUSRSYS. Some of the filed documents (those filed off the mail log) and all of the distributions that are saved are a part of mail. See Figure 3-6 for an illustration of the structure of saved mail.

   You do not have to stop all office activity when running this command. However, if you run the SAVDLO command while there is office activity, the system may not save some documents and folders unless the save-while-active function is specified on the SAVDLO command. Check your job log after running the SAVDLO command. The job log shows the documents or folders that were not saved. Documents and folders that were being used at the time of the save operation are not saved. Save these documents and folders separately.

   Note: Do not run this command when your system is at peak activity.

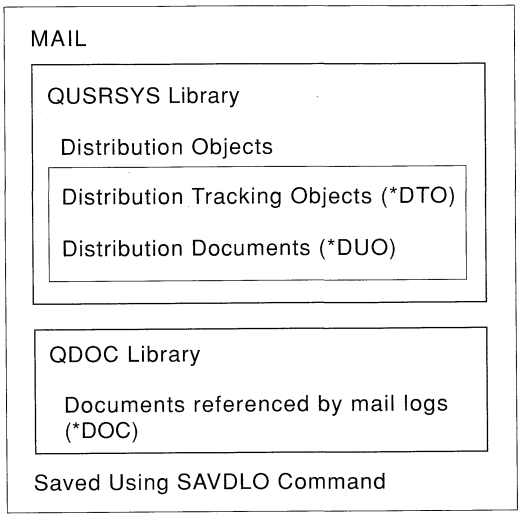


Figure 3-6. Saving Mail

Daily Save Operations

Object types saved with a daily save operation of office services data are the same as those saved with a complete save operation. However, the daily save operation provides you with the latest changes to objects on the system. It is important for disaster recovery to restore the latest version of an object.

Note: A daily save operation saves only the office services data that has changed or was created since the last complete save operation. It does not save all the office services data currently on the system.

When using the SAVDLO command, distributions and all documents associated with distributions are saved. You are saving a record of the state of the mail on your system at the time of the save operation.

The SAVCHGOBJ command saves data in addition to office services data. For a description of the data (not used by office) saved by SAVCHGOBJ, see the descriptions of these commands in this guide.

Figure 3-7 on page 3-12 shows the objects saved by a daily save.

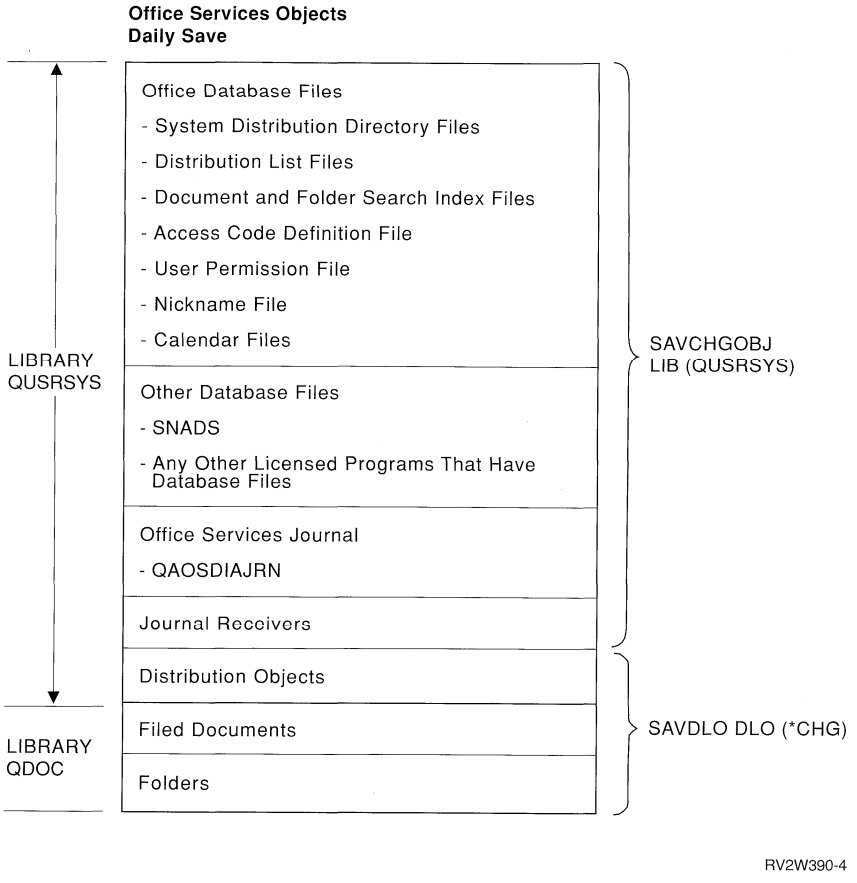


Figure 3-7. Daily Save of Office Services Objects

Commands to Use When Performing a Daily Save Operation: The set of commands used for daily save operations is as follows:

1. SAVCHGOBJ OBJ(*ALL) LIB(QUSRSYS) OBJJRN(*YES)

   The office services data saved by the SAVCHGOBJ command includes all changes that have occurred since the last complete save of library QUSRSYS.

   Note: Because office database files are journaled, specify OBJJRN(*YES). This simplifies the recovery procedures and avoids applying journal changes.

2. SAVDLO DLO(*CHG)

   Use this command to save any folders created or any documents created or changed since the latest complete save operation. Depending on the rate at which new folders are created on your system, you may or may not have new folders to save daily. This command also saves mail.

   On most systems, mail changes so frequently that a daily save operation is a must.

   You can reduce the amount of mail saved daily by doing the following:

   - Encourage users not to allow their mail logs to become too large. Promptly delete mail items that are no longer needed.
   - Encourage users to promptly file distribution documents that they want to keep. After the documents are filed, remove the mail log entry for the filed documents.

Strategies for IBM-Supplied Journals

The IBM-supplied journals shipped with the system are:

QAOSDIAJRN - Journal for DIA Files: This journal provides recovery for document library and distribution services files. The journal tracks office changes and activity from OfficeVision/400 and PC Support/400 licensed programs.

QDSNX - Journal for DSNX Log: This journal found in library QUSRSYS is only used for audit trail for DSNX activity. You can access the information to determine what DSNX functions are performed. Only entries are sent to this journal. It does not journal database files.

QLZALOG - Journal for Licensed Management: This journal found in library QUSRSYS is used to log requests exceeding the usage limit of a license.

QSNADS - Journal for SNADS Files: This journal found in library QUSRSYS is used only to provide an audit trail for SNADS activity. You can access the information to determine what SNADS functions are performed by users and when they were performed. It does not journal database files.

QSXJRN - Journal for Problem Database: This journal is used for recording the activity in the database files that are in library QUSRSYS and contain service-related problems. It is recommended that this information be kept for 30 days.

There are two optional journals that you must take specific steps to create and maintain. These journals are:

QAUDJRN - Journal for Logging Security-Related Events: See the manual *Security Reference*, SC41-8083, for more information about the security auditing journal.

QACGJRN - Journal for Job Accounting: The *Programming: Work Management Guide*, SC41-8078, has more information about job accounting and the job accounting journal.

A typical strategy is to perform the following once a week:

1. Change the journal receiver and attach a new one using the Change Journal (CHGJRN) command.
2. Save library QUSRSYS using the Save Library (SAVLIB) command.
3. Delete the detached journal receiver.

Verify Your Save Strategy

Verify what objects are being saved, and when, by doing the following:

- Determine which objects are being saved
- Locate objects not being saved
- Review the save and restore job logs
- Find out when and where libraries are saved

How to Determine Which Objects were Saved

Information about the objects saved during the save operation can be printed with the job's spooled output (OUTPUT(*PRINT)) or directed to a database file (OUTPUT(*OUTFILE)).

If the save operation was performed to a save file, see the topic "Determining the Contents of a Save File" on page 4-9 for more information about determining the contents of a save file.

If OUTPUT(*OUTFILE) is specified, an application program can analyze or reformat the data as desired. (For example, create a separate objects saved list for each user profile.)

You can use the OUTPUT parameter on the following commands:

- SAVCHGOBJ (Save Changed Object)
- SAVLIB (Save Library)
- SAVOBJ (Save Object)
- SAVSAVFDTA (Save Save File Data)
- SAVSECDTA (Save Security Data)
- SAVSYS (Save System)
- SAVCFG (Save Configuration)
- SAVDLO (Save Document Library Objects)

The output information includes:

- Library name
- Object name
- Object type
- Object attribute

- Text
- Device-specific information such as:
  - Save file name
  - Tape sequence number
  - Tape or diskette file label
  - Volume IDs

The information type (INFTYPE) parameter can also be specified with the OUTPUT parameter on the SAVCHGOBJ, SAVLIB, and SAVOBJ commands. This parameter allows the user to select the desired level of detail in the information.

For the SAVDLO command, the following is some of the information provided when OUTPUT(*OUTFILE) is specified:

- Save file name
- Save file library
- Storage Freed
- Data Compression
- Data Compaction
- Target Release
- Indicators for the following date fields:
  - Save date
  - Document creation date
  - Document sent date

How to Locate Objects That were Not Saved

Your best chance of avoiding a recovery exposure is to know exactly what you are saving (or perhaps more importantly, what you are not saving). Although you may save objects weekly, if the objects are changed daily, you may not be in a position to recover the changes.

To prevent such an exposure, you should periodically verify your backup strategy by reviewing when objects and changes made to these objects are being saved. This can be done by using the Check Save (CHKSAV) command in library QUSRTOOL. See "Check Save Strategy (CHKSAV) Command" on page D-3 for more information about this command.

When library QSYS is saved using the SAVSYS command, individual object descriptions are not updated. Instead, a SAVSYS updates the object description of three data areas named QSAVSYS, QSAVCFG, and QSAVUSRPRF in library QSYS. To determine when a SAVSYS command was run, use the DSPOBJD command to display the object description of the three data areas. (SAVSECDTA updates the object description of the data area QSAVUSRPRF only and SAVCFG updates the object description of the data area QSAVCFG only.) You do not display the data area itself. You display the object description of the data area using the DSPOBJD or WRKOBJD command.

Once you determine that all objects and changes are being saved to your satisfaction, consider using the CHKSAV command on a periodic basis, perhaps monthly, semi-annually, or yearly. When applications are changed or added to the system, use the CHKSAV command to ensure the integrity of your backup and recovery strategy. For more information about the CHKSAV command in library QUSRTOOL, see "Check Save Strategy (CHKSAV) Command" on page D-3.

How to Review the Save Job Logs

It is also important to make sure that the save command completes successfully. This can be done by reading through the job log created during the save. However, this can be a tedious task for large save operations. To help automate this function, the Check Save Restore (CHKSAVRST) command in library QUSRTOOL can be used.

The CHKSAVRST command reads the job log that includes the save or restore commands and prints a list of completion messages for that save operation, as well as any diagnostic messages found. The CHKSAVRST command summarizes the job log used during the save or restore process and summarizes what is important from a save or restore viewpoint. CHKSAVRST command allows you to direct the output to either a printer or a database file. See "Check Save/Restore Job Log for Problems (CHKSAVRST) Command" on page D-4 for more information about the CHKSAVRST command.

How to Find Out When and Where Libraries Are Saved

Using the Display Object Description (DSPOBJD) command against a specific library can tell when and where the library was saved (date, time, and what tape volume). For example, to determine

which volume or volumes contain the last backup of library MYLIB, use the following command:

```
DSPOBJD OBJ(LIB) OBJTYPE(*LIB) DETAIL(FULL)
```

The DSPOBJD command works for single libraries or objects. However, to help verify your backup and recovery strategy, you may want to look at multiple libraries. This can be accomplished by using the Print Save Status (PRTSAVSTS) command in library QUSRTOOL.

The PRTSAVSTS command is intended for use following a save of multiple libraries. The PRTSAVSTS command creates printed output that contains:

- One or more library names
- Save date
- Save command
- The volumes the libraries are saved on

This list should then be saved to tape in the event a restore is necessary. An external description exists for the libraries that were saved and what tape volumes contain the libraries. See "Print Save Status (PRTSAVSTS) Command" on page D-5 for more information about the the PRTSAVSTS command.

Verify Integrity of the Save or Restore Tapes

The time spent saving an object is wasted if the tape used for the save operation is unusable. All tapes are subject to wear over a period of time. To help monitor the quality of your tapes, use the *Work with tape or diskette statistics* option accessed using the System Service Tools functions. This option shows you two things:

- The number of temporary and permanent read or write errors that have occurred for a particular volume
- The total amount of data read from or written to the tape or diskette

Chapter 4. Save and Restore Media Considerations

Diskettes, magnetic tapes, or save files are written to and read from during save and restore operations. Information is provided here to help you decide which medium to use.

Note: Do not mark tapes or diskettes with a pencil. This can cause a media error.

Table 4-1 shows the commands and the media that can be used with the save command.

Table 4-1. Media Used with the Save Commands

Command	Type of Media		
	Tape	Diskette	Save File
SAVSYS	Yes	No	No
SAVCFG	Yes	No	Yes
SAVSECDTA	Yes	No	Yes
SAVLIB	Yes	Yes	Yes
SAVOBJ	Yes	Yes	Yes
SAVCHGOBJ	Yes	Yes	Yes
SAVDLO	Yes	Yes	Yes
SAVSAVFDTA	Yes	Yes	No
SAVLICPGM	Yes	No	No
SAVSTG	Yes	No	No

Objects are saved on a diskette in the diskette unit or on a magnetic tape in the magnetic tape unit. The diskette or magnetic tape is removed from the device and stored offline. There is no limit to the number of tapes or diskettes you can use during a particular operation, but you must specify the devices you use on the save and restore commands.

You cannot use a save or restore command with an override command to the system tape file, a diskette file, or a save file. For example, an override to tape file QSYSTAP or diskette file QSYSDKT is ignored when followed by a SAVLIB command. An attempt to change the expiration date of a saved tape library with an override to QSYSTAP is ignored, and the tape receives the expiration date specified on the SAVLIB command. Or, if the Override with Tape File (OVRTAPF) command is used to override the LABEL value for the tape file, that new value is ignored during the save or restore operation. The LABEL value for the save or restore operation is used instead.

You can specify up to 75 volume names on the save and restore commands. This limits the checking of the volume identifiers to 75 volumes but does not limit the operation to 75 media volumes. A system file is maintained with a record for each media volume entered. (If more than one media volume exists with the same name, they are assumed to be the same volume.)

The system file grows as new media volumes are used by the system. You can list the system file using the Print Error Log (PRTERRLOG) command. Specifying VOLSTAT(*DLT) on the PRTERRLOG command resets the system file.

Be certain you have enough initialized diskettes or tapes (INZDKT or INZTAP command) to complete the save operation. Use the Display Object Description (DSPOBJD) command for information on storage sizes. To find the size of a complete library, use the Display Library (DSPLIB LIB(XXX) OUTPUT(*PRINT)) command.

Naming Conventions

A typical approach to media handling is to use sets of media and rotate them on a regular basis. For example, assume you perform a weekly save operation of your payroll information. The save operation requires two tapes and you want a three-set rotational method (sets A, B, and C). The rotational schedule would be as follows:

```
Week 1          Set A
Week 2          Set B
Week 3          Set C
Week 4          Set A
          .
          .
          .
```

To help identify the tape, you can use a naming convention for the volume identifiers using PAY and a letter identifying each set and a number to identify the sequence. For example:

```
Set A   PAYA01, PAYA02
Set B   PAYB01, PAYB02
Set C   PAYC01, PAYC02
```

If you decide to add additional sets or the save operation requires additional tapes, the naming convention will allow these changes.

Color codes can be used to further identify the different sets of save tapes for a specific day. For example, Monday save tapes could be coded with a green plus, Tuesday with blue, Wednesday with yellow, and so on.

Volume Identifiers: Providing a naming convention is a good practice regardless of how you verify volume identifiers. You can verify volume identifiers two ways:

Manual Checking: You can use the default for the VOL parameter on the save or restore commands that tell the system to use the tape that is loaded. It is up to the operator to load the correct tape and in the correct order. Usually, this approach is used for small computer systems.

System Checking: You specify a list of volume identifiers on the save or restore commands. The system makes sure that the tapes loaded by the operator are the correct volumes and in the order specified on the command. If an error occurs, a message is sent to the operator requesting the correct tape volume. The operator can either load another tape or override the request. This approach is normally used for computer systems that require tighter control of the save media and are running save procedures from CL programs.

Expiration Dates: Developing a strategy for tape expiration dates is also important. There are two general approaches:

- The typical solution for small computer systems is to use the system defaults and rely on the system operator to load the correct tapes. Make all files permanent when saving to tape or diskette. Use the default value (*PERM) on the save commands for the expiration date (EXPDATE) parameter. A date of 999999 is assigned to the files on tape. When a save command is run, the system looks at the files to determine if any have dates that have not reached the expiration date.

  If the default is used to make all files permanent, you will need to do one of the following the next time you save to the same save media:

  - Specify CLEAR(*ALL) on the save commands to clear all files on tape before writing to the tape. This causes the system to ignore the expiration date. This approach relies on the operator to load the correct tape.
  - Ensure the operator responds to each system message that occurs.

- For large computer systems, consider using the volume identifier and expiration date. By doing so, the operator can easily identify the correct tapes to load. Specify a date on the expiration date EXPDATE parameter. The save commands default to CLEAR(*NONE). The system verifies that the expiration date has passed for the files that exist on the tape. If the expiration date has not passed, a message is sent to the operator explaining the fact.

  To write over expired files on a tape, you must specify the sequence number you want to overwrite. If you specify sequence number 1 to be overwritten, all the data at sequence number 1 and all the following sequence numbers are written over. Valid sequence numbers are 1 through 9999.

  Normally, a date that corresponds to your rotational cycle is used. For example, if you rotate your media every three weeks, then specify a date eighteen days past the current date. The EXPDATE parameter does not provide a way to specify the current date plus eighteen. However, the Add Date (ADDDAT) command in QUSRTOOL can be used to create the appropriate day if you use control language (CL) programs to perform your save operations.

It is recommended that you stay away from a situation where the operator must respond on every tape loaded to override either the volume identifier or the expiration date. After a period of time, the operator may automatically respond to messages without reading them. It is best to let the system provide a message when a real exception occurs.

Considerations for Using Tape

Among the items to consider for using tape are:

- Tape unit compatibility
- Performance
- Storage capacity
- Preparing tapes for use

Regardless of your save and restore strategy, you must decide how you will handle your save tapes. Consider the following when using tapes.

- Tape units must be cleaned on a regular basis. The read and write head collects dust and other material that can cause errors when reading or writing to tape. In addition to your regular cleaning cycle, you should also clean the tape unit if you are going to be using it for an extended period of time or you are using new tapes. New tapes tend to collect more material on the read and write head of the tape unit. For more specific recommendations, refer to the manual for the specific tape unit.
- Tapes must be initialized using the Initialize Tape (INZTAP) command. The command allows you to control writing to tape by clearing files on the tape. You can also specify the density or bits per inch (bpi) before writing to tape by using parameters on the INZTAP command when the tape is initialized.
- When saving and restoring to tape, always use the tape unit used as the IPL device when saving the Licensed Internal Code (SAVSYS or SAVSTG command). The IPL device was defined by your service representative when your system was installed. If you do not use the IPL device when saving the Licensed Internal Code, you may not be able to restore the system with the tapes used to save the system.
- Before you begin any save procedure, it is recommended that you initialize enough tapes to complete the save operation. Initialize at least three tapes more than you think you will need. The extra tapes allow for situations where the save operation requires more media than planned for or for damage that may occur to the tapes.
- The INZTAP command requires that a volume identifier (ID) be specified. The volume identifier is 6 characters in length. The volume identifier should allow you to identify the tape easily. You should not use the same volume identifier for all your tapes. It is best to use unique names.

  In many cases, you may need more than one tape to back up a specific function. Therefore, you may want to follow a naming convention. A recommended naming convention is discussed earlier in this chapter.
- In addition to the volume identifier, an external label should be used on the outside of the tape to allow you to identify the tape easily. A typical approach is to use the volume identifier.
- Tape devices that use 1/4-inch or 8-mm cartridge media (reference Table 4-2 on page 4-4) can only erase existing data if your save operation starts at the beginning of the tape. Therefore, when saving to 1/4-inch or 8-mm cartridge media, the sequence number (SEQNBR) parameter on the save command must be 1 to overwrite all active files. To append a file after existing data, specify *END or a sequence number that is one greater than the last file on the cartridge.

Tape Unit Characteristics

Table 4-2 on page 4-4 illustrates the characteristics of the compatible AS/400 tape unit models.

Table 4-2. Tape Unit Model Characteristics

Tape Type/Model[1]	AS/400 System Unit	Medium Type	Density	Capacity[3]
2440/A12	9406	1/2-inch reel	1600 bpi	44MB
			6250 bpi	156MB
3422 A01/B01	9406	1/2-inch reel	1600 bpi	44MB
			6250 bpi	156MB
3430 A01/B01	9406	1/2-inch reel	1600 bpi	44MB
			6250 bpi	156MB
3480 A22/B22	9406	1/2-inch cartridge	38000 bpi[2]	200MB
3490 D31/D32	9406	1/2-inch cartridge	38000 bpi	200MB
3490E D41/D42	9406	1/2-inch cartridge	72000 bpi	400MB
3490E C10/C11/C22	9406	1/2-inch cartridge	72000 bpi	400MB
6341/001	9402	1/4-inch cartridge	10000 bpi or QIC120	120MB
6342/001	9402	1/4-inch cartridge	16000 bpi or QIC525	320MB[5]
6343/001	9402	1/4-inch cartridge	36000 bpi or QIC 1000	1.2GB
6346/001	9404	1/4-inch cartridge	10000 bpi	120MB
6347	9404	1/4-inch cartridge	16000 bpi	320MB[5]
6348/001	9404	1/4-inch cartridge	36000 bpi or QIC 1000	1.2GB
6366/0001	9406	1/4-inch cartridge	10000 bpi	120MB
6368/0001	9406	1/4-inch cartridge	36000 bpi or QIC 1000	1.2GB
7208/0002	9402/9404/9406	8-mm cartridge	43200 bpi or format 2GB	2332MB
7208/0012	9402/9404/9406	8-mm cartridge top	5GB 86400 bpi or format 5GB	
9346/0001	9406	1/4-inch cartridge	10000 bpi	120MB
9347/0001[4]	9406	1/2-inch reel	1600 bpi	43MB
			3200 bpi	82MB
9348/0001	9406	1/2-inch reel	1600 bpi	44MB
			6250 bpi	156MB
9348/0002	9404	1/2-inch reel	1600 bpi	44MB
			6250 bpi	156MB
9348/002	9402	1/2-inch reel	1600 bpi 6250 bpi	44MB 156MB

Notes:

1 See Appendix C, "Save and Restore Performance" on page C-1 for information about save and restore tape performance.

2 The abbreviation *bpi* is used to represent bits per inch.

3 The values are for data that is not compressed. For software or hardware data compression, the capacity normally increases and is data-dependent.

4 The 3600-foot tape is not supported on the AS/400.

5 Capacity is 530MB on a 1000-foot tape.

The rate at which the system does save and restore operations depends on many factors, including the following:

- The processing speed of the AS/400 model.
- The distribution of data on the disk units.
- The number and speed of the disk units.
- The number and speed of the storage processors.
- The operating characteristics of the tape unit (start-stop as opposed to streaming).
- The type of data (large or small objects).

If you have only one tape unit, you must wait for the tape to rewind before loading another volume (except for the 3490E tape unit). However, if you have specified more than one tape unit, processing continues in the second unit while the first is rewinding, and so on. The save storage function (SAVSTG command) supports the use of only one tape unit.

Tape Storage Capacity

A save operation writes variable-length blocks of up to 24.5KB. On a 2400-foot tape reel at 1600 bits-per-inch (bpi), this allows approximately 44MB of data per reel and approximately 161MB at 6250 bpi. When saving data, descriptive information is added to the tape. Because of this, a tape with 500 saved objects holds only about 43MB of data at 1600 bpi, and 155MB of data at 6250 bpi. These statistics are without data compression. Tape cartridges also have these reductions in capacity. Refer to "Data Compression and Decompression" on page 4-6 for more information.

Initializing Tapes

A save operation does not require that a tape be prepared using a special format but it does require a standard label tape. Use a tape with a standard label and a volume identifier (VOL parameter). You can prepare a tape by using the Initialize Tape (INZTAP) command or by replying to an inquiry message sent during the save operation. Specifying CLEAR(*ALL) on the save command allows unexpired files to be written over without operator intervention.

In some cases the volume identifier on the loaded tape may be correct, but some attribute of the file may not be correct. An example of this is if the CODE parameter is specified as *EBCDIC on the INZTAP command and the loaded tape is *ASCII. In this case, an inquiry message is sent asking you if you want to label the tape with the same volume identifier and owner ID as that on the tape. Use the Initialize Tape (INZTAP) command to prepare a tape or to add or change a volume identifier. If more than one volume is needed for the save and restore operations, files may cross the volume boundaries. The volumes must be loaded in correct sequence for restore functions. You also can clear a tape with the INZTAP command.

Performance Considerations for Using Tapes

There are streaming tape drives and start-stop tape drives. For example, the 3430, 3422, 3480, and 6341 are start-stop tape drives while the 9348, 9347, 9346, and 6346 are streaming tape drives. The 2440 can be both a start-stop and a streaming tape drive.

A **start-stop tape drive** has the ability to stop and restart movement of the tape between reading or writing each block of tape data. A **streaming tape drive** cannot stop and start between blocks of data. If the next request does not reach the device fast enough, the tape drive overruns its position on the tape and must stop and backup before it can run the next command. This repositioning takes time and can cause additional stress to the device and the tape.

Save and restore operations are designed to keep the tape streaming as much as possible. However, on heavily used systems, the ability of the system to maintain streaming is reduced and this increases the time required for the save or restore operation. When possible, you should consider limiting save and restore operations on streaming tape drives to times of lower system activity.

Data Compaction and Data Compression

The AS/400 system offers three types of data compression and data compaction to allow you to save more data to the media:

- Software data compression is performed by the OS/400 licensed program.
- Hardware data compression is performed by the AS/400 adapter (attachment feature).
- Hardware data compaction is performed by the tape unit. It is supported on only the 3480 and 3490 tape units if the tape unit has the compaction feature. It is also supported on the 7208 Model 12 tape unit when using the 5GB format.

Data Compaction: Data compaction is available on the 3480 and 3490 tape units if the compaction feature is installed. It is also available on the 7208 Model 12 tape unit when using the 5GB format. Data compaction provides additional media capacity that reduces the amount of media handling during a save operation and allows for unattended backup.

The operating system also allows duplicating tapes (DUPTAP command) that were written using data compaction. Data compaction is not supported when writing data interchange tapes but allows for reading them.

Most save commands allow you to specify the data compaction (COMPACT) parameter. This parameter allows you to use data compaction on the 3480 and 3490 tape units.

Hardware data compaction can be used only if all tape units specified on the save command support data compaction.

Unlike data compression, data compaction and decompaction do not have software support available for devices that do not have the data compaction feature. Tapes saved using data compaction must be restored on tape units that support data compaction.

Using hardware data compaction alone (the default) usually results in the highest capacity on tape. However, hardware data compaction and hardware data compression can be used together and may result in higher capacity in rare cases. (This can be done if the COMPACT parameter is *DEV and the DTACPR parameter is *YES.)

Data Compression and Decompression: **Data compression** compresses data on the media when you perform the save operations. **Data decompression** reconstructs data when you perform a restore operation. The system ensures that information saved can be reconstructed exactly. No data is lost as a result of compression and decompression. Software and hardware data compression and decompression is available only for save and restore operations.

The AS/400 system uses software compression or hardware data compression and decompression. Most tape I/O processors support hardware compression and decompression.

Software compression and decompression require significant processing unit resources and have a considerable effect on other system users. Programming compression and decompression usually increase the save and restore time.

Using hardware data compression may improve the amount of space required on the save media. Any improvement in performance is dependent on the tape unit and the amount of data being saved.

Compression normally reduces the amount of storage media required for a save operation. Objects that contain stings of characters can be significantly compressed. Some objects, however, can actually expand by a small amount and require more storage media than if not compressed. This expansion can be caused by too few repeated strings.

Data Compaction and Data Compression Summary: Table 4-3 on page 4-7 summarizes data compaction and data compression by tape unit.

Table 4-3. Data Compaction and Data Compression Summary

Tape Unit	Hardware Data Compression	Programming Data Compression	Hardware Data Compaction
2440[1]	X	X	
3430	X		
3422	X		
3480[2]	X		X
3490[2]	X		X
3490E[2]	X		X
6341	X	X	
6342	X	X	
6343	X		
6346[1]	X	X	
6347	X	X	
6348	X		
6366	X	X	
6368	X		
7208	X	X	
7208 Model 12	X	X	X
9346		X	
9347		X	
9348[1]	X	X	

Notes:

1. Determined by the AS/400 attachment feature card
2. Can use both hardware data compression and hardware data compaction together

Data Compression Method: The compression method used compresses strings of identical characters, and adds control bytes to mark the beginning of each compressed or not compressed string. Compression occurs as follows:

- Each string of consecutive blanks (between 2 and 63 bytes long) is compressed to a single control byte.
- Each string of consecutive characters other than blanks (between 3 and 63 bytes long) is compressed to 2 bytes: a control byte and a copy of the repeated character.
- Each string of non-repeating characters (between 1 and 63 bytes) is expanded by having a control byte added at the beginning of the non-repeating character string.

All control bytes contain the control information and the length of the adjacent equivalent string not compressed. For example, assume the following data stream is being saved (b represents a blank):

```
ABCbbDEF000GHIbJKL11MNObbb
bbbbbbbbbbb
bbbPQR22222222STUSTUSTUSTU
```

This compresses into the following string where * represents a control byte:

```
*ABC**DEF*0*GHIbJKL11MNO**PQR*2*STUSTUSTUSTU
```

- A control byte appears before ABC to designate a string not compressed.
- The two blanks between ABC and DEF are compressed to a single control byte.
- A control byte appears before DEF to designate another string not compressed.
- The three consecutive zeros are compressed to a control byte and a single zero.
- The blank between the GHI and the JKL is not compressed because there is only one.
- The 11 string between JKL and MNO is not compressed because there are only two consecutive non-blank characters.
- The string of STUSTUSTUSTU is not compressed even though the string repeats itself because individual characters are not consecutive.

This compression method provides significant compression and helps ensure integrity of the data. For example, this method determines where each control byte should be, and identifies an inconsistency.

This compression method is a form of the Systems Network Architecture (SNA) compression method.

Errors That Occur When Using Tape

When reading from or writing to tape, it is normal for some errors to occur. The system has recovery functions that reposition the tape automatically and try the operation again for some tape devices. If the system is writing to tape and

an unrecoverable error occurs, the system may request you load another tape. This media can be used for recovery. Processing continues on the next tape. However, there are some situations when writing to tape where the recovery fails and the save operation is ended (processing does not continue on the next tape). The tape units that do not support automatic recovery are the 6341, 6346, 6366, and 9346.

Tapes will physically wear out after extended use. You can determine if a tape is wearing out by periodically printing the error log by using the Print Error Log (PRTERRLOG) command and specifying TYPE(*VOLSTAT). The printed output provides statistics about the volume data, which is kept by the system. If unique volume identifiers are used, the information provides a good indication of which tapes have excessive read or write errors and should be removed from the media library.

Considerations for Using Diskettes

Among the items to consider for using diskettes are:

- Performance
- Storage capacity
- Preparing diskettes for use

Performance Using Diskettes: Table 4-4 illustrates the characteristics of the compatible AS/400 diskette models.

Table 4-4. Diskette Model Characteristics

Diskette Type/Model	Maximum KB per Second	Maximum MB per Hour for Save/ Restore Rate	Maximum MB per Volume
9331/0002	19	68/60	1.2
9331/0001	19	68/60	1.2
6133/0001	19	68/60	1.2
6332/0001	19	68/60	1.2
6331/0001	19	68/60	1.2

Diskette Storage Capacity: The AS/400 system supports two types of diskettes for data exchange. The save and restore operation requires the use of the IBM diskette 2D for 8-inch diskettes with a sector size of 1024 bytes or a double-sided high-density 5.25-inch diskette with a sector size of 1024 bytes. This two-sided, double-density diskette is prepared to save and restore type-E format allowing a total capacity of 1 212 416 bytes per diskette.

Preparing Diskettes for Use: You can prepare a diskette by using a command (Initialize Diskette), or by replying to an inquiry message reported during the save operation. Diskettes have a special format used for a save and restore operation. Use the Initialize Diskette (INZDKT) command and specify FMT(*SAVRST). If active files are on the diskette, you can clear them at this time. If you specified CHECK(*YES) (which is the default), an inquiry message is sent to the operator before active files are cleared.

If the diskette was already initialized to the correct format, you can use the Clear Diskette (CLRDKT) command, or specify the CLEAR(*ALL) on the save command. The Clear Diskette (CLRDKT) command takes less time than the Initialize Diskette (INZDKT) command because the CLRDKT does not have to reformat the diskette.

Considerations for Using Save Files

Using a save file allows you to save and restore objects without first placing a tape or diskette in a tape or diskette unit. You can also use a save file to send objects from one AS/400 system to another over communications lines. You can use the save file as an online container to save the contents of a **single** library to run overnight. The next day, save the contents of the save file to tape or diskette using the Save Save File Data (SAVSAVFDTA) command. Objects saved to a save file can be restored directly from tape or diskette, using the RSTLIB or RSTOBJ command.

Among the items to consider for using save files are:

- Performance
- Storage capacity
- Preparing save files for use

Save files that are larger than those supported for the previous release (5 865 293 records) cannot:

- Be saved to a previous release using SAVOBJ SAVFDTA(*YES) TGTRLS(*PRV or V2R2M0).
- Be sent to a previous release system using the Send Net File (SNDNETF) and the Receive Net File (RCVNETF) commands.

Performance When Using Save Files: Performance can vary, depending on other disk activity. Save files can be created on or moved to an ASP for improved performance and additional protection from system disk device failures. For information on user ASPs, refer to "General Information about Auxiliary Storage Pools" on page 12-8.

Save File Storage Capacity: The maximum capacity of a save file is 536 854 528 records or 274 869 518 336 bytes. You can specify the maximum size of the save file on the Create Save File (CRTSAVF) command.

Specify data compression on the save commands to reduce the space for the save file and the amount of media needed for the SAVSAVFDTA command. (Data compression is not an option on the SAVSAVFDTA command.) For more information on data compression, refer to "Data Compression and Decompression" on page 4-6.

Preparing Save Files for Use: When saving to a save file that already contains data, use the Clear Save File (CLRSAVF) command or specify CLEAR(*ALL) on the save command, or reply to an inquiry message sent during the save operation.

Saving the Save File Data: There are two ways to save the save file data:

- With the SAVSAVFDTA command, only the data is saved. The description of the save file object is not saved. The save date and time of the save file are not updated.
- When you use the Save Object (SAVOBJ) or the Save Library (SAVLIB) command with SAVFDTA(*YES) specified, both the object description and the data are saved. The save date and time are updated for the save file.

  Note: While save file data is being saved (even when using the save-while-active function), the save file cannot be used by other jobs until the save operation completes.

Determining the Contents of a Save File: You can use the Display Save File (DSPSAVF) command or the List Save File API to determine the contents of a save file.

The DSPSAVF command displays the contents of a save file. The information includes a description of each object saved and summary information.

The List Save File (QSRLSAVF) API returns the contents of the save file in a user space. The contents of the save file is returned at a user-selected level of library information, object information, or member information. The QSRLSAVF API returns the same information that is shown on a DSPSAVF command. In addition, when the SAVF0200 format is specified the following is included:

- The serial number of the system on which the save operation was performed.
- The ASP from which the object was saved.

The *System Programmer's Interface Reference* has more information about the QSRLSAVF API.

The QUSRTOOL library provides structures for the SAVF0100, SAVF0200, and SAVF0300 formats in C, COBOL, and RPG.

Using Control Language (CL) Commands for Save Files: Use the following CL commands with save files:

- The Create Save File (CRTSAVF) command creates a save file that can be used with save and restore commands to store data. The save file stores data that would otherwise be written to tape or diskette. A save file can also be used as a container to send objects to another AS/400 user on the systems network architecture distribution services (SNADS) network.
- The Change Save File (CHGSAVF) command changes one or more of the attributes of a save file, such as the maximum number of records.
- The Override Save File (OVRSAVF) command overrides or replaces certain attributes of a save file, or overrides any file with a save file.
- The Display File Description (DSPFD) command displays the attributes of the save file.

- The Clear Save File (CLRSAVF) command clears the contents of a save file.
- The Display Save File (DSPSAVF) command displays the save and restore information in a save file, or the contents of the save file.
- The Save Object (SAVOBJ) or the Save Library (SAVLIB) command can be used to save the description of the save file and to optionally save the data to tape, diskette, or another save file in a different library.
- The Save Save File Data (SAVSAVFDTA) command writes the contents of a save file to either tape or diskette.

Several commands used for save and restore operations also apply to save files.

Save File Security: The authority you grant for a save file is the same as for any file. Be careful when granting authority for save files. The authority you grant to the save file allows access to objects in the save file. For example, the same file can be read from and written to by a high-level language program. The authority you grant for a particular save file should depend on what objects are in the file.

Consider the following factors when granting authorities to save files:

- A user with use (*USE) authority can read records and restore objects from the save file, and save the contents of the save file to tape or diskette.
- A user with use (*USE) and add (*ADD) authority can write records and save objects in a save file.
- A user with object operational (*OBJOPR) and object management (*OBJMGT) authority can clear the contents of a save file using the CLRSAVF command. The clear operation is required first when replacing existing records in a save file.
- A user with either save system (*SAVSYS) special authority or object existence (*OBJEXIST) authority for the file can save the description and contents.

Opening a Save File: The following considerations apply when opening a save file:

- Parameters specified in the file are overridden with parameters specified in the program. Program-specified parameters are overridden with parameters on the OVRSAVF command.
- The fewer parameters specified in the program and on the OVRSAVF command, the faster the file is opened.
- If no record length is specified in the high-level language program that opens the file, a length of 528 bytes is assumed. If the program specifies a record length value, it must be 528.
- For an input file, if the relative record number specified for the parameter does not exist in the file, an error message is sent and the file is not opened.
- If you do not specify EXTEND(*YES) for a save file opened for output, the save file must be empty. If the save file is not empty, you receive an inquiry message to clear the file or cancel the operation. The file can only be cleared if the job trying to open the file has operational and object management authority. You can use the CLRSAVF command before the file is opened to ensure that it is empty and to avoid the inquiry message.
- If a save file is open for output or is being used in a save or restore operation, another program or job cannot open it.
- A save file can be opened by more than one program or job for input. While it is in use, the save file cannot be opened for output.

Input and Output Operations on a Save File: The following considerations apply to input and output operations on a save file:

- Records are always read and written sequentially. The records read from a save file contain sequence and parity information that is validated when the records are written into another save file. This information ensures that the records are processed in sequence and have not been changed.

  You cannot write a record that has changed since it was retrieved from another save file. You cannot write a record that is not the next record in sequence. If you attempt either or these, an escape message is sent to report the error.
- If you attempt to read a record from a save file but the record is not available because of

an auxiliary storage error, the notify message CPF5030 is sent to your program. Your program can look for this error and do another read operation to get the next available record in the file. You will not be able to write any of the records retrieved after an auxiliary storage error into another save file, because the sequence of records was broken by the unreadable records. You may be able to use the data to manually reconstruct the data in the saved object.

- The force-end-of-data (FEOD) function is valid for both input and output.

  For an input file, FEOD signals end-of-file to the program that does the operation.

  To ensure buffered output records are not lost after an FEOD operation completes, they are written to the file. For an output file, buffered output records are not lost even if the job or system fails.

File-Dependent Attributes for a Save File: Following are the file-dependent attributes for a save file:

- The following file-dependent attributes apply when the save file is open:
  - For input operations, the first record returned for a read operation is the one specified by the parameter POSITION when the file is opened. After the first record is read, all remaining records are returned sequentially to the end of the file.
  - For output operations, new records can be added to the end of records already in the file (specified using the EXTEND parameter). Each save file record contains sequencing information used by the system to ensure that a record is not skipped or written more than once.
  - If no record length is specified in the high-level language program that opens the file, a length of 528 bytes is assumed. If the program specifies a record length value, it must be 528 bytes.
- No file-dependent parameters (such as format name) can be specified for read or write operations with a save file. Any file-dependent parameters specified are ignored.

Damage to a Save File: A save file is marked partially damaged if an attempt to read a record or restore an object from the file encounters an auxiliary storage error. When a save file is partially damaged, use file read operations to retrieve records that are not on the damaged part of auxiliary storage. You can restore objects from a partially damaged save file other than the objects on the damaged part of auxiliary storage. The objects on the damaged portion of the auxiliary storage within the save file cannot be restored. When a file is marked partially damaged, you cannot add more records to it until it is cleared.

Partial damage of the save file itself can occur that is unrelated to auxiliary storage errors. Sometimes a partial damage message is issued during a SAVSAVFDTA when the system is very busy. This can happen because an internal operation did not complete within a given time interval. It is most often seen when the SAVSAVFDTA job is running at a low priority and there is a heavy interactive load on the system. Although a SAVSAVFDTA can no longer be one from that save file, the objects in the SAVF can be restored to the system using RSTOBJ.

Clearing a Save File: Clearing a save file releases the auxiliary storage allocation to reduce the size of the object, and resets the partial damage mark on the file if it was previously marked damaged. A save file is cleared in one of two ways:

- By using the CLRSAVF command prior to the save operation.
- By specifying CLEAR(*ALL) as the first part of a save operation to the save file. If CLEAR(*ALL) is not specified and emptied, a message is sent asking whether or not you want to clear the file.

Sending Network Files: The only objects you can send with the Send Network (SNDNETF) command are database file members or save files. The SNDNETF command creates a save file and copies the information into it. Once the file has been received using the Receive Network File (RCVNETF) command, the copy on the source system is not saved. Consider backing up the information on the remote system.

Other objects (such as programs or commands) must be saved in a save file before they can be sent using the SNDNETF command.

Note: Do not use save files to save objects on a system at the current release to distribute them to a system at a previous release unless TGTRLS(*PRV or V2R2M0) is specified on the save command. The current release to previous release rules still apply.

Part 2. System and Object Recovery

Chapter 5. Description of the Save Processes

This chapter describes saving the different types of objects and considerations for the save processes.

Objects That Can Be Saved and Restored

You can save and restore an entire system or individual objects in the system.

The objects that can be saved or restored are as follows:

- The system, which includes the Licensed Internal Code, OS/400 licensed program library (QSYS), device configurations, system resource management information, and security objects.
- All security objects, including user profiles, authorization lists, and authority holders.
- All objects in all user libraries (including the general purpose library (QGPL) and licensed program libraries). You can restore either one or all of the libraries.
- All objects in one or more named libraries can be saved.
- Only the changed objects in one or more named libraries.
- A group of objects by generic name or by object type in one or more named libraries.
- Several objects by name in a single library.
- A single object in a library.
- A list of members by generic or specific name for specific database files.

To understand the save processes for different types of objects, Figure 5-1 and Figure 5-2 on page 5-3, provide an overview of the system ASP and the commands used to save different types of objects.

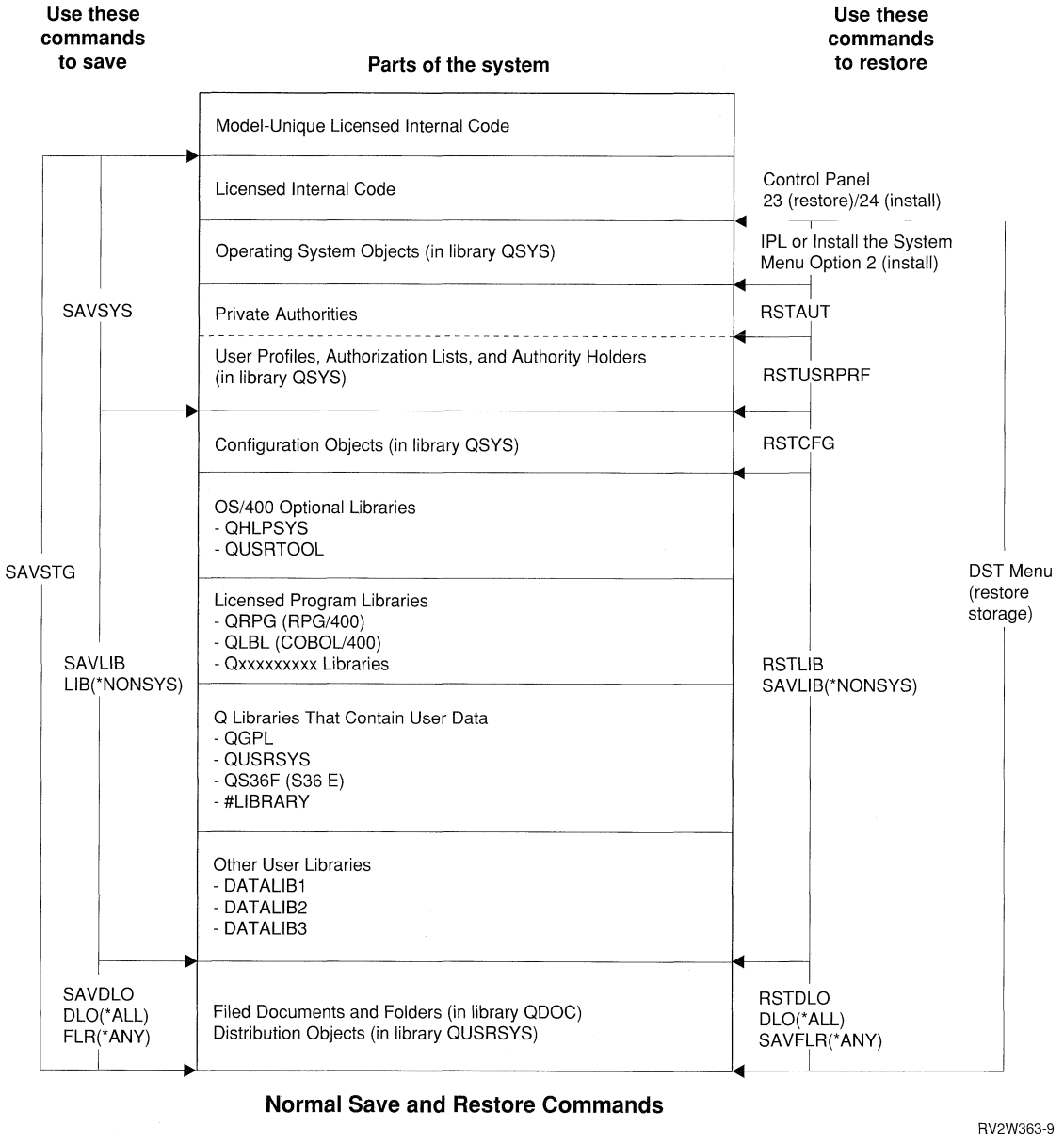


Figure 5-1. Save and Restore Commands

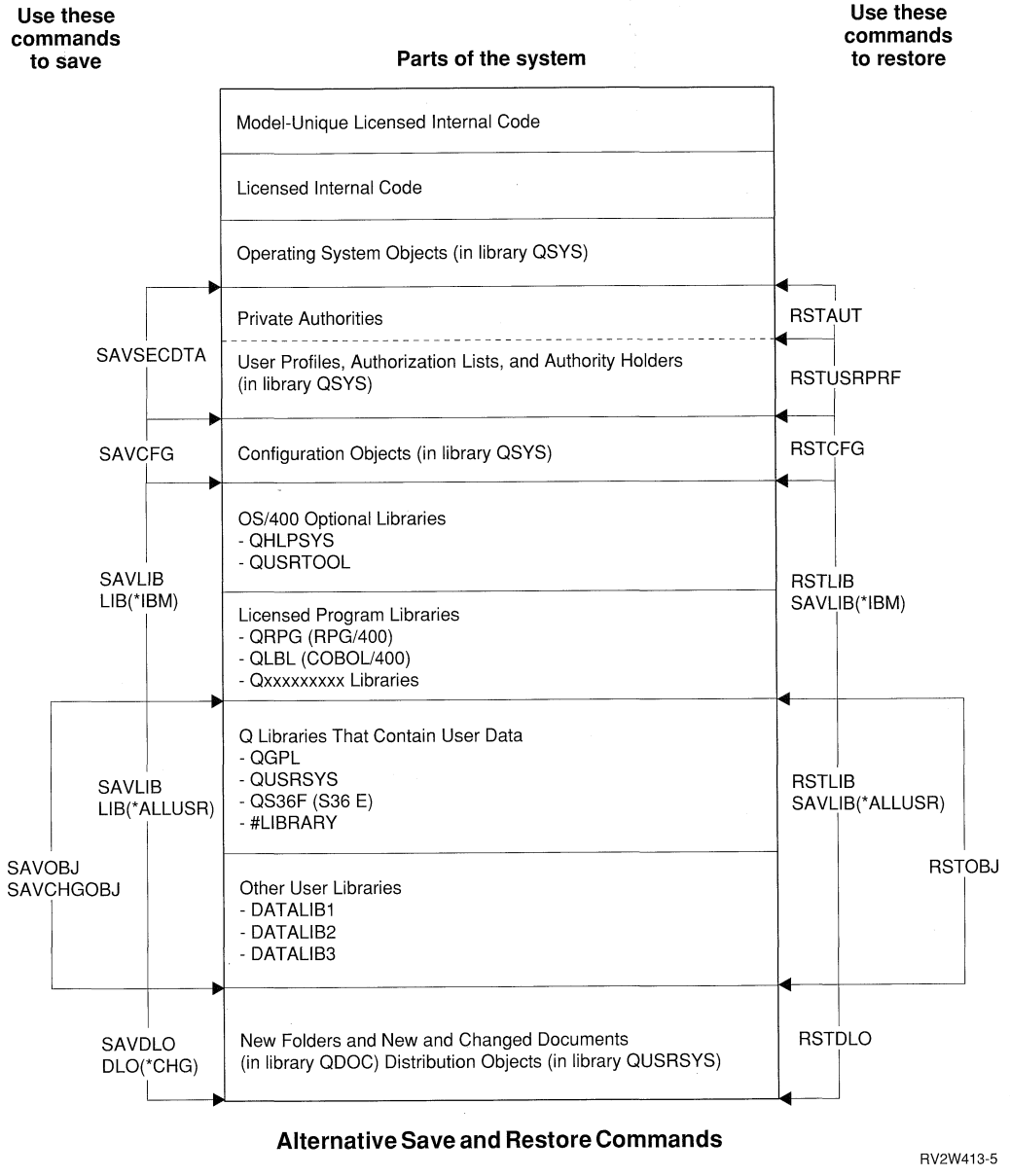


Figure 5-2. Alternative Save and Restore Commands

Saving User Libraries and IBM-Supplied Libraries

You can save one or more libraries by using the Save Library (SAVLIB) command.

Using one SAVLIB command, you can save:

- Only one library when saving to a save file.
- From 1 to 300 libraries. Specifying multiple libraries allows overlapping processing, which can improve performance.
- All libraries (including the IBM-supplied libraries QGPL, QUSRSYS, and licensed program libraries) to diskette or tape using SAVLIB LIB(*NONSYS) (see Table 5-1 on page 5-4).
- All user libraries (including QGPL and QUSRSYS) to diskette or tape using SAVLIB LIB(*ALLUSR) (see Table 5-1 on page 5-4). User libraries are defined as libraries that the user creates or IBM-supplied libraries that are intended to contain user data. IBM-supplied libraries that are not intended to contain user data are not saved.

  Note: To ensure all important files are saved when running SAVLIB LIB(*ALLUSR), the system should be in a restricted state. For example, if subsystem QSNADS or direc-

tory shadowing is active, the QAO* files are not saved in library QUSRSYS. The QAO* files in library QUSRSYS are **very** important files. If the QAO* files are not saved, you should end the QSNADS subsystem (ENDSBS command) or directory shadowing (ENDDIRSHD command) and then save the QAO* files.

- All IBM-supplied libraries (does not include QGPL and QUSRSYS) to tape or diskette using SAVLIB LIB(*IBM) (see Table 5-1).

IBM-supplied libraries that are intended to contain only IBM objects are saved.

Libraries Saved when *ALLUSR or *IBM is specified on the SAVLIB Command

Table 5-1 on page 5-4 shows which libraries are included when the *ALLUSR or *IBM value is specified on the SAVLIB command:

Table 5-1 (Page 1 of 2). Comparison of Special Values for the LIB Parameter

Library Name	SAVLIB LIB(xx) SAVLIB LIB(*NONSYS)		SAVLIB LIB(*IBM)		SAVLIB LIB(*ALLUSR) SAVCHGOBJ LIB(*ALLUSR)	
	Saved	Not Saved	Saved	Not Saved	Saved	Not Saved
QDOC		X		X		X
QGPL	X			X	X	
QGPLTEMP	X		X			X
QGPL38	X			X	X	
QPFRDATA	X			X	X	
QRCL	X			X	X	
QRECOVERY		X		X		X
QRPLOBJ		X		X		X
QSPL		X		X		X
QSRV		X		X		X
QSYS		X		X		X
QSYS2	X		X			X
QTEMP		X		X		X
QUSER38	X			X	X	
QUSRSYS	X			X	X	
QUSRTEMP	X		X			X
QDSNX	X			X	X	
QSSP	X			X	X	
QS36F	X			X	X	
#LIBRARY	X			X	X	
#CGULIB	X		X			X
#COBLIB	X		X			X
#DFULIB	X		X			X
#RPGLIB	X		X			X
#SDALIB	X		X			X
#SEULIB	X		X			X
#DSULIB	X		X			X
Qxxxxxx[1]	X		X			X

Table 5-1 (Page 2 of 2). Comparison of Special Values for the LIB Parameter

Library Name	SAVLIB LIB(xx) SAVLIB LIB(*NONSYS)		SAVLIB LIB(*IBM)		SAVLIB LIB(*ALLUSR) SAVCHGOBJ LIB(*ALLUSR)	
	Saved	Not Saved	Saved	Not Saved	Saved	Not Saved
QUSRVxRxMx[5]	X			X	X	

Notes:

1. Qxxxxxx refers to any other library that starts with the letter Q. These libraries are intended to contain IBM-supplied objects. The system processes these libraries as IBM-supplied libraries that only contain IBM-supplied objects. SAVLIB(*ALLUSR) does not save these libraries. For a complete list of IBM libraries that start with the character Q, see the *CL Reference*.
2. Libraries QDOC, QRECOVERY, QRPLOBJ, QSPL, QSRV, QSYS, and QTEMP are not saved with the SAVLIB command.
3. To ensure a complete save of all libraries, the system should be in a restricted state.
4. Users cannot update objects in libraries that are being saved unless the save-while-active function is used.
5. A different library name, format QUSRVxRxMx, may have been created by the user for each previous release supported by IBM. This library contains user commands to be compiled in a CL program for a previous release. For the QUSRVxRxMx user library, the VxRxMx is the version, release, and modification level of a previous release that IBM continues to support.

There are three data areas that store the save information when you specify one of the special values for the LIB parameter. These data areas are:

- QSAVLIBALL contains the information for the SAVLIB LIB(*NONSYS) operation.
- QSAVALLUSR contains the information for the SAVLIB LIB(*ALLUSR) operation.
- QSAVIBM contains the information for the SAVLIB LIB(*IBM) operation.

You can use the Display Object Description (DSPOBJD) command to display the description of the QSAVLIBALL, QSAVALLUSR, or QSAVIBM data areas to determine the date and time of the last save operation.

If you specify one of the three special values (*ALLUSR, *IBM, or *NONSYS) on the LIB parameter, you can exclude from 1 to 300 libraries from the save operation. You can specify the list of libraries to be excluded on the OMITLIB parameter.

Saving Objects

You use the Save Object (SAVOBJ) command to save one or more objects. Objects are not affected by this command unless it specifies that storage is to be freed.

You can specify up to 300 different libraries on the Save Object (SAVOBJ) command. However, you must save all objects (OBJ(*ALL)) when you are saving from more than one library. Libraries are processed in the order specified in the library (LIB) parameter. Specifying more than one library allows overlapping processing, which can improve performance.

Note: When specifying multiple libraries, the libraries specified are locked and unavailable for use during the save operation. Some or all of the libraries may be unavailable for use at any given moment.

You can specify only **one** library when using the SAVOBJ command to save objects to a save file.

Single Object or More Than One Object:

You can save a single object or more than one object (not a generic name) by specifying:

- A list of object names
- A list of object types
- *ALL for object name
- *ALL for object type

Group of Objects Using a Generic or Specific Name:

You can save a group of objects by a generic name or by generic name and type. However, all the objects must be in the same library.

To specify a generic name, you use the common characters of object names that identify the group of objects. For example, OBJ(ORD*) would save objects whose names begin with ORD, such as ORDPART, ORDREQ, and ORDSTK.

In addition to specifying generic names, you can also save objects by specific name. Both generic and specific names can be mixed in lists of up to 300 names. For instance, you can save the file CUSTNO as well as all other files in that library beginning with ORD and MST by specifying OBJ(CUSTNO ORD* MST*).

Saving Changed Objects: The Save Changed Objects (SAVCHGOBJ) command is like the SAVOBJ command except that the SAVCHGOBJ command saves only *changed* objects or members.

You can specify up to 300 different libraries on the Save Changed Object (SAVCHGOBJ) command. However, you must save all objects (OBJ(*ALL)) when you are saving from more than one library. Libraries are processed in the order specified in the library (LIB) parameter. Specifying more than one library allows overlapping processing, which can improve performance.

Note: When specifying multiple libraries, the libraries specified are locked and unavailable for use during the save operation. Some or all of the libraries may be unavailable for use at any given moment.

You can specify only **one** library when using the SAVCHGOBJ command to save objects to a save file.

You can save changed objects using the following information:

- Save all changed objects from all user libraries. The *ALLUSR value allows you to save all of the changed objects (with the exception of office objects) in a single operation. (See Table 5-1 on page 5-4 to determine which IBM-supplied libraries are included when *ALLUSR is specified.)
- If you specify the special value *ALLUSR on the LIB parameter, you can exclude from 1 to 300 libraries from the save operation. You can specify the list of libraries to be excluded on the OMITLIB parameter.
- The changed object information kept by the system is a date and time stamp. When an object is created, the time stamp is placed in the changed field and any change to the object causes the date and time stamp to be updated.
- As with the SAVOBJ command, you can save all objects that meet a generic selection.
- Because the SAVCHGOBJ command saves only those objects or members that have changed, you can reduce the time needed to save changed objects and may be able to change the frequency of your save operations.
- Use the SAVCHGOBJ command to specify the date and time, in the job date and time format, from which you want your changed objects saved. If you do not use the REFDATE and REFTIME parameters, the system uses the date and time of the last SAVLIB operation for that library. Using REFDATE and REFTIME parameter values that are earlier than the last date and time of the last SAVLIB operation decreases the performance of the SAVCHGOBJ command.

  Use the Display Object Description (DSPOBJD) command and specify *FULL to display the date and time of the last change for a specific object. Use the Display File Description (DSPFD) command to display the last change date for a database member. (The last change date in DSPOBJD for a file is updated only on the first change to a database member after a SAVLIB operation.)
- In a typical environment, you might be using the SAVLIB command once a week and the SAVCHGOBJ command every day. Because the default for SAVCHGOBJ is from the last SAVLIB operation, the media produced by SAVCHGOBJ tends to grow during the week.

  For example, if you use SAVLIB on Sunday, the Monday SAVCHGOBJ saves any changes from Monday, the Tuesday SAVCHGOBJ saves both the Monday and Tuesday changes, and so on. The default is to produce a cumulative result that is reset by the next SAVLIB. This causes more media to be produced, but greatly simplifies recovery in that the last SAVCHGOBJ media contains all the changes made since the last SAVLIB command.
- The default value of *NO for the object journal (OBJJRN) parameter indicates that files being journaled at the REFDATE and REFTIME specified on the SAVCHGOBJ command and are currently being journaled are not saved. If you save the journal receivers for physical

files, you do not need to save large physical files as frequently.

If you want to save the physical files that were being journaled at the REFDATE and REFTIME specified on the SAVCHGOBJ command and are currently being journaled, you must specify OBJJRN(*YES).

- Different functions cause the system to update the last-changed time stamp. For example, if you issued the Change Job Description (CHGJOBD) command, the system time stamps the job description as changed. If a file is updated, the system time stamps the file as changed. This function exists for both source and data files.

Some common operations that result in a change of the date and time are:

- Create commands
- Change commands
- Restore commands
- Add and remove commands
- Journal commands
- Generic commands (for example, Grant Object Authority (GRTOBJAUT), Move Object (MOVOBJ), and Revoke Object Authority (RVKOBJAUT))

Operations that affect only the content or attributes of a member change only the member's date and time (for example, clearing a physical file member using the Clear Physical File Member (CLRPFM) command, or updating the member through a utility (for example, source entry utility (SEU) or a user program).

The SAVCHGOBJ command can be used for backing up typical source files. Normally, a source file has many members, and only a small percentage of members is changed every day. SAVCHGOBJ saves the file description and any members that have changed.

Some operations change the change date and time of the file and all of its members (for example, the CHGOBJOWN, RNMOBJ, and MOVOBJ commands).

An IPL causes all job queues and output queues to be changed. The system does not record the change date and time for the following object types:

- *Message queue*. When a message is sent or received.
- *Data queue*. When an entry is sent or received.
- *Save file*. When a save command writes data into the object.

Changes to the following types of objects are not recorded by the system:

- Libraries
- User profiles
- Configuration objects (for example, line descriptions and controller descriptions)

Saving Database Files

You can save individual database members only with the SAVOBJ command using the FILEMBR parameter. Changed database members can be saved with the SAVCHGOBJ command.

When saving a database file, consider the following:

- The save operation saves all records in the file, but does not save unused storage at the end of the file, regardless of how much was allocated.
- A save operation of a physical file, TYPE(*DATA), with a keyed access path cannot contain more than 16 000 members. If the file is a source file, or if it is a data file that does not have a key, the limit is 32 000 members.
- When you save a keyed physical file with TYPE(*DATA), the keyed access path is also saved. If the keyed physical file is TYPE(*SRC), the access path is not saved.
- Journaled database files that started journaling after the save process reference date and time are saved even if you specified OBJJRN(*NO). Use the DSPFD command to display the journaling start date. This date is updated each time a Start Journaling Physical File (STRJRNPF) command is issued, or whenever a member is added with a create or restore operation. The *Advanced Backup and*

Recovery Guide, has a further discussion of journal management.

- Only the changed members of a database file are saved by SAVCHGOBJ.
- If you save a database file and free its storage, you cannot save it again if it still exists with its storage freed.

Saving Access Paths: Saving access paths significantly decreases the time it takes to recover the system. However, the save operation can be longer.

Note: The system always saves access paths for keyed physical files that are not source files if the access path is valid. If the access path is not valid, the system rebuilds the access path at restore time.

The access path (ACCPTH) parameter on the SAVCHGOBJ, SAVLIB or SAVOBJ command allows you to save access paths. Normally, only the descriptions of logical files are saved. The logical file access paths are saved if all of the conditions in Table 3-1 on page 3-7 are true.

Saving a List of Members: You can save a list of members for a database file using the FILEMBR parameter of the SAVOBJ command. This list may consist of specifically named members, generically named members or a combination of both specifically and generically named members.

The FILEMBR parameter is used to specify:

- A list of file members (specific or generic) for a specific database file
- The same group of members from more than one file

The following restrictions apply to the FILEMBR parameter:

- Each database file specified in the FILEMBR parameter must also be specified in the OBJ parameter by its complete name, a generic name, or *ALL.
- Generic names are not valid for the database file name.
- Generic names are valid for the member name.

  If a generic name is used, the file is not saved if it does not have members that fit the generic name. If all files specified by the FILEMBR parameter are not saved, a diagnostic message is sent and the save operation ends with an escape message giving the number of files not saved.

  If a name that is not generic is used, the specific members must exist in the file for any part of the file to be saved.
- The OBJTYPE parameter must be *ALL or include *FILE.
- The save must be a single-library save operation.

For examples of saving a list of members, see the topic "Examples of Saving a List of Members" on page 9-22.

Saving Source Files: When source files are backed up by either the SAVLIB, SAVOBJ, or SAVCHGOBJ command, you can display the exceptions if all the source cannot be saved. For example, a message can be sent that gives the status of the save source file process. An example of this program is found in Appendix D, "Library QUSRTOOL and Programming Examples" on page D-1.

Consider having a separate library or libraries restricted to production objects. Then, if the entire system must be restored, you can restore production objects first.

Saving Files Being Journaled: If you save files while they are being journaled or while their access paths are being journaled and the journal exists on the system at the time of the restore operation, then the files are journaled again provided the library for the journal and the libraries for the files are in the same ASP.

When you save a file that is being journaled, an entry is written to the journal to indicate when each member was saved.

When you save an access path that is being journaled, no entry is written to the journal to indicate it was saved.

Saving Journals and Journal Receivers

You can use the SAVOBJ, SAVCHGOBJ, SAVLIB, and SAVSYS commands to save journals and journal receivers. It is best to save the old journal receiver when you change the journal to a new receiver (CHGJRN command). This is the most efficient method and provides for a backup copy.

However, you can save a journal or journal receiver even when files are being journaled to it and when the files are not at a commitment boundary. (The *Advanced Backup and Recovery Guide* has more information about journaling and commitment boundaries.) The save operation always starts at the beginning of the journal receiver. A diagnostic message is sent when you save a journal receiver currently attached to a journal.

Storage for a journal receiver can be freed if the journal receiver is not currently attached and all previous journal receivers are deleted or have their storage freed. If you are using two journal receivers, one of the two journal receivers can be saved with storage freed at any time after it is detached provided the other journal receiver in the pair keeps its storage.

Saving Save File Data Using the SAVSAVFDTA Command

A save file can contain objects from only one library. When objects are saved to a save file, they can be saved to tape or diskette (using the Save Save File Data (SAVSAVFDTA) command). When the data in a save file is saved to tape or diskette, the data can be restored as if it was originally written to tape or diskette. Some save files cannot be saved to diskette if the save file contains data from a SAVSECDTA or SAVCFG command.

Saving Save File Data Using the SAVFDTA Parameter

The save file data (SAVFDTA) parameter can be specified on the Save Library (SAVLIB), Save Object (SAVOBJ), or the Save Changed Object (SAVCHGOBJ) command. This parameter allows you to specify, for save file objects, whether the description of the file is saved, or if both the description and the contents of the file are saved. The default SAVFDTA(*YES) saves both the description and the contents.

If the contents of the save file are saved, the restore operation restores the entire save file. The OPTION parameter allows you to control whether the objects are restored over existing objects.

The following restrictions apply when specifying SAVFDTA(*YES):

- If you are saving the save file for a system at a previous release and SAVFDTA(*YES) is specified, the system saves the save file in a previous release format. However, the objects within the save may not be saved in a previous release format. Therefore, an attempt to restore objects from the save file to a previous release system may not be successful.
- When the contents of the save file are saved (SAVFDTA(*YES)), and the save media is the same save file in the same library (SAVF parameter), only the description of the save file is saved. Message CPI374B *SAVFDTA ignored for file &1 in library &2* is sent and the save operation continues.
- The SAVFDTA(*YES) parameter cannot be specified on the Save System (SAVSYS) or the Save Licensed Program (SAVLICPGM) command. However, both of these commands save the contents of the save files (by default).
- When the contents of a save file are saved using SAVFDTA(*YES), the save file must be restored before the objects can be restored from the save file.
- A save file on the media is not restored if the save file exists and is being used in a restore operation. Message CPD371B: `Save file &1 not restore to library &2`, is sent and the restore operation continues.
- When SAVFDTA(*YES) is specified and the SAVACT parameter is also specified, the SAVACT parameter is ignored for the save file. The save file remains in use throughout the save operation.

Saving Configuration Objects

The Save Configuration (SAVCFG) command is a subset of the SAVSYS command. The SAVCFG command saves all configuration and system resource management information without requiring the system to be in a restricted state. However, if the device is varied on, being created or deleted, or the system resource management database is in use, the object will not be saved. The user must have *SAVSYS special authority to use this command.

SAVCFG offers an advantage in that it can eliminate the need to perform frequent save system (SAVSYS command) operations when changes are made to the configuration objects. The SAVCFG command saves the same configuration data as SAVSYS command. It is not necessary to run SAVSYS command after a SAVCFG command. A SAVSYS operation is only be needed for a release upgrade or after applying a cumulative PTF package.

The information saved includes the following:

- Line descriptions
- Controller descriptions
- Device descriptions
- Mode descriptions
- Class-of-service descriptions
- Network interface descriptions
- Connection lists
- Configuration lists
- System resource management information
  - Hardware resource data
  - Token-ring adaptor data

The information can be restored with the Restore Configuration (RSTCFG) command.

Saving Spooled Output Files

The system does not directly support saving spooled files on an output queue. However, you can accomplish the same thing by copying the spooled files to a database file using the Copy Spooled File (CPYSPLF) command and then saving the database file with a save command (such as the Save Object (SAVOBJ), Save Library (SAVLIB), or Save Changed Object (SAVCHGOBJ) command).

This approach saves the textual data in the file. However, advanced function attributes, such as graphics and variable fonts, are not saved.

For an example of this approach, see "Example of Saving Spooled Output Files Using the Copy Spooled File (CPYSPLF) Command" on page 9-28 and "Example of Restoring Spooled Output Files Using the Copy File (CPYF) Command" on page 9-28.

Saving Licensed Programs

Use the Save Licensed Program (SAVLICPGM) command to save licensed programs on your system. The SAVLICPGM command is not for backup purposes, but can be useful for distributing IBM licensed programs to other systems. Refer to the *Central Site Distribution Guide*, SC41-9993, for more information about saving licensed programs to distribute to other systems.

Saving Security Information

Security information can be saved to tape or to a save file without doing a complete save system (SAVSYS) command and without requiring the system to be in a restricted state. (All subsystems, batch jobs, and interactive jobs must be ended to place the system in a restricted state.)

The Save Security Data (SAVSECDTA) command saves the same security information as the SAVSYS command. A user must have save system (*SAVSYS) special authority to use the SAVSECDTA command. The following information is saved:

User profiles
Private authorities
Authorization lists
Authority holders

Note: A maximum of 16MB of authority information can be saved. If a user profile has private authorities to many objects, there may be more than 16MB of authority information in the user profile. If the 16MB limit is exceeded, the save operation ends.

Note: If the authorization list secures an object in library QSYS, the authorization list is saved. However, the authorization list is not connected back to the object during the restore operation. *A*

Complete Guide to Application System/400 Security and Auditing, GG24-4200-00, contains two sample programs that can be used to attach authorization lists to objects in library QSYS when the objects are restored. The ALLAUTL command is run by the security officer before the save operation. This command creates a database file for all objects in library QSYS that are associated with authorization lists. The database file is saved and then restored to the same system or a different system. The FIXAUTL command is run by the security officer after the restore operation to attach the authorization lists to the objects.

Consider the following when using the SAVSECDTA command:

- If the system is not in a restricted state, changing or creating user profiles and granting authority is allowed, but deleting a user profile is prevented.
- Changes made to user profiles while the save security data operation is running may not be reflected in the save media depending on when the changes occurred during the save.
- The time required to run the SAVSECDTA command is determined by the number of user profiles and private authorities on the system.

Considerations for the Save Processes

The following considerations and restrictions apply when using the save processes.

Saving Programs

To prevent the abnormal end of a program, the program being saved must not be running on the system is *FREE is specified. For ILE programs, the program does not end abnormally. However, a message is sent to indicate that the program was not saved.

Limitations When Saving Objects

The maximum number of 512 byte records that can be stored in a save file is:

- 536 854 528 for Version 2 Release 2 and subsequent releases
- 5 865 293 for Version 2 Release 1
- 3 997 574 for Version 1 Release 3 and earlier

Save operations create one or more directories on the save media for each library saved. Each directory contains a list and description of objects to be saved. Each directory can contain up to 32 766 objects and 16MB of description data. Because multiple directories can be created for each library, the chances of exceeding the limits is rare. However, the following objects are always grouped together in a single directory:

- All objects in a library, when the save device is a diskette unit
- All database file objects in a library that are related to each other by dependent logical files (32 766 limit)

In some cases, the save operation counts one OS/400 object as several objects, and these must be considered separately in the 32 766 limit, as shown in the following list (for each object, count one, with the considerations and exceptions indicated):

- For each saved subsystem description, count eight objects as saved.
- For each saved physical file of any type that has an arrival sequence access path, count one object as saved for each physical file member.
- For each saved physical file of type *DATA that has a keyed sequence access path, count two objects as saved for each physical file member. For source files with keyed sequence access paths, count one for each member.
- If a physical file with no members is saved, or a logical file description or a description of a job queue, output queue, message queue, data queue, data dictionary, or save file (SAVFDTA(*NO) is saved, count no object as saved.
- If you specify ACCPTH(*YES), access paths for all logical files based on physical files in

the library are also saved. See also "Examples of Saving Access Paths" on page 9-22. for more information. Count one object as saved for each keyed logical file member that owns an access path over the data being saved. Also count one object as saved for each secondary in each join logical file.

- Count one object as saved for the save directory that contains the descriptions of the saved objects.

Saving Object Descriptions

Table 5-2 shows object descriptions that are saved although the contents are not saved.

Table 5-2. Object Descriptions That Are Saved

Object Description Saved	Contents Not Saved
Data queues (*DTAQ)	Data queue entries.
Job queues (*JOBQ)	Jobs.
Journals (*JRN)	List of currently journaled objects. List of associated journal receivers.
Logical files (*FILE)	Physical files making up logical files. Access paths are saved with the physical file if access path (*YES) is specified on the save command.
Message queues (*MSGQ)	Messages.
Output queues (*OUTQ)	Spooled files.
Save file (*SAVF)	When SAVFDTA(*NO) is specified.
User Queue (*USRQ)	User queue entries.

Freeing Storage

When you save an object, it is not removed from the system. Rather, a copy is made on the save media. If you do not want to keep the object on the system after saving it, you can release some of the area for other uses by specifying STG(*FREE). Using STG(*FREE) deletes the contents of the object but saves the object description and search values. This process is called freeing storage and is supported for the following object types:

- *FILE (files, except save files)
- *JRNRCV (journal receivers)
- *PGM (programs)

  Note: To prevent the abnormal end of a program, the program being saved must not be running on the system if *FREE is specified. For ILE programs, the program does not end abnormally. However, a message is sent to indicate that the program was not saved.

- *DOC (documents)
- *SQLPKG (SQL packages)
- *SRVPGM (service program)
- *MODULE (module)

When a database file is freed, the member information is lost. If you save a database file and free its storage, the object cannot be saved again if it still exists with its storage freed.

After storage has been freed, the object only exists offline and must be restored to be used. The storage occupied by logical file access paths is not freed. Operations such as moving or renaming the object can continue to be performed. The object description consists of the following types of information.

- Object name
- Object type
- Date and time of the save operation
- Owner name
- Object size at the time of the save operation
- Storage required on the system
- Text description
- The public authority
- For database files, attributes of the files and members

You can also specify STG(*DELETE) on the Save Document Library Object (SAVDLO) command to delete any filed documents after they were saved. No object description remains on the system if STG(*DELETE) is used. For documents, STG(*DELETE) deletes the document description, search values, and document contents.

Determining Which Objects Were Saved

Information about the objects saved during the save operation can be printed with the spooled output of the job (OUTPUT(*PRINT)) or directed to a database file (OUTPUT(*OUTFILE)).

If the save operation was performed to a save file, see the topic "Determining the Contents of a Save

File" on page 4-9 for more information about determining the contents of a save file.

If OUTPUT(*OUTFILE) is specified, an application program can analyze or reformat the data as desired. (For example, you can create a separate objects saved list for each user profile.)

You can use the OUTPUT parameter on the following commands:

- SAVCHGOBJ (Save Changed Object)
- SAVLIB (Save Library)
- SAVOBJ (Save Object)
- SAVSAVFDTA (Save Save File Data)
- SAVSECDTA (Save Security Data)
- SAVSYS (Save System)
- SAVCFG (Save Configuration)
- SAVDLO (Save Document Library Objects)

The output information includes:

- Library name
- Object name
- Object type
- Object attribute
- Text
- Device-specific information such as:
  - Save file name
  - Tape sequence number
  - Tape or diskette file label
  - Volume IDs

The information type (INFTYPE) parameter can also be specified with the OUTPUT parameter on the SAVCHGOBJ, SAVLIB, and SAVOBJ commands. This parameter allows the user to select the desired level of detail in the information.

For the SAVDLO command, the following is some of the information provided when OUTPUT(*OUTFILE) is specified:

- Save file name
- Save file library
- Storage freed
- Data compression
- Data compaction
- Target release
- Indicators for the following date fields:
  - Save date
  - Document creation date
  - Document sent date

Considerations for Saving the System with Automatic Configuration Not Enabled

If the value for QAUTOCFG system value was set to *NO when the save operation was performed and function code 24 is specified on the operator control panel to restore the Licensed Internal Code, then the following are true:

- SRC A900 2000 may be displayed on the control panel during the restore of the operating system. You need to create a tape description and possibly a controller description to finish the restore operation. **Do not** create a user-defined device description for the console display.

  To avoid creating a tape description and a controller when restoring the operating system, leave the default value (*Y*) for the *Set the major system options* prompt on the IPL Options display. Set enable automatic configuration to *Y* to avoid receiving SRC A900 2000 on the control panel later in the restore operation.

- If the System/36 environment on your system is your primary environment, ensure that the QAUTOCFG system value is set to *NO. If the AUTOCFG system value is specified as *YES when the operating system is being restored, you may experience a problem with the System/36 environment after restoring the remaining parts of the system. The locking rules used during the restore process may cause the problem. The QS36ENV configuration object in library #LIBRARY may have been locked by the System/36 environment.

  This object contains the System/36 environment names for the workstation, printer, tape, and diskette units on the system. It also contains the default System/36 environment values used for all users. This object may have been modified by the Change S/36 Environment Configuration (CHGS36) command to customize the System/36 environment.

  When the first subsystem is started on the system after the restore process is complete, a new #LIBRARY and a new QS36ENV object in #LIBRARY is created with the AS/400 system defaults. In addition to creating the new objects, each subsystem holds a lock on

the QS36ENV configuration object to ensure that it is not deleted. This lock does not allow the saved QS36ENV configuration object to be restored.

Chapter 6. Description of the Restore Processes

Objects that were saved by separate commands must be restored by separate commands. If you try to restore them with a single command, not all of them are restored. When you use the Save Library (SAVLIB) command, objects can be restored using either the Restore Library (RSTLIB) or the Restore Object (RSTOBJ) command. You cannot use the RSTOBJ command on a data dictionary that has been saved using the SAVLIB command. If you saved an object using the SAVOBJ or SAVCHGOBJ command, it can only be restored with the RSTOBJ command.

You can restore objects to a system whether or not those objects (or their definitions) exist on that system. If the object had its storage freed or deleted, or if it previously did not exist on the system, it can be restored. When you restore an object, the original object existing on the system is replaced by the copy on the save media. If a media error occurs during the restore operation, the original object may not be usable because it is partially overlaid. If you suspect any media error exists for a restore operation, restore to a different library.

Generally, the system to which you are restoring objects must be the same or at a higher release level than the system from which the objects were saved. The target release (TGTRLS) parameter allows you to save objects in a previous release format so they can be restored on a previous release system. Data interchange can also be used to send data to a system at a previous release level. For more information on release levels, see Chapter 8, "Release-to-Release Support."

The following list shows which restore commands can be used, depending on the save command you used.

Save Command	Restore Commands to Use
SAVOBJ	RSTOBJ
SAVLIB	RSTOBJ RSTLIB
SAVCHGOBJ	RSTOBJ
SAVSYS (see note)	RSTOBJ RSTUSRPRF RSTAUT RSTCFG
SAVSAVFDTA	RSTOBJ RSTLIB RSTUSRPRF RSTAUT RSTCFG
SAVLICPGM	RSTLICPGM
SAVDLO	RSTDLO
SAVSECDTA	RSTUSRPRF RSTAUT
SAVCFG	RSTCFG

Note: You can run the RSTOBJ command only against files with the following labels:

- Q5738SS1 vrmxx0001
- Q5738SS1 vrmxx0002
- Q5738SS1 vrmxx0003
- Q5738SS1 vrmm.0002

where vrm=version release and modification level and xx=last two digits of the language ID. QSYS must be specified for the library name and the file label must be specified for the LABEL parameter.

You can restore documents and folders only with the Restore Document Library Objects (RSTDLO) command.

You can restore a library that was saved on your AS/400 system or another AS/400 system, even though that library did not previously exist on the system. Restoring an object requires that the library exists, although you can restore an object to a library different than the one from which it was saved to create a duplicate object. All objects restored by a single command must be in the same library, except when *ALLUSR, *IBM, or *NONSYS is specified on the RSTLIB command. If only selected objects from a library were saved, only those objects, not the entire library, can be restored.

When you restore from diskette and multiple copies of a library were saved to the same diskette, specify a save date and time, or a diskette file label to distinguish the save operations. Doing so allows you to specify which copy you want to restore. If you do not specify a save

date and time, or a file label, the first copy encountered on the volume is restored.

When restoring from tape, and multiple copies of the library were saved to the same tape, the save date and time or SEQNBR allows you to distinguish between the files. If you do not know the save date and time, file label, or the sequence number, use the Display Tape (DSPTAP) command with DATA(*SAVRST) specified to view the contents of the media.

When you restore a library, you do not have to specify the volume on which the library was saved. The default (*MOUNTED) uses the volume currently placed on a tape or diskette unit. If you are restoring over an existing object and want the volume containing the most current saved copy, specify VOL (*SAVVOL).

You can restore only those objects that were previously saved on your system, or on another AS/400 system or System/38. For more information about restoring System/38 and System/36 objects, see the *System/38 to AS/400 Migration Aid User's Guide and Reference* and *System/36 to AS/400 Migration Aid User's Guide and Reference*.

If you are restoring from media that was created using the save-while-active function, special recovery procedures may be required after the objects are restored from the media. The *Advanced Backup and Recovery Guide* has more information about recovery using the save-while-active media.

Restoring Libraries

Use the Restore Library (RSTLIB) command to restore a single saved library, all libraries, all user libraries, or all IBM libraries. Library QDOC is not restored with the RSTLIB command. Objects in library QDOC can be restored using the Restore Document Library Object (RSTDLO) command.

Using the RSTLIB command, you can restore:

- All libraries (including the IBM-supplied libraries QGPL, QUSRSYS, and licensed program libraries) that were saved with SAVLIB LIB(*NONSYS) from diskette or tape using RSTLIB SAVLIB(*NONSYS).
- All user libraries that were saved with SAVLIB LIB(*ALLUSR or *NONSYS) from diskette or tape using RSTLIB SAVLIB(*ALLUSR).
- All IBM-supplied libraries that were saved with SAVLIB LIB(*IBM or *NONSYS) from tape or diskette using RSTLIB SAVLIB(*IBM). Only IBM-supplied libraries that contain IBM objects are restored.
- If RSTLIB SAVLIB(*ALLUSR, *IBM, or *NONSYS) is specified, up to 300 libraries can be excluded from the restore operation using the OMITLIB parameter.

The RSTLIB command restores the entire library, including the library description, object descriptions (only descriptions are restored for logical files, job queues, message queues, output queues, user queues, and data queues), and the contents of other objects. This command also restores status information for programming temporary fixes (PTFs) that were in the library at the time the library was saved.

The following options are used when restoring old, new, and freed objects:

- OPTION(*OLD). Only old objects that already exist on the system are replaced in a library.
- OPTION(*NEW). Only objects not found on the system are added to a library. The old objects are not replaced.
- OPTION(*ALL). Old objects are replaced and new objects are added to a library. *ALL is the default.
- OPTION(*FREE). Only those objects that have their storage freed on the system are restored.

The following example restores the general-purpose library QGPL:

```
RSTLIB  SAVLIB(QGPL) DEV(TAP01) OPTION(*ALL) RSTLIB(*NLB)
```

Old objects are replaced, and new objects are added to the library (*ALL specified for OPTION)

Restoring Objects

The Restore Object (RSTOBJ) command is like the RSTLIB command except the additional parameters OBJ and OBJTYPE are used for object selection. Also, the library description is not restored using the RSTOBJ command. Objects can be restored to only one library with the RSTOBJ command.

Restoring Database Files

Restoring a database file involves the following considerations:

- A saved version and a copied version of the same file are not the same and cannot be used interchangeably in a restore operation. If a copy is made of file A (using the Copy File (CPYF) command) and then both file A and the copy are saved, the saved version of the copy cannot be used to restore file A. Only the saved version of file A can be used to restore file A. Figure 6-1 illustrates the save process for files. Figure 6-2 illustrates how files can be restored.

  There is a restriction if you are journaling File A. You cannot apply journal changes made to File A to any other file. A journal identifier is used to ensure this regardless of the external name for the file. In addition, the file must have been journaled at the time of the save operation in order for the journal entries to be applied. The *Advanced Backup and Recovery Guide* has more information about journaling database files.

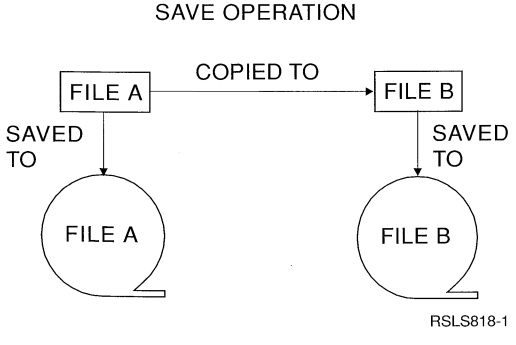


Figure 6-1. How Files Are Saved

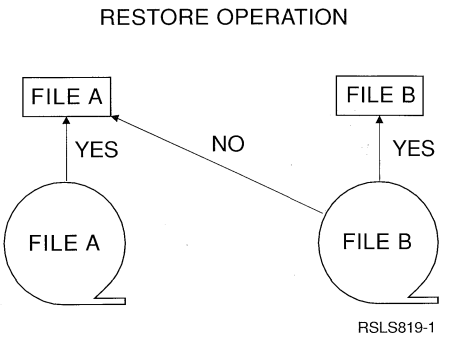


Figure 6-2. How Files Can Be Restored

- When you are restoring to an existing database file and MBROPT(*MATCH) is specified (the default), the list of members in the database file must be identical to that on the media.
- When you restore an existing database file or member, only the data is restored. If you want to restore the file attributes as they existed at the time of the save operation, delete the file, then restore it. To restore the attributes of a member as they existed at the time of the save operation, remove the member (RMVMBR) and then restore it. For files, only the attributes that can be changed using CHGPF, CHGLF, or CHGSRCPF commands are affected. For members, only the attributes that can be changed using CHGPFM and CHGLFM are affected.
- When you restore a file, no member of the file can be used during the restore operation, even through logical files. The file is exclusively locked during the restore operation.
- When you restore a keyed physical file, its access path is also restored, unless it is a keyed source physical file. In most instances, you will not have keyed source physical files because the Create Source Physical File (CRTSRCPF) command will create a non-keyed source file by default. When you restore a keyed source physical file, the access path is rebuilt after the restore operation. After restoring a keyed source physical file or a keyed logical file with ACCPTH(*NO) specified during the save operation, the file and physical files associated with the logical files are unavailable while access paths are rebuilt. This is true for both immediate and delayed maintenance. See the topic "Restoring Access Paths" on page 6-5 for

information about immediate and delayed maintenance.

Considerations for Using the ALWOBJDIF Parameter When Restoring Database Files

Consider the following before using the ALWOBJDIF parameter when restoring database files and members. For differences in ownership, see "Ownership" on page 9-15.

ALWOBJDIF(*NONE): If you specify ALWOBJDIF(*NONE) and the creation date for the file or member does not match, the file or member is not restored. A message is sent to the user to indicate the file or member could not be restored from the media. If you really want to restore the file, then delete the file on the system and then restore it from the media.

Member or creation date can be different because:

- A user deleted a file or member and then created it again using the Create Physical File (CRTPF), Add Physical File Member (ADDPFM), Create Duplicate Object (CRTDUPOBJ), or Copy File (CPYF) command. The file or member gets a new creation date and does not match any on the save media.
- The object on the media has the same name as another object on the system. The restore media was not created on the same system it was saved from.

In either case, the system does not know the contents of the two files or if they are in the same format. Therefore, the system restricts restoring over a file or member that does not have the same creation date. If you really want to replace the object on the system with the object on the media, delete the object on the system and then restore it from the media.

ALWOBJDIF(*ALL): Using ALWOBJDIF(*ALL) can cause problems when restoring database files or members. If you specify ALWOBJDIF(*ALL) when restoring files or members and the creation date of the file or members does not match the creation date on the save media, the system renames the file or member on the system and then restores the copy from the save media. A message is sent to the user to indicate that the file or member has a new name and the saved copy has been restored.

When restoring files, the user usually has no problems associated with the renaming of the files. The user can do one of the following:

- If the user did not want to restore over the original file, the file can be renamed back to its original name.
- If the user wants the copy on the save media, the renamed file can be deleted.

For members, the situation becomes complicated.

- If there are any logical files associated with the members that were renamed, they are still associated with the renamed member, not the member restored from the media.
- The differences in the members on the system and on the media are not immediately known. Each member must be looked at to determine which ones to keep.
- During the rename operation, the system overrides any file attributes about how many members can exist in the file. You may have a file that has more members than the file MAXMBRS value. The file can be saved because the save operation does not check the file attributes. However, when restoring the file again that has more members than the file attributes, an escape message is sent and the file cannot be restored unless you specifically request the members you want restored. The number of members must be less that the MAXMBRS attribute for the file.

If you decide that you really do want to restore the file or member using ALWOBJDIF(*ALL) on the restore command, do the following if you want to keep the copy restored from the media:

1. Delete the renamed file on the system.
2. Create the logical file again over the physical file.

If you did not want the copy restored from the media, delete the restored file and rename the file on the system back to its original name.

Restoring Access Paths

Access paths are restored if all of the conditions in Table 3-1 on page 3-7 apply.

Note: The system always saves access paths for keyed physical files that are not source files if the access path is valid. If the access path is not valid, the system rebuilds the access path at restore time.

If ACCPTH(*YES) was specified when saving a physical file, and a dependent logical file was in a different library, and the logical file was deleted before the restore operation, do the following:

1. Restore the physical file first using the Restore Object (RSTOBJ) command.
2. Restore the logical file using the Restore Object (RSTOBJ) command.
3. Use the Edit Rebuild Access Path display (EDTRBDAP command) to change the value in the *Seq* column to *OPN or *HLD.
4. Restore the physical file again.
5. Change the sequence number to a value from 1 through 99 on the Edit Rebuild Access Path display (EDTRBDAP command) to remove the access path from the Edit Rebuild Access Path display.

Restoring a List of Members

You can restore a list of members for a database file using the FILEMBR parameter of the RSTOBJ command. This list may consist of specifically named members, generically named members, or a combination of both specifically and generically named members.

The FILEMBR parameter is used to specify:

- A list of file members (specific or generic) for a specific database file
- The same group of members from more than one file

The default value *ALL causes all file members of files specified with the OBJ parameter to be restored.

The following restrictions apply to the FILEMBR parameter:

- Each database file specified in the FILEMBR parameter must also be specified in the OBJ parameter by its complete name, a generic name, or *ALL.
- Generic names are not valid for the database file name.
- Generic names are valid for the member name.

  If a generic file member name is used, and the file does not have members that fit the generic name, the file is not restored. If all files specified by the FILEMBR parameter are not restored, a diagnostic message is sent and the restore operation ends with an escape message giving the number of files not restored.

  If a name that is not generic is used, the specific members must exist in the file for any part of the file to be restored.
- The OBJTYPE must be *ALL or include *FILE.
- The MBROPT parameter must not have the *MATCH value.

Restoring a Different Set of File Members

When restoring database files, the set of members in the database file need not be identical to the members on the save media. During the restore operation, members are created or replaced according to the following values, which can be specified on the MBROPT parameter on the RSTLIB and RSTOBJ commands:

- *MATCH. The set of member lists on the save media and in the database must be identical, or the restore operation fails. *MATCH is the default.
- *ALL. All members on the save media are restored.
- *NEW. Only those members on the save media that do not exist in the database file are restored.
- *OLD. Only those members on the save media that already exist in the database file are restored.

If the creation date and time stamp differ for either the file or one of the file members, the file is not restored regardless of what you specify on the

MBROPT parameter unless ALWOBJDIF(*ALL) is specified. See "Considerations for Using the ALWOBJDIF Parameter When Restoring Database Files" on page 6-4 for restrictions on using the ALWOBJDIF parameter.

Restoring Shared Formats

When a database file is restored and that file, before it was saved, had shared the record format of another file, an attempt is made to find the file whose format was shared, and reestablish the original format sharing.

The search for restoring the shared format starts in the library to which the restored file is directed and continues in the library from which the restored file was saved. Following are the results of the search:

- If the sharing file is found and has not been changed (level check) since the save, then no new format is created for the restored file.
- If the sharing file is not found, or it is found but fails the level check, then a new format for the restored file is created with the same definition as the one it initially shared.
- If a format sharing file has been renamed, deleted, or moved to a library other than the save or restore library, a new format is created for the dependent file when the dependent file is restored.

Restoring Journaled Files

If the journal exists on the system before the files are restored, all files that were saved while being journaled (or saved while having their access paths journaled) are journaled again provided one of the following is true:

- The files are not on the system at restore time.
- The files are on the system and journaling was not ended for the files.

When you restore a file that was being journaled at the time of the save operation, an entry is written to the journal to indicate that it was restored.

When you restore access paths that were being journaled at the time of the save operation, no journal entry is written to the journal to indicate that it was restored.

If the journal is not on the system at the time a journaled file is being restored, the restore operation for the file causes a warning message to be sent and journaling is not resumed. This warning message causes a diagnostic message to be sent at the end of the restore operation. (See the topic "Restore Completion Messages" on page 9-8.)

Restoring Journaled Files to a Different Library

The system assigns a unique internal journal identifier to every object that is journaled. When restoring a journaled file that already exists on the system, the file must be restored to a different library. If you are restoring a journaled file to a library other than the original library, and the file still exists on the system and continues to be journaled to the same journal, the journal identifier of the restored file is changed. No message is sent telling the user that the journal identifier of the restored file is changed.

For example, in Figure 6-3, the original file FILEA in LIBX library has an internal journal identifier of Z that is recorded with every journal entry associated with FILEA in LIBX. When FILEA is restored from the media to LIBC library, it is assigned the journal identifier of Y because FILEA still exists in LIBX and continues to be journaled.

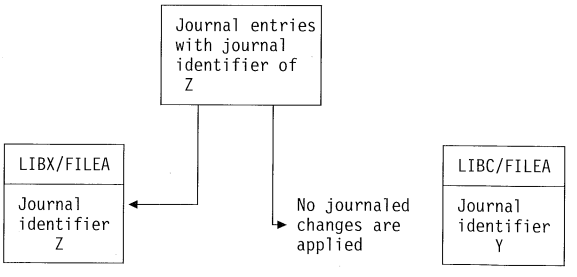


Figure 6-3. Restoring a Journaled File to a Different Library

Any journal operation that references a file by name and involves using journal entries requires that the journal identifier of the file and the journal identifier recorded in the journal entries be the same. Because FILEA in LIBC has journal identifier Y, journal entries with journal identifier Z are not associated with the restored FILEA in LIBC.

As a result, journal changes recorded for FILEA in LIBX cannot be applied to FILEA in LIBC. For the same reason, referencing FILEA in LIBC on the Display Journal (DSPJRN), Receive Journal Entry (RCVJRNE), or Retrieve Journal Entry (RTVJRNE) commands does not return entries for FILEA in LIBX.

Restoring Logical Files

You can restore a logical file to a library different than the library for the associated physical file. However, the associated physical file must remain in or be restored to its original library location, or be in the same library as the logical file.

If you try to restore a logical file to a library in which it does not exist, the restore operation fails if any of the associated physical files have had their storage freed.

If the access path for a logical file was saved with the physical file, the access path is automatically restored when all of the following conditions are true for the logical file at restore time.

- All physical files on which the logical file is based are being restored with the same command.
- All physical files on which the logical file is based are in the same library.
- The logical file has not been changed to MAINT(*REBLD) since the save operation was performed.
- The logical file owned the access path when the save operation was performed.
- If the logical file is created again by the restore operation, the key length for the access path must be equal to the maximum key length for the logical file.

When a logical file is restored, it must be dependent on the same physical files as it was when it was saved:

- The logical file is created over the physical files in the library where they are being restored if any of the following occur:
  - The logical file and the associated physical files existed in the same library at the time of the save operation.
  - The logical file and the associated physical files are present in the library where the files are being restored.
  - The logical file and the associated physical files are being restored to the same library.
- If the files are not present in the restore library, then the logical files are created over the physical files in the original saved library.
- If the correct physical files are not found in either library, then the restore operation of the logical file fails. To correct the problem, run the RSTOBJ command again and specify OBJ(*NEW). If the restore operation is successful, an informational message (CPF3291) is sent to indicate which library was used for associated physical files.

The creation dates of the physical files must not have changed since the logical file was saved. If the date has changed, an informational message (CPF3293) is sent indicating that the physical file has been changed since the save operation, but the restore operation continues.

Restore physical or logical files with dependent logical files before the dependent logical files, unless the physical and logical files already exist on the system. The following considerations apply to restoring logical files:

- If the dependent physical or logical files are in the same library, the system provides the proper sequencing.
- If the files are in different libraries, you must restore the libraries in order, so that the physical or logical files that have logical files built on them are restored first.
- If the depended-on physical or logical files are not restored before you attempt to restore the logical files, restoring the logical files fails.
- This sequencing also applies to other requirements between files, such as shared formats. You can restore those logical files that failed by using the RSTOBJ command.

Restoring Journals and Journal Receivers

You can restore journals or journal receivers only to the same library from which they were saved. Use the RSTOBJ and RSTLIB commands to restore journals and journal receivers. When you are restoring multiple objects with one of these commands, journals and journaled files are restored before the journal receivers.

When you use several commands to restore several objects, restore the objects in this order:

1. Journals
2. Based-on physical files associated with those journals
3. Dependent logical files
4. Journal receivers

Restore the journal receivers in the order of newest to the oldest.

Journals: You cannot restore a journal to a library containing a journal with the same name because you would overlay the existing journal with old information. If a journal must be restored (because of damage) to a library, the existing journal must be deleted first.

Attention

If the journal was restored to a library in the system ASP and the journal receivers are in a user ASP, the journal receivers associated with the journal must also be restored.

When you restore a journal, the system creates a journal receiver with the same attributes as the receiver that was attached when the journal was saved, and attaches it to the journal. The system attempts to assign the same owner and to create the journal receiver in the same library as the receiver that was attached when the journal was saved. If the owner of the receiver is not found, the receiver is assigned to the default owner (QDFTOWN) user profile.

Journal receivers: If the library for the receiver is not found, the receiver is created in the same library as the journal being restored. If the auxiliary storage pool (ASP) does not exist for the receivers that were attached to the journal at the time of the save operation, and the journal is restored, then the receivers are usually created in the same ASP as the library for the receiver.

If two receivers were being used when the journal was saved, two receivers are created and attached to the journal. The system-created journal receiver is named by adding a number to the name of the attached journal receiver at the time of the save operation.

If the attached journal receivers did not end up in the desired ASP, it is recommended that you create a journal receiver in a library in the desired ASP and then use the Change Journal (CHGJRN) command to detach the current receiver and attach the new journal receiver immediately after restoring the journal. (After a successful restore of the journal, you are informed of the name of the attached journal receiver in an informational message.) If a receiver cannot be created, you receive an error message indicating the journal was not restored.

You cannot restore a journal receiver currently attached to a journal. Also, if the journal receiver being restored contains less information than the one on the system, a message is sent, and the restore operation ends.

Restoring Save File Data

If the data in a save file is saved to tape or diskette using the SAVSAVFDTA command, it appears as though the data originally came from tape or diskette when it is restored. You can use the RSTOBJ, RSTLIB, RSTDLO, RSTCFG or RSTUSRPRF commands to restore the data.

If the save file data is saved to tape or diskette using the SAVLIB, SAVOBJ,or SAVCHGOBJ command and SAVFDTA(*YES) was specified on the save command, the save file must be restored before the objects contained in the save file can be restored.

Restoring Spooled Output Files

You cannot directly save and restore spooled files on an output queue. If you use the technique described in "Saving Spooled Output Files" on page 5-10, you can restore the spooled files by first restoring the database files with a restore command, such as Restore Object (RSTOBJ) or Restore Library (RSTLIB), and then copy the database file members to the spooled output files by using the Copy File (CPYF) command and specifying TOFILE(QSYSPRT).

Restoring Licensed Programs

Use the RSTLICPGM command to add or replace licensed programs on the system. Refer to *Licensed Programs and New Release Installation Guide*, SC41-9878 for more information about installing licensed programs.

Restoring Configuration Objects

Use the Restore Configuration (RSTCFG) command to restore all configuration objects either as a group or individually. A restricted system is not required. Before these objects can be restored, they must be varied off.

The following objects can be restored:

- Line descriptions
- Controller descriptions
- Device descriptions
- Mode descriptions
- Class-of-service descriptions
- Configuration lists
- Connection lists
- Network interface descriptions
- System resource management information
  - Hardware resource data
  - Token-ring adapter data

  Note: System resource management objects can only be restored as a group, such as *HDW, *TRA, or *ALL by specifying the SRM parameter on the RSTCFG command.

Attention

Restoring configuration objects to a different system whose configuration objects exist, overlays the existing configuration.

Restoring Objects in User Auxiliary Storage Pools (ASPs)

If you are using user auxiliary storage pools (ASPs), you can restore libraries and objects that were contained in user ASPs by using the Restore Library (RSTLIB) or Restore Object (RSTOBJ) command. Libraries and objects are automatically restored to the same user ASP from which they were originally saved, but you can place them into either the system ASP or into another user ASP through the RSTASP parameter on the appropriate restore command. For more information on ASPs, refer to "General Information about Auxiliary Storage Pools" on page 12-8.

Restoring Security Information

The following topics discuss restoring security information, such as user profiles, authorization lists, authority holders, and authority to objects. For more information about user profiles, authorization lists, authority, and authority holders, see the manual *Security Reference.*

Restoring User Profiles

You can restore a single user profile or a list of user profiles with the RSTUSRPRF command. Before using the RSTUSRPRF command, you must end all subsystems (using the ENDSBS command). The RSTUSRPRF command also allows you to move a user from one AS/400 system to another AS/400 system and to recover a damaged user profile more easily.

The RSTUSRPRF command restores all user profile attributes originally defined on the Create User Profile (CRTUSRPRF) command. When you restore all user profiles, the RSTUSRPRF command also restores authorization lists and authority holders. However, it does not restore private authorities for objects owned by other users.

Each use of the RSTUSRPRF command must be followed by the RSTLIB, RSTOBJ, and RSTDLO commands to restore all objects owned by the profiles. Then, use the RSTAUT command to restore authorities for objects owned by other users.

If you use the RSTUSRPRF command more than once during a restore operation, each use of the command resets the profile attributes, such as passwords, to their status at the time of the save operation.

Note: If the IBM-supplied user profiles were saved before the default passwords were changed and this media is used in a restore operation, then the passwords are changed back to the system-supplied defaults after a restore operation. This is a security exposure. After a restore operation, verify that the IBM-supplied user profiles do not have the default passwords.

User Profile Considerations: Consider the following when restoring all user profiles or individual user profiles:

- If a user profile exists on the system, but is not on the media, the profile remains on the system.
- If a user profile exists on the media, but is not on the system, a new user profile is created on the system.
- If the user profile on the system is damaged, the last SAVSYS or SAVSECDTA media can be used for the restore operation to recover the user profile and its authorities.

  Note: If an IBM-supplied user profile is damaged, it cannot be deleted. You must restore the operating system again to restore the IBM-supplied user profile.
- *ALLOBJ special authority is removed from user profiles being restored to a system at security level 30 or higher in either of these situations:
  - The profile was saved from a different system.
  - The profile was saved from the same system at security level 10 or 20.
- *ALLOBJ special authority is not removed from the following IBM-supplied profiles:
  - QSYS
  - QSECOFR
  - QLPAUTO
  - QLPINSTALL

When you use the RSTUSRPRF command to restore *all* user profiles, the following conditions occur:

- If a user profile exists on both the media and the system, the user profile from the media replaces the user profile on the system.
- Authorization lists and authority holders are restored only when RSTUSRPRF USRPRF(*ALL) is specified. However, if the authorization list secures an object in library QSYS, the authorization list is not restored.

  A Complete Guide to Application System/400 Security and Auditing, GG24-4200-00, contains two programs that can be used to attach authorization lists to the objects in library QSYS when the objects are restored. The ALLAUTL command is run by the security officer before the save operation. This command creates a database file for all objects in library QSYS that are associated with authorization lists. The database file is saved and then restored to the same system or a different system. The FIXAUTL command is run by the security officer after the restore operation to attach the authorization lists to the objects.

To transfer the user profiles and their authorities to another system, you must do the following steps:

1. Save the user profiles and authorities.
2. Save the owned objects.
3. Restore the user profiles using RSTUSRPRF USRPRF(*ALL) ALWOBJDIF(*ALL).
4. Restore the needed objects using the RSTLIB, RSTOBJ, or RSTDLO commands specifying ALWOBJDIF(*ALL).
5. Restore the private authorities of the user profiles using the RSTAUT command.

Table 6-1 on page 6-11 shows what occurs when you restore all user profiles or individual user profiles from the SAVSYS or SAVSECDTA media. This situation does not apply when migrating from a System/38. See the *Migrating from System/38 Planning Guide* for more information.

Table 6-1. Results of Restoring User Profiles

User Profile Attributes	Restore *ALL User Profiles	Restoring Individual User Profiles That Existed on the System before Using RSTUSRPRF Command	Restoring Individual User Profiles That Do Not Exist on the System before Using RSTUSRPRF Command
Associated group profile (GRPPRF owner and GRPAUT values)	Values are restored from SAVSYS or SAVSECDTA media.	The values remain as they currently are on the system.	The values restored are GRPPRF(*NONE), OWNER(*USRPRF), and GRPAUT(*NONE).
Sign-on and document passwords	Values are restored from the SAVSYS or SAVSECDTA media.	Password values remain as they are on the system.	The sign-on and document password are *NONE.
Password change date	The date the password was last changed is taken from the media.	The date on the system is used for the date the password was last changed.	The current date is used.
Owner of user profile	If the profile being restored is currently on the system, ownership remains the same. If the profile being restored is not currently on the system, ownership is from the SAVSYS or SAVSECDTA media unless the owning profile does not exist on the system; in that case, the QDFTOWN user profile becomes the owner. If ownership on the media is different than the owner on the system and ALWOBJDIF(*ALL) was specified, then the owner on the system remains the owner.	Ownership remains the same.	Ownership is from the SAVSYS or SAVSECDTA media unless the owning profile does not exist on the system; if that occurs, then the QDFTOWN user profile becomes the owner.

1 "User Profile Considerations" for more information when *ALLOBJ special authority is restored.

Restoring Object Authorities

When you restore objects and profiles, you do not simultaneously restore the authority to those objects. Private authority is restored only using the Restore Authority (RSTAUT) command. This command cannot be used until the user profiles and some user libraries are restored to the system. Before using this command, you must end all subsystems.

The Restore User Profile (RSTUSRPRF) command restores authorization lists and resets the profile attributes to their status at the time of the save operation, but does not restore any other private authorities. The RSTUSRPRF command builds an authorization table during the restore operation. This table contains information about the association of objects and authorities to the user profiles being restored. The RSTAUT command grants private authorities in addition to any authorities granted since the save operation. Because the RSTAUT function uses and then deletes the authorization table built by the RSTUSRPRF command, the RSTAUT command can be used only once for each restored user profile.

You can use the RSTAUT command to restore private authorities for individual user profiles with the USRPRF parameter. If USRPRF(*ALL) is specified, authorities are restored from each available user profile authorization table.

The following examples illustrate possible security considerations:

- When you restore private authorities for an object, you have the same authorities for that

object that you had when the system was saved including authorities granted after the save operation.

For example, assume Tom creates an object and authorizes Bob to use that object. After saving the object authorities through the SAVSYS or the SAVSECDTA command, Tom revokes Bob's authority. When the RSTUSRPRF and RSTAUT commands are issued, Bob has all the original authorities that he had when the SAVSYS or SAVSECDTA command was run. Tom can revoke the original authority using the RVKOBJAUT command.

Assume Tom gives Joe authority to use an object after using the SAVSYS or SAVSECDTA command. If Joe's profile exists on the system and is not damaged at the time the RSTUSRPRF command is run, Joe will have authority to the object regardless of whether the RSTAUT command is run.

- If you give a user authority to an object, enter the SAVSYS or SAVSECDTA command, and then restore the user's authority to the object at a later date, the user is granted the original authority to the object, even though the contents may have changed.

  For example, you can give Ann private authority to program ABC/XYZ, save the system (SAVSYS) or save security data (SAVSECDTA), then delete that program. If a new program called ABC/XYZ is created, and the security officer restores Ann's authority (RSTAUT), Ann has the original authority to the new program ABC/XYZ. See "Security Considerations When Saving and Restoring" on page 9-15 for more information.

- Ownership for an object is established when the object is restored (RSTOBJ, RSTLIB or RSTDLO commands), and is not changed by the RSTAUT command.

- If the owner of the object on the system does not match the owner of the object on the save media and the allow object differences (ALWOBJDIF(*ALL)) parameter was specified on the restore command, then the object is restored. However, the user on the system becomes the owner of the object.

- If the owner of an object being restored does not exist on the system at the time of the restore operation, then the object is restored with the default owner (QDFTOWN) user profile as the owner.

Limiting the Restore of Programs

When the system security level is 40 or higher, the restore of programs that have been changed or that contain restricted instructions is controlled by the allow object differences (ALWOBJDIF) parameter on the restore commands.

To detect changes to a program (rather than through a normal system interface), a validation value is calculated when the program is created. When the program is restored, the validation value is calculated again and compared to the value that was calculated when the program was created.

- If the program was created on a Version 1 Release 2 or earlier system, no validation value is saved with it. The QSECURITY system value and the ALWOBJDIF parameter on the restore command is checked as follows:

  - If the security level is 30 or lower, or when ALWOBJDIF(*ALL) is specified, the program is restored with no further validation or notification given.

  - If the security level is 40 or higher and ALWOBJDIF(*NONE) (the default) is specified, an attempt is made to translate the program again. If the translation succeeds, the copy of the retranslated program is restored. No *AUTFAIL type journal entry is written in the QAUDJRN journal.

    If the translation fails, the original copy of the program is restored and all public and private authorities are revoked. Ownership of the program is transferred to the QDFTOWN user profile. A *AUTFAIL type journal entry is written to the QAUDJRN journal to indicate the changes. Message CPF375B is sent to the job log. The security officer must decide whether to accept the program (change ownership, grant authority, or reject it).

    The translation fails if the observability of the program has been removed.

For more information on setting up and managing the QAUDJRN journal, see the *Security Reference* manual.

- If the program has a correct validation value saved with it, the original program is restored. The QSECURITY system value and the ALWOBJDIF parameter on the Restore commands do not apply. No *AUTFAIL type journal entry is written in the QAUDJRN journal.
- If the program has a validation value that fails, an attempt is made to retranslate the program.
  - If the translation succeeds, the program is restored. A *AUTFAIL type journal entry is written to the QAUDJRN journal to indicate what happened. Message CPF375C is sent to the job log.
  - If the translation fails, the original copy of the program is restored from the media. The security and logging actions taken depend on the QSECURITY system value and the ALWOBJDIF parameter on the Restore command.
    - If the security level is 30 or lower, a *AUTFAIL type journal entry is written to the QAUDJRN journal to indicate that a program was restored that may result in a possible violation of security. Message CPF375A is sent to the job log.
    - If the security level is 40 or higher and ALWOBJDIF(*ALL) is specified on the restore command, a *AUTFAIL type journal entry is written to the QAUDJRN journal to indicate that a program was restored (as requested by a user with *ALLOBJ special authority) that may result in a possible violation of security. Message CPF375D is sent to the job log.
    - If the security level is 40 or higher and ALWOBJDIF(*NONE) is specified on the restore command, all public and private authorities are revoked and ownership of the program is transferred to the QDFTOWN user profile. A *AUTFAIL type journal entry is written to the QAUDJRN journal to indicate the changes. Message CPF375B is sent to the job log.

Table 6-2 shows what happens at each security level.

Table 6-2. Restore of Programs That Use Interfaces That Are Not Supported

Validation Value	Successful Translation	Level 40 or higher and ALWOBJDIF (*NONE)	Level 40 or higher and ALWOBJDIF (*ALL)	Levels 30 or lower
None	Yes	1	N/A	N/A
None	No	2	N/A	N/A
None	Not attempted	N/A	3	3
Valid	Not attempted	4	4	4
Not valid	Yes	5	5	5
Not valid	No	2	6	6

Notes:

1 Restore a copy of the translated program. No notification is given.

2 Restore the original program, revoke all public and private authorities, unlink any authorization lists, and change the owner to the QDFTOWN user profile. Write the journal entry to the QAUDJRN journal and send a message to the job log.

3 Restore the original program. No notification is given.

4 Restore the translated program. No notification given.

5 Restore the translated program. Write the journal entry to the QAUDJRN journal and send a message to the job log.

6 Restore the original program. Write the journal entry to the QAUDJRN journal and send a message to the job log.

Restoring the System in Parts

You do not have to restore all user libraries before restoring authority and beginning operations. If your restore strategy is to recover the critical applications first, your save strategy must be designed to allow for a partial recovery. During a partial recovery, libraries QGPL and QUSRSYS must be restored (in that order) before the application libraries or document library objects. You may want to save libraries QGPL and QUSRSYS to the media as a group. If applications A and B are the most critical applications to your business, you should save those applications and application-dependent objects (including journals and journal receivers) to the media as a group. This allows you to restore applications A and B first.

After the Licensed Internal Code and the OS/400 licensed program have been installed, you can restore the remainder of your system in parts. You can restore all user profiles, restore only critical user libraries, and then restore object authorities (RSTAUT command).

Attention!

If you restore a subset of user profiles, the password and group profile information is not restored. Any subsequent RSTUSRPRF command will not restore the remaining private authorities to the user profiles already restored. Therefore, you should use RSTUSRPRF USRPRF(*ALL) when restoring the user profiles.

Later, you can restore less critical libraries, but you must enter the RSTUSRPRF, RSTLIB, and RSTAUT commands again (in that order).

The RSTUSRPRF command builds an internal table of authorities that existed when the user profiles were saved. The RSTAUT command uses this table to grant authorities and then deletes the table.

Notes:

1. The subsequent RSTUSRPRF command resets the user profile attributes to their status at the time of the save.
2. The subsequent RSTAUT command grants the private authorities saved at the time of the original save, but does not revoke any private authorities granted since then.

The following are the basic steps for a partial recovery:

1. Restore the Licensed Internal Code.
2. Restore the operating system.

   Attention!

   During a partial recovery, you must ensure that all the libraries in the library list (QSYSLIBL and QUSRLIBL system values) are restored or remove the libraries not being restored from the library list. During the restore of the operating system, you can select the option to define or change the system at IPL. Then, select to change the system values on the Define or Change System at IPL display.

3. Restore all the user profiles using RSTUSRPRF USRPRF(*ALL). This recovers object ownership, public authority, and automatically links the objects to the authorization lists.
4. Restore the configuration objects using the RSTCFG command.
5. Restore libraries QGPL and QUSRSYS using the RSTLIB SAVLIB(QGPL QUSRSYS) command (in that order).
6. Restore the critical applications and application-dependent objects or document library objects using the RSTLIB, RSTOBJ, or RSTDLO command (this depends on how the libraries and objects were saved).

   Note: If the application-dependent objects were journaled at the time of the save operation, the journals must be restored before the journaled files.

7. Restore any changed objects from your daily save media for QGPL, QUSRSYS, and the critical libraries using the RSTOBJ command.

8. If necessary, apply any journaled changes to the objects.
9. Restore the private authorities to the objects using the RSTAUT command. The RSTAUT command also restores user authorities to authorization lists.
10. When your system activity allows you to put the system in a restricted state again, restore all user profiles again, the remaining libraries, and run the RSTAUT command.

Restoring Related Objects in the Correct Order

Certain related objects (see the following list) must be restored in a specific order. When the related objects are in the same library, the *system* restores the objects in the correct order. When the related objects are in different libraries, *you* restore them in the correct order, as follows:

- Journals must be restored and then the files being journaled must be restored. Otherwise, journaling is not started again for the restored files.

  If you save your libraries using SAVLIB LIB(*NONSYS or *ALLUSR), the system cannot determine if your journals are restored before your files. Also, if the based-on files are not in the same library as the logical files, the system cannot determine if the based-on files are restored before the logical files. SAVLIB LIB(*NONSYS or *ALLUSR) saves the libraries in alphabetic sequence while RSTLIB SAVLIB(*NONSYS or *ALLUSR) restores the libraries in the order they were saved. You can name your journal library in such a way that it is restored before the database files (for example, #JOURLIB).

  For more information about restoring libraries, journals, journal receivers, and database files in the correct order, see the topic "Using Database Recovery Operations" in the *Advanced Backup and Recovery Guide*.

- Logical files cannot be restored until the physical files or logical files on which they are dependent are restored.

When a file is restored that causes an access path to be rebuilt, rebuilding occurs asynchronously from the restore operation and can finish later (after you have finished restoring files).

Interrupted Operation

The restore operation can damage an object so that the object and its data may not be restored properly. For instance, if you cancel the restore operation of a member before the entire member is replaced, the member contains some old and some restored data, and is considered logically damaged. You should delete such an object. For each damaged object a message is sent to the history log and to the user who first encounters the damage.

If a restore operation on a database file is interrupted by a system or job end, an escape message is sent. Recovery for that file is started when you attempt to restore the file again, save it, or do an IPL. The system will do restore recovery when any database recovery-sensitive function is done. At that point, informational messages are sent to the history log to indicate if recovery was successful or unsuccessful. Recovery does not mean that the restore operation is completed. Instead, it means that the file is recovered so other operations on it can succeed.

Considerations for Restoring from a Distribution Tape

If you are installing a new release or restoring the system from a distribution tape, any object that you have changed (such as system values or network attributes) is changed back to the IBM-supplied defaults when it is restored from the distribution tape. The objects you previously changed have to be changed again after the restore operation is completed.

If you do not have a current backup copy of the operating system (SAVSYS media) and restore the operating system from a distribution tape, you may have a problem with sending messages or creating documents if you have OfficeVision/400. When the operating system is restored from the distribution tape, it rebuilds the OfficeVision/400 message file. To prevent errors, enter the following command:

```
MRGMSGF QOFC/QZOFCMSG  QSYS/QOFCMSG
```

Determining Which Objects Were Restored

Information about the objects restored during the restore operation can be directed to a database file using OUTPUT(*OUTFILE).

If OUTPUT(*OUTFILE) is specified, an application program can analyze or reformat the data as desired.

You can specify OUTPUT(*OUTFILE) on the following commands:

- RSTLIB (Restore Library)
- RSTOBJ (Restore Object)
- RSTCFG (Restore Configuration)
- RSTDLO (Restore Document Library Objects)
- RSTUSRPRF (Restore User Profile)

The Restore outfile and the RSTDLO outfile have the following fields in common:

- Device names
- Save file name
- Save file library
- Restore release
- Save release
- File label
- Sequence number
- Volume identifiers
- Save timestamp
- Restore timestamp
- Restore status

The RSTDLO outfile specific fields are: system object name, sender user ID, sender address, and date sent.

The Restore outfile-specific fields are: restore command, member name, object attribute, restore library, and restore ASP.

The information type (INFTYPE) parameter can also be specified with the OUTPUT parameter on the RSTLIB and RSTOBJ commands. This parameter allows the user to select the desired level of detail in the information.

Considerations for Restoring the System with Automatic Configuration Not Enabled

The following considerations apply to the restore operation after function code 24 (Install) is used to restore the Licensed Internal Code.

If the QAUTOCFG system value was saved as *NO on the save media, SRC A900 2000 is displayed on the control panel during the restore of the operating system. You need to create a tape description and possibly a controller description to finish the restore operation. **Do not** create a user-defined device description for the console display.

To avoid creating a tape description and a controller when restoring the operating system, you can leave the default value (*Y*) for the *Set the major system options* prompt on the IPL Options display. If enable automatic configuration is set to *NO*, you will receive SRC A900 2000 on the control panel later in the restore operation.

If you are using the System/36 environment on your system as the primary operating environment, ensure that the QAUTOCFG system value is set to *NO. If the AUTOCFG system value is specified as *YES when the operating system is being restored, you may experience a problem with the System/36 environment after restoring the remaining parts of the system. The locking rules used during the restore process may cause a problem. The QS36ENV configuration object in library #LIBRARY may have been locked by the System/36 environment.

This object contains the System/36 environment names for the workstation, printer, and tape and diskette units on the system. It also contains the default System/36 environment values used for all users. This object may have been modified by the Change System/36 (CHGS36) command to customize the System/36 environment.

When the first subsystem is started on the system after the restore process is complete, a new #LIBRARY and a new QS36ENV object in #LIBRARY are created with the AS/400 system defaults. In addition to the new objects being created, each subsystem holds a lock on the QS36ENV configuration object to ensure that it is

not deleted. This lock does not allow the saved QS36ENV configuration object to be restored.

Considerations When Restoring Object Audit Values

If an object is being restored over an object on the system, the object auditing value on the system is maintained. If the object does not exist on the system at restore time, then the object auditing value on the media is restored. If the object is a library and the library does not exist on the system, the auditing value for each object restored in the library comes from the media.

Chapter 7. Saving and Restoring Office Services Data

Office services data includes the following:

- Document library objects
  - Documents
  - Folders
- Mail
  - Distribution objects
- Office database files
  - System distribution directory files
  - Distribution list files
  - Document and folder search index files
  - User permission file
  - Nickname file
  - Calendar files
- Office services journal
  - QAOSDIAJRN
  - Journal receivers

Figure 7-1 illustrates a complete save operation.

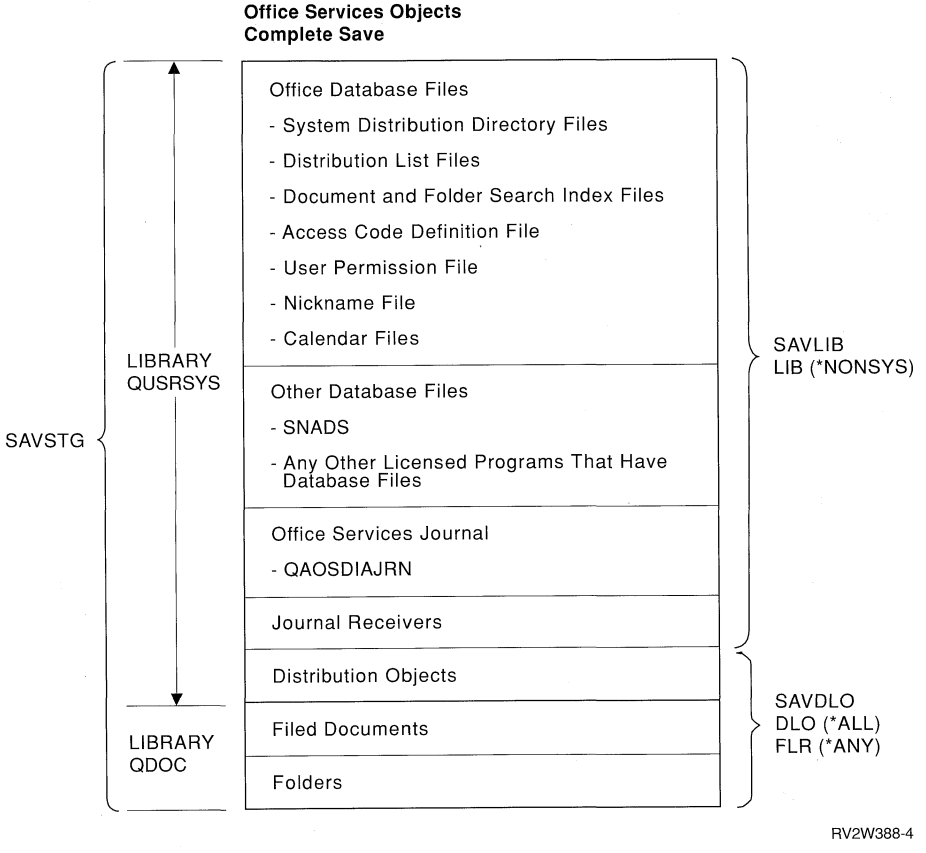


Figure 7-1. Complete Save of Office Services Objects

Saving Document Library Objects

When a document is filed or created by an office product, it is stored in library QDOC as an object with the type *DOC. Documents can be saved individually or in a group using the SAVDLO command.

Restrictions:

- You must have *ALLOBJ or *SAVSYS special authority to use the following parameter combinations on this command:
  - DLO(*ALL) FLR(*ANY)
  - DLO(*CHG)
  - DLO(*MAIL)
  - DLO(*SEARCH) OWNER(*ALL)
  - DLO(*SEARCH) OWNER(*user-profile-name*)

  where the *user profile name* specified is not the *user profile name* of the user running the SAVDLO command.
- Users that do not have *ALLOBJ or *SAVSYS special authority must:
  - Have *ALL authority for each document or folder to be saved
  - Be enrolled in the system distribution directory

Parameters for the SAVDLO command allow you to:

- Name specific documents to save by user-defined name or by system object name.
- Specify search values using DLO(*SEARCH) and the SRCHTYPE parameter to identify which documents or folders to save.

  You can use the search type (SRCHTYPE) parameter to specify that you are searching for only documents, or you can search for both folders and documents. SRCHTYPE(*DOC) is the default. If you specify SRCHTYPE(*DOC), then you can specify any of the search parameters:
  - FLR–Folder
  - CHKFORMRK–Marked for offline storage
  - CHKEXP–Document expiration date
  - CRTDATE–Creation date
  - DOCCLS–Document class
  - OWNER–Owner
  - REFCHGDATE–Document last changed date
  - REFCHGTIME–Document last changed time

  If you specify SRCHTYPE(*ALL), then all the folders (including all the folders and documents within them) that meet the specified search parameters are saved. If you specify SRCHTYPE(*ALL), then you can specify the following search parameters:
  - CRTDATE–Creation date
  - OWNER–Owner
  - REFCHGDATE–Document last changed date
  - REFCHGTIME–Document last changed time

  If REFCHGDATE, REFCHGTIME, and CRTDATE are specified, the date and time must be the same.
- Specify saving all distribution objects (mail), all filed documents and all documents referenced by a distribution by specifying DLO(*MAIL).
- Save all new folders, new and changed documents, and distribution objects by specifying DLO(*CHG).
- Save documents, folders, and distribution objects while they are in use by specifying SAVACT(*YES).

There are different methods you can use for planning to save documents. If you do not plan to save many documents, you could save individual documents or a selected group of documents when necessary. For example, if you mark all documents to be saved, you could use the SAVDLO command once a week (or once a day or month) to save all marked documents. Or you could use the SAVDLO command once a week (or once a day or month) to save all documents you have finished working with.

When you use the SAVDLO command to save filed documents and folders to a save file, the save file can be saved to diskette or tape using the Save Save File Data (SAVSAVFDTA) command. The documents and folders can then be restored using the RSTDLO command directly.

Reducing Disk Space Used by Documents

Documents tend to accumulate. As they accumulate, more and more storage is required. You should establish policies regarding saving, deleting, or freeing documents that are no longer needed to free disk space. As a regular practice, you should save the following types of documents, or folders containing the following types of documents:

- Documents only needed occasionally
- Lengthy documents

You can mark a document for offline storage before you save a document. You can mark the document so that:

- The document text, document details, and the document are deleted when the document is saved.
- The document text is deleted to free disk space, but the document details and the document remain in the search index database.
- The document remains the same after it is saved.

When the document details remain in the search index database, the document name is shown when you list the names of documents in the folder. The document name can appear in a search list when you search for documents. That way an OfficeVision/400 user can find that the document has been saved to tape or diskette. The document must be restored to the system using the RSTDLO command before a user can look at or change the document contents.

After you have marked the documents you want to save, you can use the SAVDLO command with the CHKFORMRK(*YES) parameter specified to save all documents that are marked for storage.

Even if you did not mark the documents for storage, you can specify in the SAVDLO command to delete the document from the document library by specifying STG(*DELETE) or delete the document text and keep the document details by specifying STG(*FREE).

Mail

Mail objects are internal objects created and managed by document distribution services. For a description of these objects see the *Office Services Concepts and Programmer's Guide*.

The Save Document Library Object (SAVDLO) command is used to save mail.

The following calls of SAVDLO save mail:

- SAVDLO DLO(*ALL) FLR(*ANY)
- SAVDLO DLO(*CHG)
- SAVDLO DLO(*MAIL)

Things to know about saving mail:

- *ALLOBJ or *SAVSYS special authority is required to save mail.
- Mail changes frequently and should be saved regularly.
- Mail cannot be saved to a previous release.
- Mail cannot be saved for only one user.

The Restore Document Library Object (RSTDLO) command is used to restore mail.

The following calls of RSTDLO restore mail:

- RSTDLO DLO(*ALL) SAVFLR(*ANY)
- RSTDLO DLO(*MAIL)

Things to know about restoring mail:

- *ALLOBJ or *SAVSYS special authority is required to restore mail.
- Mail cannot be restored for only one user.
- Mail objects still on the system are not replaced with the copy of the object on the media.
- Mail can be down-level.

The following scenario illustrates how mail can be down-level:

1. Save mail.
2. All recipients of a given distribution handle that piece of mail and then delete it from their mail logs.
3. Restore mail.
4. The deleted distribution is restored because it was not currently on the system.

5. All recipients of the "handled" distribution will find that distribution in their mail logs again and will have to handle it again.

Mail is not always down-level when it is restored. The following scenario illustrates when mail is not down-level:

1. Save mail.
2. All but one of the recipients of a given distribution handle that piece of mail and then delete it from their mail logs.
3. Restore mail.
4. Since one recipient of the distribution had not handled and deleted it from his mail log, the distribution was still on the system at the time of the restore and was not replaced with the copy on the media.
5. All recipients of the "handled" distribution will find that distribution in their mail logs again and will have to handle it again.

Prior to V2R2 mail was saved by a two-command process:

1. Part of the mail was saved by either the Save Security Data (SAVSECDTA) command, SAVSECDTA MAIL(*YES), or the Save System (SAVSYS) command.
2. The other part of mail was saved by the SAVDLO command.

To restore mail saved prior to V2R2 requires a two step restore:

1. Load the SAVSECDTA MAIL(*YES) or SAVSYS tape and restore the first part of mail with the Restore User Profiles (RSTUSRPRF) command, RSTUSRPRF USRPRF(*ALL) MAIL(*YES).

   Note: RSTUSRPRF USRPRF(*ALL) MAIL(*YES) restores user profiles, special authorities, authorization lists, and authority holders as well as the first part of mail.
2. Load the SAVDLO tape and restore the second part of mail with the RSTDLO command.

SAVDLO Output

If you specify OUTPUT(*PRINT) along with the SAVDLO command, the printed output for any folders, documents, and mail shows specific information about the saved documents, folders, and mail. The heading information in the output is device-dependent. All information does not appear for all devices.

The print file for the SAVDLO command uses a character identifier (CHRID) of 697500. If the printer you are using does not support this character identifier, you will receive message CPA3388. To print the SAVDLO output and not receive message CPA3388, specify the following before specifying *PRINT on the SAVDLO command:

```
CHGPRTF FILE(QSYSOPR/QPSAVDLO) CHRID(*DEV)
```

For more information about character identifiers (CHRID), see the *Guide to Programming for Printing*.

To write the information to a database file, specify OUTPUT(*OUTFILE) OUTFILE(library/file-name) OUTMBR(member-name). The file specified must have the same format as the file format name QSYS/QAOJSAVO.OJSDLO. The *Office Services Concepts and Programmer's Guide* has a description of the format of this file.

You can add records to this file for each save operation that you do. Then, if you want to write an application program that retrieves information from this file, you can do so. If you use the OUTPUT(*OUTFILE) parameter, you should periodically review the file that has output records being written to it so it does not become too large. If it gets very large, you should consider saving and then clearing it. You do not need to create the file in advance. The SAVDLO operation does this for you.

Saving from Document Lists

The command SAVDLO(*DOCL) DOCL(document-list-name) FLR(folder-name) saves all the documents referenced by a document list. The document list itself is not saved (it can be saved separately). The document list must be in a folder. If any folders are referenced by the document list, they are not saved.

IBM-Supplied Journals Used for Documents or Folders

When a document is filed or a folder is placed in the document library, details assigned by the user are placed in database files in library QUSRSYS that are separate from the document or folder. Every time a user changes the document or folder details, the database files are updated. To manage database files, the system uses journaling, which is the primary means of recovering from errors. The journal receiver can grow quite large. Therefore, you should periodically detach and save a full journal receiver, and attach a new one. For more information on how to detach and save journal receivers, see the *Advanced Backup and Recovery Guide*.

Files That Are Journaled for Directories and Search Index Database Files

Some files used by Office are automatically journaled by the system. These files, found in library QUSRSYS, contain information about directories and search index database files. The following is a list of these files:

QAOKPLCA	QAOSAY05
QAOKPX4A	QAOSAY07
QAOKP01A	QAOSSS10
QAOKP02A	QAOSSS11
QAOKP03A	QAOSSS12
QAOKP04A	QAOSSS13
QAOKP05A	QAOSSS14
QAOKP06A	QAOSSS15
QAOKP08A	QAOSSS17
QAOKP09A	QAOSSS18

If you are using SAVLIB LIB(*ALLUSR) to save QUSRSYS when the system is not in a restricted state, some of the QAO* files may not be saved (for example, if QSNADS subsystem is active). Make sure the associated subsystems are not active if you want to ensure these files are saved.

If you specify SAVACT(*YES) on the SAVLIB command, the QAO* files are saved in QUSRSYS.

The Restore Library (RSTLIB) and Restore Object (RSTOBJ) commands prevent the restore of search index database files (QAOSSS10 through QAOSSS15, QAOSSS17, and QAOSSS18) to a system where they already exist. If one of these files becomes damaged or deleted, you must run RCLDLO DLO(*ALL) after restoring the files from your most recent save tapes.

Restoring Document Library Objects

To restore documents, folders, and distribution objects, use the Restore Document Library Object (RSTDLO) command.

This command allows you to specify the documents and folders you want to restore, in several ways. You will be able to use the RSTDLO command most efficiently and effectively if you are aware of which media or save files contain the documents and folders you want to restore. If printouts from the SAVDLO command are available, you should review these, or use the Display Tape (DSPTAP), Display Diskette (DSPDKT), or Display Save File (DSPSAVF) command if no lists are available to determine which files contain the documents and folders you want to restore.

Documents and folders are stored in library QDOC. Only documents and folders should be stored in this library. After documents have been filed and saved, restore them using the Restore Document Library Object (RSTDLO) command.

Note: To restore documents and folders to a folder, you must have authority to the folder to which the documents and folders are being restored. See the *Security Reference* for more information about authority required for objects when using commands.

No search values exist for folders. You can restore individual documents or folders within the saved folders.

The name of the document to be restored is specified by the DLO parameter. Folder names are not allowed on the DLO parameter. Documents that were saved by a user-specified name can be restored by either the user-specified name or the system object name. You can enter up to 300 names on one RSTDLO command. Specifying DLO(*ALL) restores all the folders and documents that match the values specified by all the remaining parameters on this command. To restore a folder object, the entire folder (the folder

object plus all document and folder objects within it) must also be restored. However, if the specific folder being restored was saved in other folders at the time it was saved, those higher-level folders do not have to be restored to restore the specific folder.

The RSTDLO command supports RSTDLO DLO(*ALL) SAVFLR(*ANY) to restore all the document and folder objects that are on the tape volume currently placed in the tape unit for the sequence numbers you have specified.

Documents and folders are filed again when you attempt to restore documents and folders that are unknown to the system, either because they have been deleted, they are being restored on a different system than they were saved on, or they are being restored with the NEWOBJ(*NEW) parameter. The search index database is updated with the restored detail information for each restored document or folder.

The following are ways you might restore folders and documents:

- Restore 1 to 300 documents from the same media file by specifying the names of the documents. You have the option of renaming them, restoring them into a different folder, and creating new system object names.
- Restore 1 to 300 folders from the same media file, and optionally create new system object names for each document and folder object restored.
- Restore all filed documents that are not in any folder on the save media and optionally create new system object names for each document restored.
- Restore 1 to 300 documents by system object name, and optionally create new system object names for each document restored.

There are some restrictions on the results you will obtain from the RSTDLO command for certain combinations of parameters, depending on what the input was for the SAVDLO command. To help you plan your restore process, those considerations are discussed in the following topics.

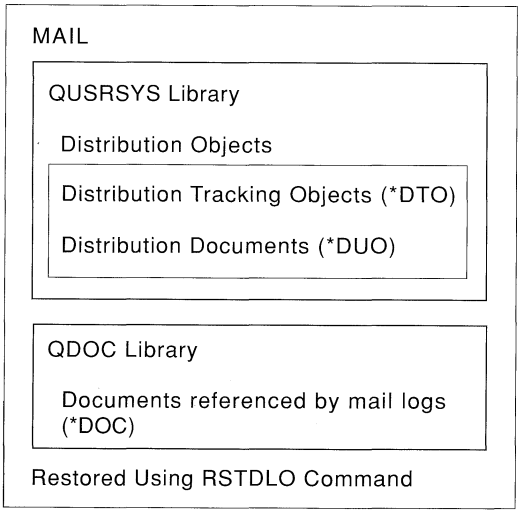
Restoring into an Existing Document Library Object: If you try to restore a document library object that already exists on the system and it is in use or you are not authorized to it, it is ignored and the restore operation continues with the next object. If you try to restore a folder that already exists on the system, and the folder is in use, the entire folder (and all documents and folders in it) is not restored.

Restoring Lists of Documents or Folders

When restoring lists, be sure that all the documents and folders in the list are in the same file on the media. The restore operation is done from the first file on the media that contains any of the items in the list.

Restoring Distribution Objects and Documents (Mail)

The following figure shows objects associated with the mail and how they are restored.



The easiest way to restore all documents and distribution objects (mail) from the save media or online save file is to specify RSTDLO DLO(*MAIL), or if SAVDLO DLO(*MAIL) is used to create the save media or online save file, you can specify RSTDLO DLO(*ALL) SAVFLR(*ANY).

Specifying RSTDLO DLO(*MAIL) restores only those filed documents that have a mail log reference at the time they are saved, plus all the distri-

bution objects and distribution documents from the save media or online save file. Specifying RSTDLO DLO(*ALL) SAVFLR(*ANY) restores all the filed documents, distribution objects, documents, and folders from the save media or online save file.

Distribution documents and objects cannot be restored individually. If you specify any other form of the RSTDLO command, such as RSTDLO DLO(*ALL) SAVFLR(A) and RSTDLO DLO(X) SAVFLR(A/B), then no distribution documents and objects are restored. If the filed documents that are restored using these other forms of the RSTDLO command contain mail log references, then the mail log references are restored if the distribution objects exist on the system.

Mail log references are updated for all existing local recipients of a restored document. Mail log references on remote systems for remote recipients are not restored. If a document being restored still exists in a mail log at the time it is restored, then the contents of the document are restored and the status of the document in the mail log is not changed. If the document being restored has been deleted from a mail log, then the status of the restored document is either *filed* for a filed document or *opened* for a distribution document.

Mail log references are restored for a local sender of a document if there was an entry in the sender's mail log at the time the distributions were saved. Entries in the mail logs of remote senders are not saved or restored.

Rename Directory Entry (RNMDIRE) Command as It Relates to Saving and Restoring the Mail: When a Rename Directory Entry (RNMDIRE) command is scheduled for a local user, it is recommended that it take place just before your scheduled backup of the mail and the system distribution directory. If the rename operation is performed just before saving the mail and the directory, the changed information is saved and the information will be the same as what is on the system. If the information on the media does not match the information on the system, the mail will not be restored during the restore operation.

RSTDLO Output

Information about the RSTDLO operation can be printed or sent to an output file.

If you specify OUTPUT(*PRINT) along with RSTDLO DLO(*ALL) SAVFLR(*ANY) or DLO(*MAIL), the printed output for any folders, filed documents, and distributions that are restored shows specific information about the restored document, folders and distributions. The heading information in the printed output is device-dependent. All information does not appear for all devices.

If you specify OUTPUT(*OUTFILE) along with RSTDLO DLO(*ALL) SAVFLR(*ANY) or DLO(*MAIL), the output for any folders, filed documents, and distributions that are restored shows specific information about the restored document, folders and distributions. The following is some of the information provided when OUTPUT(*OUTFILE) is specified:

- Save file name
- Save file library
- Storage freed
- Data compression
- Data compaction
- Target release
- Indicators for the following date fields:
  - Save date
  - Document creation date
  - Document sent date

Restoring Security for Documents and Folders

If a document or folder being restored does not already exist on the system at the time it is restored, then the personal status, authorization lists, and public authority are restored from the save media. Any access codes and explicit users are removed. If the document or folder already exists on the system, then the security information remains unchanged on the system.

Restoring Ownership for Document Library Objects: When a document or folder is saved, the name of the owner's user profile is saved with it. When an object is restored that does not already exist on the system, the system determines if the owner's user profile exists in the system distribution directory. If the owner exists

and is enrolled in the system distribution directory, that owner's documents and folders are restored with the same owner they had when they were saved. The person doing the restore operation must be authorized to create documents and folders for the owner.

If the owner of a document or folder being restored does not exist on the system or is not enrolled in the system distribution directory, then the document or folder is restored and the default owner (QDFTOWN) user profile becomes the owner.

If the owner of the document on the system does not match the owner of the document on the save media, and the allow object differences (ALWOBJDIF) parameter was specified as *ALL on the RSTDLO command, then the ownership of the document on the system is not changed and the document is restored. You must have all object (*ALLOBJ) special authority to specify ALWOBJDIF(*ALL).

Restoring Documents with Differences in Ownership: The allow object differences (ALWOBJDIF) parameter allows documents and folders to be restored even if the owner and system object name on the system, and the owner and system object name on the media do not match. You cannot specify NEWOBJ(*NEW) when ALWOBJDIF(*ALL) is also specified. You must have all object (*ALLOBJ) special authority to use the *ALL value with the ALWOBJDIF parameter.

Restoring Damaged Document Library Objects

If you try to restore into an existing document but the document is damaged, some of the security information may be lost. The restore operation continues and a message is sent informing you that the document is damaged and some of the security information is lost.

If you try to restore into an existing folder but the folder is damaged and cannot be reclaimed, you receive a message informing you that the folder is damaged and not restored. The folder and all documents and folders in it are not restored.

Reclaiming Documents and Folders

When users are working with documents and folders, you may need the Reclaim Document Library Object (RCLDLO) command to recover the documents and folders when users are having problems with the documents and folders (such as internal errors). In that case, you must reclaim the document or folder before it can be used.

In all cases, you are notified when a RCLDLO operation is necessary. For more information on this command, see the online information for the RCLDLO command.

Folder Considerations

When you restore a folder, the fully qualified folder path name you are restoring must exist unless you are restoring a root folder. For example, if you save folder A and then delete it, you can enter RSTDLO DLO(*ALL) SAVFLR(A) and restore folder A in addition to all the documents and folders in it. However, if you want to restore folder A/B/C/D, you must create folder A, then folder B in folder A, then folder C in folder A/B, before you can restore folder D in folder C. You only have to create the folders that comprise the A/B/C path, and you do not have to create folder D in folder A/B/C before you can restore it.

Document Considerations

The default for restoring documents is to restore them into the folder they were saved from. However, when you restore documents by document name, you can also specify new names for them in the RENAME parameter as well as a new folder to place them in, using the RSTFLR parameter.

For example, RSTDLO DLO(A B C) SAVFLR(Q) RENAME(D E F) would get documents A, B, and C in folder Q from the media and put them in folder Q on the system. Document A is renamed D, B is renamed E, and C is renamed F.

RSTDLO DLO(A B C) SAVFLR(Q) RSTFLR(P) would get documents A, B, and C in folder Q from the media and put them in folder P on the system (P must already exist on the system). The document names would still be A, B, and C.

RSTDLO DLO(A B C) SAVFLR(Q) RENAME(D E F) RSTFLR(P) would get documents A, B, and C in folder Q from the media and rename them as D, E, and F in folder P (P must already exist on the system).

If a duplicate name or a document that cannot be restored is found in the name list you specified on the DLO parameter, and new names are specified in the RENAME parameter, then the RENAME that corresponds to the duplicate or document that cannot be restored is ignored. For example, RSTDLO DLO(A B A C) SAVFLR(Q) RENAME(D E F G) gets documents A, B, and C in folder Q from the media and puts them in folder Q on the system. Document A is renamed as D, document B is renamed as E, the second document A is not renamed to F, and document C is renamed as G.

If you enter fewer names in the RENAME list than in the DLO name list, the RENAME entries are used until the end of the RENAME list is reached, and the remaining documents are restored without new names. If you enter more names in the RENAME list than in the DLO name list, the extra names are ignored. There is always a one-to-one relationship between the names in the DLO name list and the names in the RENAME name list. You cannot use RENAME or RSTFLR when you are restoring documents by system object name.

The creation date, file date, and revision date for restored documents and folders are set as follows:

- The creation date of the document or folder on the save media is restored with the document or folder.
- When the RSTDLO command replaces a document or folder, the file date of the document or folder being replaced on the system is used.
- The object revision date is set to the current date when the document or folder is restored.
- The content revision date of the document on the save media is restored with the document.
- The content revision date is set to the current date when replacing a folder.
- The content revision date of the folder on the save media is restored with the folder if the folder is new.

Considerations for Using the RSTDLO Command Efficiently

To use the RSTDLO command efficiently, consider the following guidelines:

- If you are restoring many objects, consider getting *SAVSYS authority, especially if you plan on doing large restore operations frequently.
- Producing an output file or printout takes time. Use OUTPUT(*PRINT or *OUTFILE) only if you need it.
- If you are restoring from a file in the middle or end of a tape with many files on it, check the contents of the tape by examining the output from either the SAVDLO printout or the Display Tape (DSPTAP) command before restoring. Then enter the sequence number(s) you need instead of leaving the *SEARCH default.
- Do not run large restore operations (thousands of documents or folders) when the system is at peak capacity, or when there is a lot of activity in a folder that you are restoring many documents or folders into.

Considerations for Restoring Previous-Release Data

If you are restoring document library objects that were saved before Version 2 Release 2, consider the following:

- The RSTDLO command no longer optimizes the storage of a document. The Reorganize Document Library Object (RGZDLO) command can be used to optimize the storage of a document after it is restored.
- Distribution objects are restored by the RSTUSRPRF command if the data was saved using the SAVSYS or SAVSECDTA command.
- If many objects were saved, more than one media file may exist. To restore all the objects, you must specify a beginning and ending sequence number on the SEQNBR parameter if the RSTDLO command is used. The following is a list of the number of objects for each file, depending on the release:

Table 7-1. Number of objects for Each File		
Version	**Release**	**Number of Objects for each File**
1	1	8000
1	2	8000
1	3	16000
2	1	32000

Restrictions for Running the SAVDLO, RSTDLO, and RCLDLO Commands at the Same Time

No two of the following commands may be run on one system at the same time: SAVDLO, RSTDLO, RCLDLO DLO(*ALL), and RCLDLO DLO(*INT). The SAVDLO and RSTDLO commands cannot be run at the same time when running other SAVDLO and RSTDLO commands, even if different devices are used. An attempt to run these commands at the same time results in the message CPF8A47:`Internal objects are in use`. The second set of SAVDLO, RSTDLO, or RCLDLO operation ends with no objects saved, restored, or reclaimed.

Recovering Text Index Files for Text Search Services

The text index database files are a part of the Text Search Services. For more information about Text Search Services, see *Office Services Concepts and Programmer's Guide.*

The text index recovery process must ensure a consistent, usable set of index files. The text search index contents must be consistent with the document library contents. The last version indexed date for all documents is recorded in both the text index and the individual documents. The dates are used in the recovery process to ensure that the text index and the document library content match.

The text index database files are saved when library QUSRSYS is saved. A list of the files that are saved when library QUSRSYS is saved is shown in a table in *Office Services Concepts and Programmer's Guide.*

If you are restoring the text index files, then all of the files must be restored together from the same backup media. If they are not restored from the same media, their association to each other is lost. The loss of the association to each other can cause unpredictable results. If you do not have saved copies of the files, then you must delete the files and then restore them from your distribution tapes.

Considerations for Saving and Restoring Text Index Files

- Before you save the text index files, it is recommended that you update the index using the Start Update Index (STRUPDIDX) command to finish any outstanding requests.
- Running one of the following commands will remove records from the index when the next STRUPDIDX command is run.
  - SAVDLO STG(*DELETE) is specified.
  - SAVDLO CHKFORMRK(*YES) is specified and the document is marked for save and delete.
  - Running the DLTDLO command.
- You must make sure that the Start Update Index (STRUPDIDX) command or the Reorganize Index (RGZIDX) command is not running during the save operation. To ensure that STRUPDIDX or RGZIDX is not running, use the End Index Monitor (ENDIDXMON) command to end the automatic administration monitor and then select option 8 (Display all status) on the Work with Text Index (WRKTXTIDX) display to verify that the update and reorganize functions are not running.
- The text index details are kept in the administration table file. Pointers to the current index are stored in the table. The administration table file must be restored with the other files. If you have changed the defaults for the text index details, then before restoring the files, write down the current text index details (if available). To display the text index details, type `WRKTXTIDX` on a command line and press the Enter key. Then select option 5 (Display details) on the Work with Text Index display. You can enter the values again after the table is restored.

- If the scheduling queue (file QABBIQTB) is damaged and there are documents on the system, you can restore the scheduling queue and can get back some of the requests that were lost if the saved scheduling queue is a very recent copy. Retaining the requests on the restored scheduling queue may not be a benefit if it is not a recent copy. You can clear the scheduling queue by selecting option 2 (Change details) on the Work with Text Index display. The restored scheduling queue will be empty but usable.

See Chapter 10, "Working with the Save and Restore Procedures" on page 10-1 for the procedures to save and restore the system. If you plan to use these procedures to restore the entire system, you do not need to use the recovery steps in Table 7-2.

Recovering the Text Index

Table 7-2 shows problems that can occur with the text index data base files and associated libraries. The table also provides solutions and procedures to correct the problems.

Table 7-2 (Page 1 of 4). Recovery for Search Index Services Files

Problem and Cause	Solution	Procedure
PROBLEM: All text index files are gone. CAUSE: Library QUSRSYS was cleared or deleted[1].	Restore all files from save media. After the restore operation is complete, run the reclaim operation[3,4]. After the reclaim operation is complete, start updating index requests.	RSTLIB SAVLIB(QUSRSYS) RCLDLO DLO(*ALL) STRUPDIDX
PROBLEM: The scheduling queue file is not usable. CAUSE: Scheduling queue was damaged or deleted.	Restore the scheduling queue file and optionally clear the scheduling queue.	RSTOBJ OBJ(QABBIQTB) SAVLIB(QUSRSYS) WRKTXTIDX Select option 2 (Change details) on the index that has the scheduling queue to be cleared. Under the clear parameter, select a *Y* to clear the scheduling queue.
PROBLEM: The text index files are usable, their content is not usable. CAUSE: Text index files were restored that were not all saved at the same time.	Delete all the text index files from QUSRSYS and then restore all the files from save media[6]. After the restore operation is complete, run the reclaim operation[3,4]. After the reclaim operation is complete, start updating index requests.	DLTF OBJ(QABB*) LIB(QUSRSYS) RSTOBJ OBJ(QABB*) SAVLIB(QUSRSYS) RCLDLO DLO(*ALL) STRUPDIDX

Table 7-2 (Page 2 of 4). Recovery for Search Index Services Files

Problem and Cause	Solution	Procedure
PROBLEM: The document library and text index files are lost. CAUSE: A disk unit failure occurred that resulted in data loss on the system ASP or function code 24 was selected to install the licensed internal code.	Restore text index files and then the document library[2]. See rules 1 through 4 in Table 7-3 on page 7-15 about the types of index request created when using the RSTDLO command.	See Chapter 13, "Working with Disk Recovery" for the procedure to restore the system ASP. The procedure restores QUSRSYS (text index files) and documents.
PROBLEM: The document library is lost. The text index files are not lost. CAUSE: Library QDOC was cleared or deleted.	Clear the scheduling queue[7], restore the document library and start updating index requests. After the update operation has completed[8], you may optionally want to run the reclaim operation, and then start updating index requests again[3]. See Table 7-3 on page 7-15 for rules about the types of index request created when using the RSTDLO command.	WRKTXTIDX Select option 2 (Change details) on the index that has the scheduling queue to be cleared. Under the clear parameter, select a *Y* to clear the scheduling queue. RSTDLO DLO(*ALL) SAVFLR(*ANY) STRUPDIDX RCLDLO DLO(*ALL) STRUPDIDX
PROBLEM: One or more documents are lost. CAUSE: One or more documents was damaged or deleted.	Start updating index requests[7]. After the update operation has completed[8], restore the lost documents, and then start updating index requests again. See rules 1 through 4 in Table 7-3 on page 7-15 about the types of index request created when using the RSTDLO command.	STRUPDIDX RSTDLO DLO(document-name SAVFLR(folder-name) STRUPDIDX

Table 7-2 (Page 3 of 4). Recovery for Search Index Services Files

Problem and Cause	Solution	Procedure

PROBLEM:
One or more text index files are lost.
 	
CAUSE:
One or more QABB* files (except (QABBIQTB)) was damaged or deleted. Library QDOC is not lost.
	Create a save file for the undamaged scheduling queue and save the scheduling queue to the save file. Delete all the text index files from QUSRSYS and then restore all the files from save media[6]. Delete the restored scheduling queue and then restore it from the save file[2]. After the restore operation is complete, run the reclaim operation[3,4]. When the reclaim operation is complete, start updating text index requests. When the update index requests are complete, delete the save file.	CRTSAVF FILE(QUSRSYS/SAVTXTQ)
		  TEXT('Save of Text Search
		  Scheduling Queue')
		
		SAVOBJ OBJ(QABBIQTB)
		  LIB(QUSRSYS)
		  DEV(*SAVF)
		  SAVF(QUSRSYS/SAVTXTQ)
		  ACCPTH(*YES)
		
		DLTF FILE(QUSRSYS/QABB*)
		
		RSTOBJ OBJ(QABB*)
		  SAVLIB(QUSRSYS)
		
		DLTF FILE(QUSRSYS/QABBIQTB)
		
		RSTOBJ OBJ(QABBIQTB)
		  SAVLIB(QUSRSYS)
		  DEV(*SAVF)
		  SAVF(QUSRSYS/SAVTXTQ)
		
		RCLDLO DLO(*ALL)
		
		STRUPDIDX
		
		DLTF FILE(QUSRSYS/SAVTXTQ)

Table 7-2 (Page 4 of 4). Recovery for Search Index Services Files

Problem and Cause	Solution	Procedure
PROBLEM: Documents last version indexed dates do not match or documents you expected to find in search are not found. CAUSE: STRUPDIDX command was interrupted, encountered errors, or was not started.	Start updating index requests[7]. After the update operation has completed[8], run the reclaim operation[3,5].	STRUPDIDX RCLDLO DLO(*ALL) STRUPDIDX

Notes:

1 Only library QUSRSYS is lost. The recovery for this problem is not used if you are recovering the system using function code 24 to install the licensed internal code.

2 If the scheduling queue contains requests, these requests will be processed the next time the STRUPDIDX command is run.

3 The RCLDLO command will delete from the index all document content that does not have a corresponding document on the system. Documents that are stored in the index, but not on the system take up space in the index but will not be found in the search.

4 The RCLDLO command looks at each index entry to see if the last version index date for both the entry and the corresponding document match. If the document date does not match, the date is stored in the index. If the document has a last version index date with no corresponding entry in the index, the RCLDLO command creates an add request for the document to bring the index up to date.

5 The RCLDLO command looks at the entry to see if the last version index date for both the entry and the document match. If the document dates do not match the date stored in the index, or if the document has a last version index date with no corresponding entry in the index, the RCLDLO command will update the document to synchronize it with the index.

6 If only the damaged files are deleted and then restored without all other index files, then the restore operation clears the text index and the reclaim operation (RCLDLO command) creates an add index request for every document on the system that is marked as being indexed before. The documents should correctly indicate whether they are or are not in the index.

7 Pending requests on the scheduling queue could cause unpredictable results if the queue is not processed or cleared prior to performing the rest of the recovery operation.

8 While the update operation is in progress, the *Update Started* status on the Work with Text Index panel will be set to *Yes*. When the update operation has completed, this status will be set to *No*. A job completion message will also be sent to the user who executed the STRUPDIDX.

Table 7-3. Type of Index Request Created when Using the Restore Document Library Object (RSTDLO) Command

NEWOBJ(*NEW) Is Specified	Document Was Indexed when Saved	Index Entry Exists for Document in QABB* Files	Type of Index Request Created
(1) No	No	No	None
(2) No	No	Yes	Remove
(3) No	Yes	No	Add
(4) No	Yes	Yes	Create an add request if version indexed dates are different. None if version indexed dates are equal.
(5) Yes	No	N/A	None
(6) Yes	Yes	N/A	Add

Chapter 8. Release-to-Release Support

The release-to-release support on the AS/400 system allows you to move data from the current release to a previous-release system. This support also allows you to move data from a previous-release system to a current-release system.

Current Release-to-Previous Release Support

This support enables objects (such as programs and files) that are created and saved on the **current release** (such as Version 2 Release 3) to be restored and used on the **previous release** (such as Version 2 Release 2 Modification 0). Object compatibility is provided for many languages, and most object types are supported on both release levels as long as the objects use only functions from a previous release.

You can enable current release-to-previous release support by using the target release (TGTRLS) parameter on create or save commands.

Table 8-1 illustrates the TGTRLS parameter and values available for the current and previous releases. The values in the table are used throughout this chapter. Refer to this table to determine the valid values for the release currently on your system.

Table 8-1. Values for TGTRLS Parameter

Current OS/400 Release	*CURRENT	*PRV	Other Valid Values
V2R3M0	V2R3M0	V2R2M0	V2R3M0 V2R2M0
V2R2M0	V2R2M0	V2R1M0	V2R2M0 V2R1M1 V2R1M0
V2R1M1	V2R1M1	V2R1M0	V2R1M1 V2R1M0 V1R3M0
V2R1M0	V2R1M0	V1R3M0	Not supported
V1R3M0	V1R3M0	V1R2M0	Not supported
V1R2M0	V1R2M0	V1R1M0 V1R1M1	Not supported

This support is extremely useful to:

- A network enterprise with a central site development system on the current release and with remote sites still on the previous release.
- An application development business with a single system on the current release that supports customers who may still be on the previous release.

Current release-to-previous release support provides great savings and productivity improvements to application developers. By using this support, most network enterprises and application development businesses no longer need to maintain two development systems. (For example, two development systems could contain a previous-release system that contains previous-release objects, or a current-release system that contains current-release objects.) In most cases, this support enables previous- and current-release objects to exist on one development system.

The following sections describe how to create and save objects on the current release, and how to restore and use them on the previous release.

Installing the Previous-Release Compiler on the Current Release

To create program objects (*PGM) that are targeted to run to the previous release, one or more of the following optional compilers must be installed on the current release:

5738RG1 RPG/400	*PRV Base Support
5738RG1 RPG/400	*PRV System/36 compatible RPG/II
5738CB1 COBOL/400	*PRV Base Support
5738CB1 COBOL/400	*PRV System/36 compatible COBOL
5738SS1 OS/400	*PRV CL Compiler Support
5738CX1 C	*PRV Compiler Support
5738FT1 Fortran/400	*PRV Compiler Support

Programs that are created on V2R3M0 using TGTRLS values *PRV or V2R2M0, and have their

observability removed (using the CHGPGM command), can be restored on a V2R2M0 system.

Creating the Object for the Previous Release

If the object is a program (*PGM) or a C Local Description (*CLD), create the object on the current release using the appropriate create command with the TGTRLS parameter. All other object types can skip this step. If the object was created on, or is restored from, the previous release, and is not created again on the current release, you can skip this step. To determine what release the object was created on, use the DSPOBJD command and specify DETAIL(*SERVICE) to display the *System-level* value.

It is recommended that previous- and current-release programs be stored in separate libraries to simplify maintenance. Using the DSPPGM command, the *Earliest release that program can run* field shows if a program can be saved to the previous release.

The following languages provide Create commands that support the TGTRLS parameter:

- C
- CL (AS/400 Environment)
- COBOL/400 (AS/400 Environment)
- COBOL/74 (S/36 Environment)
- FORTRAN/400
- RPG/400
- RPG/II (S/36 Environment)

RM/COBOL-85 creates programs that will run on V1R3 or later systems.

The following languages do not support the TGTRLS parameter:

- BASIC
- CL (S/38 Environment)
- COBOL/74 (S/38 Environment)
- PASCAL
- PL/I
- RPG/III (S/38 Environment)
- ILE C/400

Saving the Object for the Previous Release

You must save the object on the current release using the TGTRLS parameter before restoring it on the previous release or previous modification. This saves the object in a format that is known to the previous release or previous modification.

The objects can be moved from the current-release system to the previous-release system by using communication lines or removable storage media (tape or diskette).

It is recommended that previous-release and current-release objects be stored in separate libraries to simplify maintenance.

The following save commands support the TGTRLS parameter:

- Save Object (SAVOBJ)
- Save Changed Objects (SAVCHGOBJ)
- Save Library (SAVLIB)
- Save Document Library Objects (SAVDLO)
- Save Calendar (SAVCAL) (you must have OfficeVision/400 licensed program installed to use this command)

Object compatibility is provided for most object types supported on ***both*** levels as long as the object only uses previous-release function.

The following table shows the object types that support and do not support current release-to-previous release capability. IBM does not support saving IBM-supplied objects (such as system commands and programs) from the current release and restoring them on a previous-release system.

Table 8-2 (Page 1 of 2). Previous-Release Support by Object Type

Object Type	Supported	Not Supported
*ALRTBL	X	
*AUTHLR		X
*AUTL		X
*BINDDIR		X
*CFGL		X
*CHTFMT	X	
*CLD	X	
*CLS	X	
*CMD	X	
*CNNL		X
*COSD		X
*CSPMAP	X	
*CSPTBL	X	
*CSI		X
*CTLD		X
*DEVD		X
*DOC	X	
*DTAARA	X	
*DTADCT	X	
*DTAQ	X	
*EDTD	X	
*FCT	X	
*FILE (database, device, save)	X	
*FLR	X	
*FNTRSC	X	
*FORMDFN	X	
*FTR	X	
*GSS	X	
*IGCDCT	X	
*IGCSRT	X	
*IGCTBL	X	
*JOBD	X	
*JOBQ	X	
*JOBSCD	X	

Table 8-2 (Page 1 of 2). Previous-Release Support by Object Type

Object Type	Supported	Not Supported
*JRN	X	
*JRNRCV	X	
*LIB	X	
*LIND		X
*MENU	X	
*MODD		X
*MODULE		X
*MSGF	X	
*MSGQ	X	
*NWID		X
*NODL		X
*OUTQ	X	
*OVL	X	
*PAGDFN	X	
*PAGSEG	X	
*PDG	X	
*PGM (see note)		X
- BASIC		
- C	X	X
- CL[1]		
- CL[2]	X	
- COBOL/400[2]	X	X
- COBOL/74[1]		
- COBOL74[3]	X	
- CSPAE	X	
- FORTRAN/400	X	X
- PASCAL		X
- PL/I		
- RM/COBOL-85	X	
- RPG/II[3]	X	X
- RPG/III[1]		
- RPG/400[2]	X	
*PNLGRP	X	
*PRDAVL		X
*PRDDFN		X
*PRDFUN		X
*PRDLOD		X
*QMFORM	X	
*QMQRY	X	
*QRYDFN	X	
*RCT		X
*SBSD	X	
*SCHIDX	X	
*SPADCT	X	
*SQLPKG	X	
*SRVPGM		X

Table 8-2 (Page 2 of 2). Previous-Release Support by Object Type

Object Type	Supported	Not Supported
*SSND	X	
*S36		X
*TBL	X	
*USRIDX	X	
*USRPRF		X
*USRQ	X	
*USRSPC	X	
*WSCST	X	

Notes:

1 System/38 environment
2 AS/400 environment
3 System/36 environment

This assumes the program has been created on the current release. If a program was created on an earlier release (for example, V2R1.1 or V2R2), it can be saved using the TGTRLS parameter and restored and run on a V2R3M0 system. To determine what release a program was created on, use the DSPOBJD command and specify DETAIL(*SERVICE) to display the system-level value.

Testing the Object on the Current Release

Once the object has been created and saved using the TGTRLS parameter it can be tested on the current-release system. Thus, it is no longer necessary to support and maintain two development systems (one running the current release and one running the previous version). Testing this object should be like testing any other object. Make sure that all the objects that are to be used on the previous-release system have been saved using the TGTRLS parameter, restored onto the current-release system, and tested as a group on the current-release system.

Restoring and Using the Object on the Previous Release

Once testing on the current-release system is completed, it is recommended that the object be distributed on a limited basis to previous-release systems or previous modification systems. Thus, if problems arise, they can be quickly corrected and contained with minimal impact to users.

Restrictions for Current Release-to-Previous Release Support

The following restrictions apply when you create and save objects on the current release, and then restore and use them on the previous release.

- A program created and saved on a current-release system using TGTRLS(*PRV) with the observability tables of the program removed, restores and runs correctly on a valid previous-release system.

  If you decide to remove the observability tables of a program, it is advisable to keep a copy of the observable form of the program and the program source.

- The System/38 environment compilers (CL, COBOL/74, and RPG/III) do not support TGTRLS(*PRV). Programs created using these compilers cannot be saved to, restored, or run on a previous-release system.
- The only way to save an object for a previous-release system is to use the TGTRLS parameter. If TGTRLS parameter is not specified on the save command, and you attempt to restore the object on the previous-release system, the object is not restored.
- IBM does not support saving IBM-supplied objects (such as system commands, system programs, IBM spelling aid dictionaries, and so forth) from a current-release system and restoring and using them on a previous-release system or previous modification. As a result, the TGTRLS parameter is not supported on a SAVLIB command that specifies *ALLUSR, *IBM, or *NONSYS on the LIB parameter.
- IBM does not support new function from the current release to be used on a previous-release system or previous modification.
- When saving document library objects for a previous release, only folders and filed documents can be saved. Other items, such as mail or documents that are not filed cannot be saved using TGTRLS(*PRV or V2R2M0).
- If a current-release program temporary fix (PTF) save file is sent from a current release-system to a previous-release system for distribution to another current-release system,

object distribution must be used. The Copy PTF (CPYPTF) command or any save file command, such as DSPSAVF, cannot process the PTF save file.

- TGTRLS(*PRV or V2R2M0) cannot be specified when the save-while-active function is used.

Previous Release-to-Current Release Support

Generally, the system to which you are restoring objects must be at the same or a higher release level than the system from which the objects were saved. When moving data to a higher level release, you should only move user data. This may include user libraries, user profiles, user objects in IBM-supplied libraries, document library objects (documents and folders), and mail. IBM-supplied libraries should not be restored to a higher release since these are handled during the licensed program install process. The target system should have the current-level release installed. This includes the licensed internal code, OS/400 operating system, IBM-supplied libraries QGPL and QUSRSYS, OS/400 optional libraries, and any licensed programs purchased. See the *Licensed Programs and New Release Installation Guide*, to install the current release.

When saving data on the source system, the contents of output queues, job queues, data queues, and message queues are not saved; only their descriptions are saved. If your source system is at V1R3M0) or later, the contents of save files are saved if you specify SAVFDTA(*YES) (the default) on the save command. If your system is at a release earlier than V1R3M0, the contents of save files are not saved. To save spooled output files, use the Copy Spooled File (CPYSPLF) command to copy the spooled file to a database file member before saving.

If mail is moved from a V1R3M0 or earlier system to the current release, the following information will be lost:

- The *sent or received* information in a hard-copy reference mail item.
- The *assigned to* information in all mail items.
- The retain ID for a file pending mail item causing the status of the mail item to remain at OPEN.
- The internal *file and delete from mail log* indicator causing the mail item to remain in the mail log after the item has been filed.

Considerations when Restoring Configuration Objects

Configuration and system resource management objects are not normally moved to a different system since each system has different physical devices, communications lines, and so on. If you do have similar configurations, you can use the RSTCFG (Restore Configuration) command on the target system to restore the configuration object (excluding the system resource management objects). However, you will probably need to modify the resource IDs in the configuration objects after the restore.

Configuration data such as network attributes, configuration lists, system values, RJE configuration, SNADS configuration, DSNX data, Problem Log, and Q&A Database cannot be saved from one system and restored to the higher release system. This data must be re-created manually on the target system.

Network attributes are optionally restored when the operating system is installed. If you save the network attributes from a different system or you use the distribution tapes for the restore operation, the following network attributes will not be restored.

- System name
- Local network ID
- Local control point name
- Default local location name
- Default node
- Default type
- Maximum number of intermediate sessions
- Route addition resistance
- Network node servers
- Alert primary focal point
- Alert default focal point

Saving Data on a Previous-Release System

This section describes restoring objects previously saved on another AS/400. For information about restoring System/38 or System/36 objects, see the *System/38 to AS/400 Migration Aid User's Guide and Reference* and *System/36 to AS/400 Migration Aid User's Guide and Reference*. These instructions are **not** the intended method to perform a release upgrade. The *Licensed Programs and New Release Installation Guide* should be used to upgrade the previous release to the current release.

To move the user data to the current-release system, you must first save the data from the source system. Perform one or more of the following steps to save the data you wish to move:

1. Print a list of libraries and user objects in IBM libraries.

   Use the DSPOBJD command to print a list of all libraries on your system. Some of the libraries listed are IBM-supplied libraries and should **not** be moved to the target system. These include #CGULIB, #COBLIB, #DFULIB, #RPGLIB, #SDALIB, #SEULIB, #DSULIB, and all libraries that begin with the letter 'Q' except QS36F.

   ```
   DSPOBJD OBJ(*ALL) OBJTYPE(*LIB) OUTPUT(*PRINT)
   ```

   Use the DSPLIB command to print a list of all objects in IBM-supplied libraries QGPL and QGPL38. These libraries may contain user data that you wish to move to the target system.

   ```
   DSPLIB LIB(QGPL QGPL38) OUTPUT(*PRINT)
   ```

2. Process the objects in library QRCL.

   Enter the following command to print objects in QRCL:

   ```
   DSPLIB LIB(QRCL) OUTPUT(*PRINT)
   ```

   If library QRCL does not exist, or there are no objects in the library, continue with the next step. If there are objects in the library, see "Considerations for Lost Objects" on page 9-4 to delete or move objects found in library QRCL.

3. Change the system operator message queue delivery mode.

   Use the CHGMSGQ command to change the system operator message queue to break mode.

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(60)
   ```

4. End all subsystems.

   Use the ENDSBS command to end all subsystems. This will result in improved save performance and avoid any save failures due to objects locked.

   ```
   ENDSBS SBS(*ALL) OPTION(*IMMED)
   ```

5. Change the system operator message queue delivery mode.

   Use the CHGMSGQ command to change the system operator message queue to break mode.

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(99)
   ```

6. User profiles and mail (distribution objects)

   If you are moving user profiles to the target system, enter one of the following:

   - If your source system is at V1R1M0 or V1R1M2, enter the following:

     ```
     SAVSYS DEV(tape-device-name) ENDOPT(*LEAVE)
     ```

   - If your source system is at V1R2M0 through V2R1M1, enter the following:

     ```
     SAVSECDTA DEV(tape-device-name) ENDOPT(*LEAVE)
       MAIL(*YES)
     ```

   - If your source system is at V2R2M0, enter the following:

     ```
     SAVSECDTA DEV(tape-device-name) ENDOPT(*LEAVE)
     ```

7. User data in QAO* files in library QUSRSYS

   Use the SAVOBJ command if you wish to save user data from files beginning with QAO* in library QUSRSYS. These files include system directory files, distribution list files, office calendar files, office enrollment files, and document library search index files.

Warning

This step should only be performed if the current release has just been installed on the target system and no user data is on the system (Licensed Internal Code was installed using option 24). In addition, the source system must be at V1R2 or higher. The QAO* files cannot be moved if the source system is at V1R1M0 or V1R1M2.

Restoring these files replaces the existing data on the target system. There is no capability to merge the data in the QAO* files in library QUSRSYS from the source system with the data on the target system.

Enter the following command to save the data:

```
SAVOBJ OBJ(QAO*) LIB(QUSRSYS) DEV(tape-device-name)
     ENDOPT(*LEAVE) OBJTYPE(*FILE) ACCPTH(*YES)
```

8. User libraries

   Using the DSPOBJD listing from step 1, identify the user libraries you wish to move. Do NOT move IBM libraries to the target system. These include #CGULIB, #COBLIB, #DFULIB, #DSULIB, #RPGLIB, #SDALIB, and #SEULIB and all libraries that begin with the letter 'Q' except QS36F.

   Enter the SAVLIB command to save only the user libraries that you wish to move. Libraries QS36F and considered user libraries and should be specified on the SAVLIB command.

   If your source system is V2R1M0 or a later release, use *ALLUSR on the LIB parameter to save the user libraries.

   If your source system is earlier than V2R1M0, then you can specify up to 50 libraries on each SAVLIB command when saving the user libraries. If you have a large number of user libraries to save, you may want to create a CL program to perform the SAVLIB operations.

   This step will preserve the object ownership and public authority; however, private authorities will not be saved with the objects. If you did not save the user profiles, you will need to manually grant private authorities to the objects after restoring to the target system.

   Note: Do not specify *NONSYS for the LIB parameter since this option saves IBM libraries in addition to user libraries.

   Enter one of the following commands to save user libraries:

   ```
   SAVLIB LIB(*ALLUSR) DEV(tape-device-name)
        ENDOPT(*LEAVE) ACCPTH(*YES)

   SAVLIB LIB(user1 user2 userN) DEV(tape-device-name)
        ENDOPT(*LEAVE) ACCPTH(*YES)
   ```

9. User objects from IBM-supplied libraries

   IBM libraries that contain user data (for example, QGPL) must be handled with special instructions and must not be restored to the target system using the RSTLIB command. RSTLIB would overlay current-release IBM objects with previous-release objects and destroy the PTF status information that currently exists in the library. In addition, the install process may delete obsolete objects in these libraries during a release upgrade and you would re-create these objects if you used RSTLIB.

   The IBM libraries that may contain user data are QGPL, QGPL38 and QUSRSYS. To move all user output queues, spelling aid dictionaries, and message queues from library QUSRSYS, enter the following:

   ```
   SAVOBJ OBJ(*ALL) LIB(QUSRSYS) DEV(tape-device-name)
        ENDOPT(*LEAVE) OBJTYPE(*MSGQ *OUTQ *SPADCT)
   ```

   To move user objects contained in libraries QGPL and QGPL38, perform the following for each IBM library containing user data:

   a. Use the list created by the DSPLIB command for libraries QGPL and QGPL38 in step 1 to identify the user objects you intend to move. Do not move IBM objects from a previous release to the current-release system except for IBM-supplied source files. The IBM-supplied source files in library QGPL have the naming convention QxxxSRC, where xxx identifies the type of source file (such as QCLSRC, QCMDSRC, QDDSSRC). Most IBM objects begin with the letter 'Q'. Other IBM objects can usually be identified by the text associated with the object (for example, created by Auto-Configuration). If you have created members into IBM-supplied source files, include these files on the SAVOBJ command.

   b. Enter the following command:

      ```
      SAVOBJ OBJ(A B C QCLSRC) LIB(library-name)
           DEV(tape-device-name) ENDOPT(*LEAVE)
      ```

This command saves the objects identified in the previous step (A, B, C and QCLSRC in this example) from the specified IBM library. Up to 50 object names can be specified on each SAVOBJ command. If the source system is V2R2M0, 300 objects names can be specified.

10. Documents, folders, and mail (distribution objects)

    The SAVDLO command saves all the documents and folders on the system and all distribution (mail) objects if the source system is at V1R2 or higher. If the source system is prior to V1R3, all subsystems must be ended (ENDSBS *ALL *IMMED) in order to save all documents and folders. If you only wish to move specific documents or folders, specify the desired documents and folders on the SAVDLO command. If you only wish to move mail, specify DLO(*MAIL) on the SAVDLO command. Enter the following command to save all documents, folders, and distribution objects:

    ```
    SAVDLO DLO(*ALL) FLR(*ANY) DEV(tape-device-name)
         ENDOPT(*REWIND)
    ```

11. Print job log

    The printed output should be kept with the save media to determine what libraries and objects to restore on the target system. Enter the following command to print the job log:

    ```
    SIGNOFF *LIST
    ```

    Or

    ```
    DSPJOBLOG OUTPUT(*PRINT)
    ```

12. Start subsystems

    Enter the STRSBS command for the controlling subsystem and any other subsystems that must be active for normal system operations.

    ```
    STRSBS SBSD(subsystem-name)
    ```

Restoring Data to the Current-Release System

The target system should have the current release installed. To verify, enter GO LICPGM and select option 10 (Display installed licensed programs). The *Installed Release* field for the Operating System/400 licensed program should be V2R3. If not, install the target system with the current release (OS/400 and all ordered licensed programs) before restoring the previous release data. See the *Licensed Programs and New Release Installation Guide* to install the current release.

Perform the following instructions to restore the user data:

1. Sign on the system as QSECOFR by typing QSECOFR in the user prompt and the associated password in the password prompt.

   The data should be restored using the QSECOFR user profile to avoid restore failures due to insufficient authorization.

2. Enter the CHGMSGQ command to change the system operator message queue to break mode.

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(60)
   ```

3. End all subsystems.

   If you will be restoring user profiles (RSTUSRPRF) or private authorities (RSTAUT), all subsystems must be ended. The ENDSBS command must be entered from a workstation in the controlling subsystem. Enter the following commands to end all subsystems:

   ```
   ENDSBS SBS(*ALL) OPTION(*IMMED)
   ```

4. Enter the CHGMSGQ command to change the system operator message queue to break mode.

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(99)
   ```

5. Restore user profiles.

   Restore the user profiles onto the target system using the SAVSECDTA or SAVSYS media. If SAVSYS media is used, the user profiles are located in the next to the last tape file (labelled QFILEUPR). If you are only moving specific user profiles, specify up to 50 names for the USRPRF parameter rather than *ALL. Enter the following command to restore the user profiles:

   ```
   RSTUSRPRF DEV(tape-device-name) USRPRF(*ALL)
          MAIL(*NO) ALWOBJDIF(*ALL)
   ```

6. Restore user data to QAOK*, QAOC*, QAOF*, QAOO, QAO1, and QAOS* files in library QUSRSYS.

   Perform this step to restore the system directory, personal directories, distribution lists, office enrollment and calendars files to the target system.

Warning: This step should only be performed if the current release has just been installed on the target system and there is no user data on the system In addition, the source system must be at V1R2M0 or higher. The QAO* files cannot be moved if the source system is at V1R1 or V1R1.2. The user data in the QAO* files from the source system cannot be merged with existing data on the target system.

a. Enter the RSTOBJ commands to restore the following to the target system using the corresponding save media. You may receive multiple CPI8A17 messages indicating several files containing document details were not restored. These messages can be ignored.

```
RSTOBJ OBJ(QAOK* QAOS* QAOF* QAOC* QAOO* QAO1*)
     SAVLIB(QUSRSYS) DEV(tape-device-name)
     OBJTYPE(*FILE) ENDOPT(*REWIND) MBROPT(*ALL)
     ALWOBJDIF(*ALL) RSTOBJ
```

b. Use the INZSYS command to initialize the office-related files in library QUSRSYS. Inquiry message CPA3703 is displayed if the current release of the system files contains user-created office data. Specify I (Ignore) in response to the message to replace the current-release data with the new data.

```
INZSYS
```

c. Delete any obsolete QAO* files in library QUSRSYS that may have resulted from the previous steps. This step is optional, and should be done only if you want to delete these obsolete files. You may want to save the QAO* files before doing this step. This allows you to restore any files that might be deleted accidentally. If you accidentally delete the wrong file, you can restore it from the save media made in this step and then start again with step 6c. If you delete the wrong file and did not save the QAO* files, you do need to start again with step 6 on page 8-8. The SAVOBJ command listed below can be used to save the QAO* files from library QUSRSYS:

```
SAVOBJ OBJ(QAO*) LIB(QUSRSYS)
     DEV(tape-device-name)
```

The set of steps shown below must be run once for each set of the QAO* files (QAOK*, QAOS*, QAOC*, QAOF*, QAOO*, and QAO1*).

1) Use the WRKOBJ command to display a list of the files.

```
WRKOBJ OBJ(QUSRSYS/QAOx*) OBJTYPE(*FILE)
```

where *x* is a number or letter, for example QAOK*.

2) An obsolete file is identified by its name and description. The obsolete files all have 10 character file names. In addition, the text description of each obsolete file has the prefix of *Old name*, followed by the name of a QAOK*, QAOS*, QAOC*, QAOF*, QAOO*, or QAO1* file. If you find a file on the Work with Object display, and the file name and description meets these guidelines, then it can be deleted using option 4.

All the obsolete logical files must be deleted before deleting any obsolete physical files. If you attempt to delete a physical file, and it has a dependent logical file, the delete operation fails. The WRKOBJ display has a column labeled *Attribute* that identifies the file as a logical or physical file (LF for logical and PF for physical).

7. Enroll users in system distribution directory.

If you are restoring mail to the target system and did not perform the previous step, you may need to add users to the system distribution directory. If you performed the previous step, the system directory was already restored and you can skip this step.

Use the WRKDIR (Work Directory) command to determine if the user profiles you moved are in the system distribution directory. If not, type a 1 (Add) in the *Opt* column to add each user with mail to the system directory on the target system.

```
WRKDIR
```

8. Restore the mail.

If the data saved from your system is V1R2M0 through V2R1M1 and you are restoring mail to the target system, enter the RSTUSRPRF command with the MAIL parameter set to *YES. Use the SAVSECDTA media and enter

the following command to restore the distribution objects (mail).

```
RSTUSRPRF DEV(tape-device-name) USRPRF(*ALL) MAIL(*YES)
          ALWOBJDIF(*ALL)
```

9. Update MAXSTG parameter on QUSER and QSYSOPR user profiles.

   If the user profiles QUSER and QSYSOPR own many objects, you should change the MAXSTG parameter on these profiles to *NOMAX.

```
CHGUSRPRF USRPRF(user-profile-name) MAXSTG(*NOMAX)
```

10. Grant *ALLOBJ special authority.

    If the target system is at security level 30 or higher and any of the user profiles moved to the target system had *ALLOBJ special authority, use the CHGUSRPRF command to grant *ALLOBJ authority back to each profile that requires all object authority. The restore process removes *ALLOBJ special authority from non-IBM user profiles if the security level is 30 or higher. Enter the following command to grant *ALLOBJ special authority to the user profile:

```
CHGUSRPRF USRPRF(user-profile) SPCAUT(*ALLOBJ)
```

11. Restore the user libraries.

    Use the RSTLIB command for each user library saved. The user libraries or *ALLUSR was specified on the LIB parameter of the SAVLIB commands performed on the source system. If you have a large number of user libraries to restore, you may want to create a CL program to perform the RSTLIB operations.

    Enter one of the following commands, depending on how the user libraries were saved:

    If a SAVLIB LIB(*ALLUSR) was done:

```
RSTLIB SAVLIB(*ALLUSR) DEV(tape-device-name)
      ENDOPT(*LEAVE) OMITLIB(QGPL QGPL38 QUSRSYS)
      MBROPT(*ALL) ALWOBJDIF(*ALL)
```

    If a SAVLIB that specified user libraries was done:

```
RSTLIB SAVLIB(user1) DEV(tape-device) ENDOPT(*LEAVE)
      MBROPT(*ALL) ALWOBJDIF(*ALL)
```

    Note: If you restore library #LIBRARY, you may receive error message CPF3761 indicating object QS36ENV was not restored. This message can be ignored.

12. Restore user objects to IBM-supplied libraries.

    Enter one or more RSTOBJ commands for each IBM library you saved user objects from on the source system (for example, QGPL). The save media should only contain objects you created into the IBM libraries or IBM-supplied source files (for example, QCLSRC) that you have created members into.

```
RSTOBJ OBJ(*ALL) SAVLIB(QUSRSYS) DEV(tape-device-name)
     ENDOPT(*LEAVE) OBJTYPE(*MSGQ *OUTQ *SPADCT)
     MBROPT(*NEW) ALWOBJDIF(*ALL)
```

```
RSTOBJ OBJ(*ALL) SAVLIB(library-name) DEV(tape-device-name)
     ENDOPT(*LEAVE) MBROPT(*NEW) ALWOBJDIF(*ALL)
```

13. Restore documents and folders.

    Use the RSTDLO command to restore the document library objects saved from the source system. If distribution objects (mail) were saved from the source system, they will be restored at this time. If multiple tape files were created from the SAVDLO on the source system, you must specify a beginning and ending sequence number (SEQNBR parameter) on the RSTDLO command.

    See "Considerations for Restoring Previous-Release Data" on page 7-9 for considerations when restoring documents and folders from a previous release.

    Enter the following command to restore the documents, folders, and mail (distribution objects):

```
RSTDLO DLO(*ALL) SAVFLR(*ANY) DEV(tape-device)
```

14. Restore private authorities.

    If you ran the RSTUSRPRF command previously, enter the RSTAUT command to restore private authorities to objects on the target system. If you did not run the RSTUSRPRF command, use the GRTOBJAUT command to grant private authorities to the newly restored objects.

    Enter the following command to restore private authorities:

```
RSTAUT
```

15. Print the job log

    The printed output should be kept with the save media to determine what libraries and objects to restore on the target system. Enter the following command to print the job log:

```
SIGNOFF *LIST
```

Or

```
DSPJOBLOG OUTPUT(*PRINT)
```

16. Start subsystems.

    If you ran the ENDSBS *ALL command, enter the STRSBS command for the controlling subsystem and any other subsystems that must be active for normal system operations.

    ```
    STRSBS SBSD(subsystem-name)
    ```

Chapter 9. Save and Restore Considerations and Command Examples

This chapter provides save and restore considerations and examples of using the save and restore commands.

Considerations for Damaged Objects

Damaged is a term used to describe the condition of any object that for some reason, usually unknown, is in a state in which the system can no longer process it. Although objects can become damaged in many ways, the system is designed to minimize object damage, so damaged objects are not common. Examples of what can cause objects to become damaged follow:

- Physical damage on the auxiliary storage disk drives
- A power failure during a critical update to any object
- A hardware or tape error that occurs while an object is being restored

The system provides you with functions to deal with damaged objects should they occur.

When damaged objects are detected during an IPL, the system notifies you by sending messages to the history log and to the system operator message queue QSYSOPR. The message sent to QSYSOPR states that damaged objects were encountered during the IPL and that messages were sent to the history log. You may not be able to use the objects until they have been repaired and are no longer damaged.

When a damaged object is detected other than during an IPL, the system notifies you, and you may not be able to use the object until it has been repaired and is no longer damaged. The first time the system detects a damaged object, it sends messages to your program message queue, the system operator message queue QSYSOPR, and the history log. Thereafter, only the program is notified and the damaged object is referenced in the job log.

Because object damage is not common, your programs probably will not monitor for the escape messages sent for damaged object conditions. The escape messages that are not monitored cause function checks. (See the *CL Programmer's Guide* for more information about monitoring for messages.) For interactive command entry, a function check is always handled by the command processor QCMD or the IBM-supplied program associated with the IBM-supplied menu from which a function was selected. For batch jobs, the default action for a function check that is not handled is to end the job. Only a single function or job is affected. If an object that is critical to the operation of a subsystem or system is damaged, a larger group of jobs is affected.

If a job description becomes damaged, it cannot be changed, displayed, or used to start jobs. A damaged job description is indicated by escape message CPF1618. You must delete the job description and create it again or restore it from a saved copy. If the job description specified for the console work station entry (in the subsystem description, for the controlling subsystem) is damaged, the console will not be usable at the end of the IPL operation.

When this situation occurs and no other work station entries exist in the subsystem description, the system is not usable. To avoid this damage, you can create another controlling subsystem that specifies a work station as another device from which jobs can be accepted.

The recovery procedure you follow for a damaged object depends on the type of damage and what object was damaged (an IBM-supplied object or a user-defined object). If an IBM-supplied object is damaged, you must either delete and then restore or create the object, do an IPL, or install the system again (unless the message indicates that the object is automatically created again by the system). (See the *Operator's Guide* for more information about these messages.) For user-defined objects, there are three types of damage:

- Header damage. The object cannot be accessed or used, and the name and type of object are not known.
- Full object damage. The object cannot be used, but the name and type of object are known.
- Partial object damage. Only part of the object is usable, and the name and type of object are known.

The recovery procedure you should follow depends on the type of damage.

In general, if you refer to an object and header damage is detected, a message is sent to the QSYSOPR message queue. Do not try to repair the header damage condition. The system tries to free the storage occupied by the object with header damage. After it has been freed, you will receive an object-not-found condition when you refer to the object. To recover from the object-not-found condition, restore or create the object again. For complex objects such as database files, it may be necessary to reclaim storage to find the lost pieces and either delete them or recover them if the user's data is found. If you cannot proceed, your system may need to be installed again.

For some damaged objects such as database files or device descriptions, special recovery procedures are possible. For example, when a database file is partially damaged, you can attempt to copy the data to another file using the Copy File (CPYF) command to keep the readable data, or you can use a different recovery method if you have one (for example, restoring or journaling). When you copy a file, the system can optionally bypass unreadable data and copy only readable data. (The *Data Management Guide* has more information about bypassing unreadable data.) In some cases of partial object damage to device descriptions, you can recover by varying the associated device off and on.

In most instances, to recover from full or partial object damage to a user-defined object, you must delete the damaged object, and then either restore a saved copy or create the object again. Exceptions to this are job queues and output queues. You cannot use a delete command to recover from these damaged objects. You should power down the system and then start the system again. The system automatically deletes the damaged job queues and output queues. If the default output queue for a printer is damaged, the system automatically creates the queue again and creates queue entries for all files that were on the queue before it was damaged. Other output queues and job queues are not automatically created again by the system. All jobs or files on these queues are lost. You can create these queues again when the system has finished the IPL.

Some IBM-supplied user profiles cannot be deleted if they are damaged. If you try to delete any of the previously listed IBM-supplied user profiles because they are damaged, message CPD2205 is sent to the user to indicate that you cannot delete the user profile. You must run the RCLSTG command and install the operating system again to recover the following IBM-supplied user profiles:

- QDBSHR
- QDFTOWN
- QDOC
- QDSNX
- QFNC
- QGATE
- QLPAUTO
- QLPINSTALL
- QSNADS
- QSPL
- QSPLJOB
- QSRV
- QSRVBAS
- QTSTRQS

Every part of a damaged object that can be found is deleted and its storage freed. Sometimes, some parts of a damaged object may not be deleted although it appears to you that they have been. If this happens when you are trying to delete an object, a diagnostic message is issued and every part of the damaged object found is deleted.

How the Save Operation Handles Damage

Following is an overview of unique situations when the save operation determines that damage exists in the system. The situations vary depending on the extent of the damage and the type of object involved.

- Prior to the save operation, the system determines if an object is damaged and marks the object. An object marked as damaged cannot be saved, but the save operation continues with the next object. The operation completes with an indication of how many objects were saved and how many were not. Diagnostic messages describe the reason each object was not saved.
- If an object is not marked as damaged, the save operation attempts to save the object. If the object is found to be damaged, the save operation ends and the object is marked as damaged. The objects that are already marked as damaged are bypassed on the next save operation.
- There can be some unusual cases where a save operation does not detect damage. The save operation may detect physical damage on the disk, but it may not detect all damage. For example, the system does not attempt to determine if all bytes within an object are valid and consistent (logical damage). For some cases, you will not be able to determine a damage condition unless you attempt to use the object (such as call a program object). If this type of damage exists, the object will be restored normally. Database files can be checked for most damage conditions by the VALDBF tool in QUSRTOOL library.

How the Restore Operation Handles Damage

Following is an overview of some unique situations in which a restore operation determines that damage exists on the media or in the system. The situations vary depending on the extent of damage and the type of object involved.

If damage exists within the data portion of a database file that has already been marked as partially damaged, the system bypasses the object and does not restore it. If this situation occurs, you must first delete the object on the system and then do the restore operation.

When a database file that exists on the system is restored, the existing address for the data in storage is used for the restore operation. Consequently, any data on the system is overlaid during the restore operation. When restoring some object types over existing objects, the system gives the restored copy a new address, and deletes the old copy if the restore operation is successful.

Restoring Over Objects Marked as Damaged

The Restore Library (RSTLIB), Restore Object (RSTOBJ) Restore Configuration (RSTCFG), and the Restore Document Library Object (RSTDLO) commands allow a restore operation over objects that are marked as damaged. If a system object is found that is marked as damaged, the object is deleted from the system and the object is restored from the media. For damaged folders, the folder is automatically reclaimed. No message is sent to the history log for damaged documents of folders.

A message is sent to the history log indicating that a damaged object was found. Then the restore operation attempts to delete the object, if eligible, and restore the object from the media. For objects that are not eligible for deletion, a message is sent to the user indicating that a damaged object cannot be restored over. The restore operation continues with the next object.

If the object is deleted successfully, two messages are sent indicating that the object was damaged and then deleted. For folders, no message is sent for folders that are automatically reclaimed. Another message is sent indicating that the object is restored, all authorities to the object are lost, and the public authority for the object is changed to *EXCLUDE. (This is the only message sent for documents.)

Consider the following when restoring over objects that are marked damaged:

- The processing for objects that are partially damaged and for damage that is not marked remains the same.
- The damaged system object is deleted and then restored only if the object is eligible for deletion. Object types that are not eligible for deletion are:
  - Database files and members (*FILE - database)
  - Job queues (*JOBQ)
  - Journals (*JRN)
  - Journal receivers (*JRNRCV)

  - Libraries (*LIB)
  - Output queues (*OUTQ)
- Authorities to the damaged object are lost.

Media Damage during a Restore Operation

If you receive a media error from which you can recover, the operation is not ended. Any objects that are damaged on the media are not restored, but all other objects are. The diagnostic message CPF3864 (CPF3811 when a save file is used) is issued for each OS/400 object that cannot be restored indicating that the object was damaged on the media.

If any part of an object, a part of a subsystem description, for example, is damaged on the media, the entire object is considered damaged. If an access path for a member cannot be restored because of media damage, it is automatically rebuilt. Only those members of a file that are damaged on the media are not restored.

If media errors are discovered when loading an object and the object is partially loaded, what happens depends on whether the same address is being used.

- For a database file, the system marks the object as partially damaged and attempts to continue the restore operation.
- If a different address is being used, the system deletes the partially loaded object, keeps the old object, and attempts to continue the restore operation.
- At the completion of the restore command, a message is sent stating the number of restored objects and the number not restored (diagnostic messages exist for objects not restored).

Significant media damage may cause several objects to be bypassed on the restore operation. If unrecoverable media errors exist, the restore operation is ended.

Damaged Document Library Objects: If you try to restore into a document or folder that already exists on the system, but it is damaged, the restore operation deletes the document or folder and restores it from the media. A message is sent indicating that the object was damaged, and that authorities to the object are lost.

Considerations for Lost Objects

Objects may be lost because of power or equipment failures or other types of system problems. An object is considered to be lost if its addressability has been affected (the object cannot be found in a library), its ownership information is recorded incorrectly, or the interrelationship of pieces of the object is lost. By using the Reclaim Storage (RCLSTG) command, you can correct some of these conditions, delete objects, or remove pieces of objects that cannot be made usable. In general, you should run the RCLSTG command for general maintenance. In addition, consider using the RCLSTG command in the following situations:

- An attempt was made to start the system, but there was not enough storage for the system to be fully operational.
- The system ended abnormally several times since the RCLSTG command was used last.
- Objects shown on the Owned Objects display show no library names were associated with them.
- The system status display shows an unexpectedly high percentage of auxiliary storage used.
- Data cannot be accessed because a database file member is damaged. This condition is indicated by message CPF8113.
- Objects cannot be accessed because they are secured by a damaged authorization list or damaged authority holder.

Note: Using the RCLSTG command requires some auxiliary storage to run, and if auxiliary storage is already being used extensively, the RCLSTG command can fail because not enough storage is available for it to run.

The purpose of the RCLSTG command is to ensure that objects residing permanently in auxiliary storage can be accessed and that all auxiliary storage is either used properly or is available for use. Every object that resides permanently in auxiliary storage is checked, and the following happens:

- If an object is encountered that does not address a library, it is placed in an IBM-supplied library based on the object type. For all lost objects, information such as the programming temporary fix (PTF) status, save and restore information, attributes, and text descriptions may no longer be retrievable, even though the objects themselves are reclaimed.
- If the system encounters a lost object that has the same name as another lost object, is of the same object type, and has already been placed in QRCL, the object is given a new name as it is placed in QRCL. The new name has this format: QRCLnnnnnn, where nnnnnn is a unique number assigned to the object. The former, duplicate name is kept as the text description for the object.
- If data still exists for a lost or damaged physical file, the file may be rebuilt and placed in QRCL. The text description for the file indicates whether the file has been rebuilt. If a physical file is rebuilt, it is not a duplicate of the original file because of the damage encountered. The file keeps as many attributes as the system can recover. After the RCLSTG command is complete, the file should be created again, and the data can be copied from the rebuilt file. However, because the file is not a duplicate of the original file, it should not be used as a production file. (Not all types of damage can be handled.)
- If the system recovers a user object that is considered a user domain object, the object is deleted if one of the following is not specified for the ALWUSRDMN system value:
  - QRCL
  - *ALL

  If the user object is considered a system domain object, it is moved to library QRCL.
- If the system encounters an object that does not have an owner, an IBM-supplied user profile is assigned to the object based on the object type. If the object type is not required to be owned by a specific user profile, it will be assigned to QDFTOWN user profile.
- If the descriptions of the objects in a library (as shown using the Display Object Description (DSPOBJD) command) are damaged in such a way that they cannot be accessed, the library is rebuilt.
- If the system encounters an object that is secured by a damaged authorization list or damaged authority holder, the system authorization list (QRCLAUTL) is granted authority to the object.

  The Display Authorization List Objects (DSPAUTLOBJ) command can be used to display the objects secured by Authorization list QRCLAUTL. Authorization list QRCLAUTL is created during a reclaim storage operation if it is needed.

After the reclaim storage function has finished running, you can display the system operator message queue (QSYSOPR) or the history log (QHST) for a record of what was done. You can use the DSPOBJD command or the Display Library (DSPLIB) command to obtain a list of the reclaimed objects in library QRCL. When you have this information, you can do the following:

- Delete unusable objects.
- Move objects to another library and rename them if necessary.
- Grant authority for objects if necessary.
- Transfer ownership of objects.
- Copy data from rebuilt files to other files.

It is possible that some IBM-supplied objects are in QRCL. If so, see your service representative to determine which library these objects belong in.

Using the Reclaim Storage (RCLSTG) Command

Note: When using the RCLSTG command, information such as the programming temporary fix (PTF) status, save and restore information, attributes, and text descriptions may no longer be retrievable, even though the objects themselves are reclaimed.

Before you can use the Reclaim Storage (RCLSTG) command to reclaim lost storage, you must place the system in a restricted state. *All* subsystems, including the controlling subsystem, must be ended. This can be done using either the ENDSYS or ENDSBS SBS(*ALL). If you do not want the reclaim job interrupted by messages,

change the BRKMSG parameter to *HOLD on the Change Job (CHGJOB) command. It is recommended that you perform an IPL before running the RCLSTG command.

To run the RCLSTG command, you must either be signed on as QSECOFR or have authority authority to run the command. See the *Security Reference* for information about running this command.

If power or equipment failures or other system problems occur while running the RCLSTG command, processing might stop. If so, enter the command again immediately or, if the system was ended, enter it after the system is started again.

While you are running the RCLSTG command, status messages that inform you of current processing are shown on the bottom line of the display. During object processing, the percentage of objects already processed is displayed on the bottom line of the display. Messages may be sent informing the operator of actions taken during the reclaim storage (RCLSTG command) operations.

Note: The RCLSTG command is a long-running function and the amount of time it takes depends on the number of objects in the system, the types of those objects, the amount of damage to them, the amount of auxiliary storage configured to the system, and the percentage of auxiliary storage in use. You should consider when to use the RCLSTG command because the system must be in the restricted state, and the RCLSTG command can require a considerable amount of time to run.

For an example of how to use the RCLSTG command in an unattended situation, see the DLYCMD tool in library QUSRTOOL.

Save and Restore Status Information

When an object is saved, the system updates the object description with information about the save process. The following information is updated:

- Save date and time
- Save active date and time (if last save operation used the save-while-active function)
- Save command used
- Size of the object on the system at the time of the save operation
- Identifier volumes (up to ten) containing the last copy saved (tape and diskette only)
- If the data portion of the object resides on the media
- File sequence number (tape only)
- Save file name (if the last save operation was to a save file)

When performing a save operation to a save file, you can specify UPDHST(*NO) to prevent updating the save history information of the objects being saved. If UPDHST(*NO) is specified on a save, the last save date and time is not updated. In this case, Apply Journal Change (APYJRNCHG) and Remove Journal Change (RMVJRNCHG) sends an inquiry message to indicate the difference between the date of the last save journal entry and the save date of the files. The user can cancel the apply or remove operation or ignore the difference in dates and attempt the operation.

You can display the status information using the Display Object Description (DSPOBJD) command and specify DETAIL(*FULL). Only the object attributes are shown. The data attributes and the actual data are not shown. The status information is shown for only the most recent save of each object kept.

The following special data areas are in library QSYS. These data areas contain save and restore history information and do not contain data. The system uses the data area's object description to record the save and restore information that can be shown using the DSPOBJD command.

- QSAVALLUSR contains the last use of the SAVLIB LIB(*ALLUSR) and RSTLIB SAVLIB(*ALLUSR) commands.
- QSAVCFG contains the last use of the SAVCFG or SAVSYS command.
- QSAVDLOALL contains the last use of the SAVDLO DLO(*ALL) FLR(*ANY).
- QSAVIBM contains the last use of the SAVLIB LIB(*IBM) and the RSTLIB SAVLIB(*IBM) commands.

- QSAVLIBALL contains the last use of the SAVLIB LIB(*NONSYS) and RSTLIB SAVLIB(*NONSYS) commands.
- QSAVUSRPRF contains the last use of SAVSYS, SAVSECDTA, and RSTUSRPRF commands.
- QSAVSYS contains the last use of the SAVSYS command.
- QSAVSTG contains the last use of the SAVSTG command and the restore storage function in DST.

  Note: The history information is not updated for individual objects when using the SAVSYS, SAVSECDTA, SAVCFG or SAVSTG command. Only the data area is updated. You must use the DSPOBJD command to display these data areas to see the date and time of the last save for these commands.

The following is an example of displaying QSAVLIBALL data area using the DSPOBJD command:

```
DSPOBJD  OBJ(QSYS/QSAVLIBALL) OBJTYPE(*DTAARA) DETAIL(*FULL)
```

Save and Restore Completion Messages

The completion message sent for each save and restore command indicates how many objects were saved or restored and how many were not. An object is reported as not saved or restored only if it fits the selection values in the command and it was not saved or restored. Examples of why an object is not saved or restored are:

- The object is in use. If a single member of a multiple member file is in use, the entire file is not saved.
- The object is damaged.
- The user is not authorized to save or restore the object.

Messages When Objects Are Not Saved or Restored: If an object is not saved or restored, a message is sent to the job log. These messages are shown by pressing F10 (Display detailed messages) from the Command Entry display, or by printing the job log. The messages cannot be retrieved by a program in the job that does the save or restore operation. However, you can end the job and have another job copy the completed QPJOBLOG spooled file to a database file where the messages can be accessed. If you specify OUTPUT(*PRINT or *OUTFILE), most of this information, such as objects not restored, also appears in the list. Specifying the OUTPUT parameter can affect performance.

For an example of how to access the information in the job log, see the CHKSAVRST tool in library QUSRTOOL.

Output Files in Use at the Time of the Save or Restore Operation

Consider the following when saving and restoring output files:

Save output file: If you receive message CPF379A during the save operation, the save output file could not be saved because the output file was specified for the OUTFILE parameter on the save command.

Do the following:

Use the Save Object (SAVOBJ) command to save the file and the members. Do not specify a the file for the OUTFILE parameter on the save command.

Restore output file: If you receive message CPF379D during the restore operation, the restore output file on the media could not be restored because the output file was specified for the OUTFILE parameter on the restore command.

Do one of the following:

- Use the Restore Object (RSTOBJ) command and specify a different library name on the RSTLIB parameter to restore the file to a different library.
- Use the Rename Object (RNMOBJ) command to rename the file on the system, and then restore the file from the save media using the RSTOBJ command.

Save Completion Messages: When a SAVOBJ or SAVLIB command is used, a completion message CPC3701 for tape or diskette, or CPC3722 for save files, is sent for each library saved and contains the number of objects saved. The message help of the completion message includes the volume identifiers of the first 75

volumes used (for tape or diskette); these identifiers are used to update the status information of each object saved. The message data contains this information as well as the last volume ID and the last device, or the last save file used.

Note: Overlap processing is performed during normal save operations. Some libraries can be written to the media while other libraries are being preprocessed. This may cause the preprocessing and completion messages in the job log to appear in a different order than the order in which the libraries were written to the media.

If multiple libraries are saved in a single command, a final completion message (CPC3720 or CPC3721) also contains the last device used. If a series of save commands is being performed in a CL program and each save command specifies that multiple devices can be used, you can start each save command on a different device. The device name in the message data can be used to determine where the save operation completed so that the alternative device name can be used on the next save command. The CL program can cause the next save command to start writing output to the same device where the previous save operation completed.

For an example of a CL program that retrieves the device name from the CPC3701 message (found in positions 126 through 135 of the message data) and uses the information to determine which device is used by the next save command, see Appendix D, "Library QUSRTOOL and Programming Examples."

Restore Completion Messages: If an object does not fit the selection values in the restore command, it is not included in the count of how many objects were not restored. For example, assume that the following objects (all files) were saved from the DSTPRODLB library with a SAVLIB command on tape:

- ORDFILL
- ORDHDRP
- ORDDTLP
- INVMSTP

If the following command is issued,

```
RSTOBJ OBJ(ORD*) SAVLIB(DSTPRODLB)
OBJTYPE(*FILE)
```

the resulting messages are:

```
CPF3760  Not authorized to save or restore *FILE ORDFILL
         in DSTPRODLB

CPF3773  2 objects restored, 1 not restored to DSTPRODLB
```

In this example, ORDFILL is not restored because the user is not authorized to restore it. INVMSTP is not included in the count of how many objects were not restored because it does not match the generic name ORD* specified on the OBJ parameter.

If a restore operation ends abnormally due to a security or integrity change, a message is sent instructing you to display specific informational messages. You can display these messages by pressing F10 or by displaying the job log.

A diagnostic message for a security change is sent if:

- Private or public authorities are revoked.
- The owner name is changed.
- The authorization list is not linked to the object.

A diagnostic message for an integrity change is sent if:

- Journaling could not be started for an object that was being journaled at the time of the save operation.
- A logical file is restored over a deleted and re-created physical file.

If one of the above conditions occur, an escape message is sent at the completion of the restore command. You can monitor for this escape message through the MONMSG command. If the job is a batch job, you may need to adjust the message severity level through the Submit Job (SBMJOB) command.

Results of a Successful Restore Operation

When a restore operation is successfully completed, the following steps occur:

- The save and restore history for each object is updated unless the restore operation for the object is to a different library from which it was saved.

- A count of the number of objects successfully restored is sent to the user in a completion message (CPC3703).

Results of an Unsuccessful Restore Operation

A restore operation can be unsuccessful either because an error was encountered when trying to restore an object or because the operation was interrupted. If the object existed on the system before the restore operation, it may be damaged by the unsuccessful restore operation.

An object is not restored when an error is encountered. The error is either recoverable or not.

Restore Operation Error Is Recoverable: If an object cannot be restored and the error is recoverable, the following occurs:

- A diagnostic message is sent to the job log for each object that is not restored. The message ID can vary, depending on why the object was not restored.
- Each object associated with the errors is not restored. However, other objects not associated with the errors but involved in the same restore operation are restored.
- Only the save and restore status information for the objects that were successfully restored is updated.
- A count of the number of objects successfully restored and a count of the number of objects not restored are sent to the user in a diagnostic message (CPF3773).

Restore Operation Error Is Not Recoverable: If the error is not recoverable, the following occurs:

- Diagnostic messages are sent to the job log for each object.
- The save and restore status information for each object is not updated.
- A diagnostic message identifying the error condition is sent to the user.
- The restore command ends immediately. No other objects are restored.

Recovering from Device and Media Errors

The following discusses recovery from device and media errors. Device error recovery is done by the system. Restarting the save operation is done by the user.

Automatic Recovery from Tape-Write Errors

Automatic tape-write error recovery is supported by the 1/2-inch and 8-mm tape units, and some 1/4-inch tape units; included are the 2440, 3422, 3430, 3480, 3490, 6342, 6343, 6346, 6347, 6348, 7208, 9347, and 9348.

When a tape-write error is encountered on one of the supported tape units, the system completes processing the current tape and requests that you load a new tape to continue the operation. After the header labels have been written, writing to tape is started again with the area of data that encountered the error on the previous tape.

Note: Tape-write error recovery is not supported for the data interchange commands such as CPYFRMTAP or DSPTAP. There is no tape-write error recovery for the first four files on the SAVSYS tape.

The tape-write error recovery is only supported by the save and restore commands for supported devices.

Tape Write Error Messages: When data error occurs when writing to tape, message CPA400F is sent asking you if you want to continue on another volume or cancel the job. If you select to continue, and the volume can be closed by writing end-of-volume labels, message CPI4025 is sent. This message informs you that the tape had an error and it should probably be replaced before the next save operation is done with this set of tapes. If the end-of-volume labels can not be written, a message is sent to indicate that the recovery failed.

A media error near the beginning of a volume may result in message CPA401A instead of CPA400F. This message informs the user that the volume is not usable and should be removed from this set of tapes. The user has the option of ending the save

operation or trying the operation again using a new volume.

Media or Device Error When Running the SAVLIB or RSTLIB Command

The STRLIB parameter is only for recovery situations in which the *NONSYS, *IBM, or *ALLUSR save or restore operation ended or failed because of a media or device error. If a media or device error occurs and cannot be handled by the automatic tape error recovery, you do not have to start from the beginning again. A new tape can be loaded and you can run the RSTLIB or SAVLIB command again and specify the STRLIB parameter to start the save or restore operation again at a specific library, or to use the default value of *FIRST. The default value begins the save or restore operation at the first library. (The libraries are saved or restored in ascending alphabetical order.)

The following restrictions apply when the STRLIB parameter is specified using *NONSYS, *IBM, or *ALLUSR for the LIB parameter on the SAVLIB command, *ALLUSR for the LIB parameter on the SAVCHGOBJ command, or the SAVLIB parameter on the RSTLIB command.

- You should not start the SAVLIB command on the failed tape. The results of attempting the second save on the end of the tape can vary greatly, depending on what was previously on it and how the save library operation ended. The correct procedure is to begin again on a new tape, as if starting the complete save again.
- When you run the restore operation from the SAVLIB tape and an incomplete library is found, the object being restored is marked as damaged on the system. You can run the second restore operation without any recovery from the previously failed restore operation because the system deletes the object, if eligible, and then restores it. You can exclude the incomplete library by specifying the OMITLIB parameter on the command.
- When you specify *NONSYS, *IBM, or *ALLUSR, the STRLIB parameter is shown on the prompt display. If the STRLIB parameter specifies a starting library other than *NONSYS, *IBM, or *ALLUSR, then message CPD3769 is sent to indicate you must specify *NONSYS, *IBM, or *ALLUSR on the LIB or SAVLIB parameter. If the STRLIB value is a system library (not allowed), message CPD3770 is sent to indicate that the STRLIB value is not valid. If the library does not exist, the SAVLIB or RSTLIB command ends with escape message CPF3818, indicating the starting library was not found, and no libraries were saved or restored.

If an unrecoverable media error occurs during the SAVLIB procedure, you can restart the procedure using the STRLIB parameter on the SAVLIB command. The STRLIB parameter is valid only when *NONSYS, *ALLUSR, or *IBM is specified for the SAVLIB or SAVCHGOBJ command.

The basic recovery steps for a save operation are:

1. Check the job log to determine the library where the previous SAVLIB LIB(*NONSYS, *IBM, or *ALLUSR) failed. Find the last library saved which is indicated by a successful save completion message.
2. Load the next tape and ensure the tape is initialized.
3. Type the following and press the Enter key:

   ```
   SAVLIB LIB(*NONSYS, *IBM or *ALLUSR) DEV(tape-name)
       ENDOPT(*LEAVE) STRLIB(library-name) ACCPTH(*YES)
       OMITLIB(library-name)
   ```

   The *library-name* for the STRLIB and the OMITLIB parameters is the last library successfully saved. This starts the save operation on the next library after the last successfully saved library. Specify the value for the ACCPTH parameter that was specified on the previous SAVLIB command.

   Note: A restore of the system using this set of media requires two RSTLIB SAVLIB(*NONSYS, *ALLUSR, or *IBM) commands to restore the libraries.

If an unrecoverable media error occurs during the RSTLIB procedure, you can restart the procedure using the STRLIB parameter on the RSTLIB command. The STRLIB parameter is valid only when *NONSYS, *ALLUSR, or *IBM is specified for the restore operation.

The basic recovery steps for a restore operation are:

1. Check the job log to determine the library where the previous RSTLIB SAVLIB(*NONSYS, *IBM, or *ALLUSR) command failed. Find the library that follows the last library successfully restored. It is indicated by a successful restore completion message in the job log. If the library is not identified in the job log, look at the output from the save operation or display the tape file QFILE to determine which library is next.
2. Load the first tape of the SAVLIB LIB(*NONSYS, *ALLUSR, or *IBM) media.
3. Type the following and press the Enter key:

   ```
   RSTLIB SAVLIB(*NONSYS, *IBM or *ALLUSR) DEV(tape-name)
       ENDOPT(*LEAVE) STRLIB(library-name)
       OMITLIB(library-name)
   ```

   The *library-name* for the STRLIB and the OMITLIB parameters is where the RSTLIB failed. This starts the restore operation on the next library after the library where the RSTLIB failed.
4. You will be asked to load the volume containing the starting library.
5. After the restore operation is complete, restore the library that failed using the media from a previous save operation.

   Note: Consider eliminating the tape with the media error on the next save rotation cycle to avoid a tape error again.

Because the starting library for the *NONSYS, *IBM, or *ALLUSR save operation must be a library allowed by the SAVLIB or RSTLIB command, some libraries may not be specified for the STRLIB parameter. The following libraries *cannot* be specified for the STRLIB parameter:

- QDOC
- QRPLOBJ
- QSPL
- QSRV
- QSYS
- QTEMP
- QRECOVERY

If the library is not listed in the description on the first save tape, no tapes are searched for the starting library, no libraries are restored, and message CPF3818 is sent indicating that the starting library was not found.

Media or Device Error When Running the RSTDLO Command

If an unrecoverable error occurs when running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command, you must determine where the restore operation failed. Use the following information to determine where the failure occurred. Do the following:

1. Check the job log to determine if the failure occurred on a distribution object or a folder. The job log may identify where the failure occurred.
2. If the failure occurred on a distribution object, then the restore failed during the restore of mail. Go to "Recovering Mail."
3. If the failure occurred on a folder, go to "Recovering Documents and Folders."

Recovering Mail: To recover, do **one** of the following:

- If you have daily save (SAVDLO DLO(*CHG or *MAIL)) tapes to restore later, mail will be restored during the restore of these tapes.
- Restore the mail from the next most current SAVDLO DLO(*ALL, *CHG, or *MAIL) FLR(*ANY) tapes. Type the following to restore the mail:

  ```
  RSTDLO DLO(*MAIL) DEV(tape-device-name)
  ```

- If you do not have any tapes from SAVDLO DLO(*ALL, *CHG, or *MAIL) FLR(*ANY), run the following command:

  ```
  QOHFIXIX
  ```

  Run this command so that the mail that was restored is usable. Some of your mail may not have been restored.

If you need to restore the documents and folders from this set of save media, continue with "Recovering Documents and Folders."

Recovering Documents and Folders: If an unrecoverable error occurs during the RSTDLO procedure, you can restart the procedure using the SAVFLR parameter on the RSTDLO command.

The basic recovery steps for a restore operation are:

1. Check the job log to determine where the previous RSTDLO DLO(*ALL) command failed. The job log identifies which folder failed to restore.

   Note: If the failure occurred during the restore of mail, you need to restore all documents and folders.

2. Find the first folder after the folder that failed to restore. Use the list that was created during the last SAVDLO OUTPUT(*PRINT or *OUTFILE) operation or use the DSPTAP DATA(*SAVRST) command to determine which first-level folder is next. To find the first-level folders, find the object type *FLR. Look at the *Document or Folder Information* column. The name of a first-level folder does not contain a forward slash (/).

3. Load the first tape of the SAVDLO DLO(*ALL) media.

   Note: You must always start with the first volume of the SAVDLO media for each set of 300 first-level folders. Each volume in the set of SAVDLO tapes must be loaded in sequence.

4. Type the following and press the Enter key:

   ```
   RSTDLO DLO(*ALL) SAVFLR(folder-name)
       DEV(tape-device-name)
   ```

   where the *folder-name* is the name of the first-level folders identified from the list created in step 1. A limit of 300 first-level folders can be specified.

   Repeat this step for each set of 300 first-level folders.

If this was a restore of a complete save, continue with the task "Restoring Changed Documents and Folders" in the restore procedures.

Lock Conditions When Saving and Restoring Objects

The following reviews the object locking types:

- Exclusive (*EXCL). The object is reserved for the exclusive use of the requesting job; no other job can use the object. However, if the object is already allocated to another job, your job cannot get exclusive use of the object.
- Exclusive allow read (*EXCLRD). The object is allocated to the job that requested it, but other jobs can read the object. This lock is appropriate when you want to prevent any other job from doing any operation other than a read.
- Shared for update (*SHRUPD). The object can be shared either for update or read with another job. That is, another job can request either a shared-for-read lock state or a shared-for-update lock state for the same object. This lock state is appropriate when a job intends to change an object but wants to allow another job to read or change the same object.
- Shared no update (*SHRNUP). The object can be shared with another job if that job requests the object with either a shared-no-update or shared-for-read lock. This lock state is appropriate when you do not intend to have a job change an object but want to ensure that no other job changes the object.
- Shared for read (*SHRRD). The object can be shared with another job if the job does not request exclusive use of the object. That is, another job can request an exclusive-allow-read, shared-for-update, shared-for-read, or shared-no-update lock state.

Note: The address of a library does not restrict the operations that can be performed on the objects within the library. That is, if one job places an exclusive-allow-read or shared-for-update lock state on a library, other jobs can no longer place objects in or remove objects from the library; however, the other jobs can still update objects within the library that are not being restore. Table 9-1 shows the valid lock state combinations for an object.

Table 9-1. Valid Lock State Combinations

	Another Job Step Can Obtain This Lock State				
If One Job Step Obtains This Lock State:	**Exclusive**	**Exclusive Allow Read**	**Shared for Update**	**Shared No Update**	**Shared for Read**
*EXCL					
*EXCLRD					X
*SHRUPD			X		X
*SHRNUP				X	X
*SHRRD		X	X	X	X

Locks on Objects during a Save or Restore Operation: You can save and restore objects while normal system operation continues. In general, a particular object is locked to prevent an update attempt while it is being saved (except when using the save-while-active function), and locked to prevent a read attempt while it is being restored.

| **Note:** You cannot run more than one save or restore operation concurrently against the same library.

If an object is being updated, or if it is allocated *EXCL to another job, it cannot be saved or restored while it is being used, with the exception of journal receivers. A journal receiver can have journal entries added to it while it is being saved. In addition, an object cannot have its storage freed if it is being used in a job. During normal save operations, database files are locked in *SHRNUP when a save is specified. Another job can have the same file in *SHRNUP or *SHRRD lock state.

Some object types cannot be saved while they are in use. Job queues, output queues, journals, and journal receivers are locked *SHRRD while they are being saved. Other objects are locked *SHRNUP unless storage is to be freed, then the objects are locked *EXCL.

Restrictions for Configuration Objects. Configuration objects are not locked during a save (SAVCFG) operation. System resource management objects are locked during a save operation.

Most objects cannot be restored while they are in use. Job queues and output queues are locked *SHRRD. Message queues are locked *EXCLRD. Other objects are locked *EXCL. Restoring a program that is in use usually results in it ending abnormally because the one in use on the system is deleted when the copy from the save media is restored.

| **Note:** Integrated Language Environment (ILE) objects cannot be restored when they are in use.

Locks on Objects During a Save While Active Operation: You can save objects while they are being changed by using the save-while-active (SAVACT) parameter on the save command.

The *Advanced Backup and Recovery Guide* has more information about locking conditions when using the save-while-active function.

Lock Conditions on Libraries during Save and Restore Operations: An internal lock is placed on the library while a save or restore operation is performed. The following lock conditions exist against a library:

- *Restrictions for Libraries When Saving.* When a save library, save object, or save changed object is in progress, the library is locked with a *SHRUPD lock.
- *Restrictions for Libraries When Restoring.* When a restore library operation is in progress, the library is locked with an *EXCLRD lock. When a restore object operation is in progress, the library is locked with a *SHRUPD lock.

| **Note:** You cannot run more than one save or restore operation concurrently against the same library.

Save and Restore Operations Requiring a Restricted System

When doing the following tasks, you must have the system in a restricted state with all subsystems ended:

- Saving the entire system
- Saving storage
- Restoring all *IBM libraries
- Restoring user profiles
- Restoring authority
- Saving and restoring all *NONSYS libraries

The system is placed in the restricted state by the End System (ENDSYS) or End Subsystem (ENDSBS SBS(*ALL)) command.

Performance Considerations for Save and Restore Operations

The following considerations influence performance:

- Size and activity level of the storage pool
- Run priority of the save or restore job
- Size of the system
- Size of the machine pool
- Size of save data
- Type of save data
- Number of objects saved
- Type of command
- Number of recoverable errors
- Number of diskettes or tapes used
- Model size
- System status (restricted or non-restricted state)
- Amount of user activity on the system
- Data rate of save and restore device
- Data compression (specified or not specified) provided by tape I/O adapter or programming
- Number of disk units on the system
- Special authority of user running operation
- Save-while active (SAVACT) parameter is specified.
- Output (OUTPUT) parameter is specified.
- Specific sequence number (SEQNBR parameter) is specified

Save and Restore Operations: Save and Restore operations should run without the need for special tuning when it is run in a non-restricted state. Ensure that care has been taken to reduce adverse performance on other jobs while save and restore operations are running. However, performance can be tuned, if necessary, by changing one of the following:

- The run priority of the save or restore job. If your save operation is competing with other jobs at the same priority, you can change the save operation job to run at a higher priority. For example, run the save operation at priority 45 instead of 50, or at priority 19 instead of 20. The priority change can be made at any time and will take effect even if the save operation is in progress when the change is requested. Use the Change Job (CHGJOB) command to run faster or slower.

  If your save operation is competing with other jobs running at a higher priority, then the only way to improve performance is to reduce the workload the save is competing with by arranging a different scheduling order, or by upgrading the system to make more resources (CPU cycles) available.

- The storage pool size or the activity level of the subsystem in which the job is running. The save and restore operation obtains buffers from the storage pool in which the save or restore job is running. The minimum storage pool size is 160KB (KB equals 1024 bytes) for diskette and save files and 224KB for tape.

  The amount of storage used as buffers appears in the *Reserved size* field on the Work with System Status display. You can adjust the amount and the effect on other operations by changing the storage pool size and the activity levels of the subsystem (using the Change Subsystem Description (CHGSBSD) command) in which the save or restore job is running.

- Size of the machine pool. Save-while-active operations require an additional 300KB in the machine pool compared to normal save operations.

- Using data compression and decompression. For more information about the effects of using data compression, see the topic "Data Compression and Decompression" on page 4-6.

Save System Special Authority: Performance is improved if the user profile running the operation has *SAVSYS special authority because no authority checking is necessary during the save and restore operation.

System Status: For either a save or restore operation, performance is improved if the operation is run when the system is in a restricted state (all subsystems ended) or user activity is limited. Performance is improved because:

- The OS/400 licensed program does not have to lock all objects.

- Sufficient main storage exists to provide an improved save operation.

Effect on Users: Save and restore operations affect users of the system. The effect on other users can be reduced if you have more disk units on the system.

If your system is not in a restricted state when a high-speed tape unit is used, the performance degradation for other users is greater than if you are using diskettes because the tape unit has a higher data transfer rate.

Security Considerations When Saving and Restoring

Security considerations include ownership of objects and granting of public and private authorities.

Security for the Restore Commands

For systems in which security is especially important, only data or source files should be restored from other systems. Examination of the source, recompilation on the new system, and re-creation of objects (for example, job descriptions) are required to maintain tight security.

You may want to secure the restore commands and authorize them to specific user profiles. You can change this public authority except for the Restore Licensed Program (RSTLICPGM) commands, which are authorized only to QSECOFR.

Ownership

Every object on the AS/400 system must have an owner. The restore commands RSTOBJ, RSTUSRPRF, RSTLIB, RSTCFG, and RSTDLO, provide a parameter to allow object differences (ALWOBJDIF). This allows the restore operation to override any differences found in ownership. If there are differences in ownership and ALWOBJDIF(*ALL) is specified, then the system will restore the object to the owner on the system instead of the owner on the media.

If the object does not exist on the system prior to the restore operation, the owner on the media becomes the owner.

If the owner and the object on the media do not exist at the time of the restore operation, then the object is restored and the QDFTOWN user profile becomes the owner.

Passwords for IBM-Supplied User Profiles

IBM-supplied user profiles are shipped with default passwords. You should have changed these passwords immediately after the system was installed. When you save the system, the passwords are saved with the user profiles. Under some circumstances, it may be necessary to restore IBM-supplied user profiles from a distribution tape. If this is necessary, make sure you change the default passwords for the IBM-supplied user profiles after the restore operation. If you do not change the passwords, anyone can sign on the system using an IBM-supplied user profile and the default password. THIS IS A SECURITY RISK.

Public and Private Authorities

The object on the media includes the object owner and the public authority attributes. If the object exists on the system, the public authority for the object on the system is used (not the authority on the media). If an object has public authority specified on one system and is restored to another system where the object does not exist, its public authority is also restored on the new system. The only exception is when programs adopt their owner's user profile (USRPRF (*OWNER) specified when the program was created).

Programs that adopt their owner's user profile must be restored by the owner or by a user with *ALLOBJ and *SECADM special authority. If the owner of the program does not exist on the new system or the restore operation is running under a profile other than the owner or the security officer, then the public authority for the object is changed to *EXCLUDE.

Private authorities for an object are saved with the user profile. Private authorities for users other than the owner are not saved when the object or library is saved, but they are saved with the user profiles when saved with the SAVSYS or SAVSECDTA command. When an object is restored to a library where the object does not

exist, the owner must grant private authorities again.

If the entire system is restored, three restore commands must be used in the following sequence. The authorization structure is reset to the point when the user profiles were saved.

- The Restore User Profiles (RSTUSRPRF) command restores one or more user profiles. This command is normally used when restoring the entire system or when transferring a user from one AS/400 system to another.
- Make sure all of the objects owned by the restored user profiles are restored (RSTLIB or RSTOBJ command).
- The Restore Authority (RSTAUT) command grants the private authorities existing when the system was saved. This command does not revoke any private authorities granted since that time.

Authority Holders

When an authority holder exists on the system that has the same name as a file being restored, the file is linked to the authority holder when it is restored only if the following conditions exist:

- The owner of the file has *ALL authority to the authority holder.
- If the file is a physical file, the owner had *ALL authority to the file when it was saved.
- If the file is a logical file, the owner had *OBJEXIST, *OBJMGT, and *OBJOPR authorities to the file when it was saved.

Authorization Lists

During a save operation, if an object is secured by an authorization list, the name of the authorization list is saved with the object.

The object is restored and linked to the authorization list if all of the following occur:

1. The object must be restored on the same system from which it was saved unless ALWOBJDIF(*ALL) is specified on the restore command. If ALWOBJDIF(*NONE) is specified, the object will be restored, but will be given *EXCLUDE public authority.
2. If the object (except documents and folders) already exists on the system, it must have the same authorization list as the object on the media. If not, the object will not be restored.
3. The authorization list must exist on the system. If not, the object will be restored, but will be given *EXCLUDE public authority. Documents and folders will be restored and linked to the authority of the object on the system.

Media and Save File Security

Control of who can use the media device or save file, and for what purpose, is essential to maintain security of the system. The tape, diskette, or save file should be secured so that only authorized users have access to the media or save file.

Printing Security Information

If you specify OUTPUT(*PRINT) on the Restore Object (RSTOBJ), Restore Library (RSTLIB), or Restore Licensed Program (RSTLICPGM) commands, you obtain a list of what was restored. The list indicates the following:

- If a program adopted the owner's user profile.
- The associated user profile of a job description.
- If the object is restored and ownership is given to the default owner profile (QDFTOWN) or the system owner.
- The old owner's user profile.
- If authorization is revoked.

The LABEL Parameter on the Save and Restore Commands

Most save commands allow you to specify a file label up to seventeen characters in length to be associated with the file saved on tape or diskette. The default value for this parameter, either LABEL(*LIB) or LABEL(*GEN), results in the label being generated from the name of the library from which the objects are saved.

If you do not choose the default and enter a label of your own on the label parameter, you must enter that same label on the corresponding

Restore command in order to restore the objects. For example, if you specified SAVOBJ DEV(TAP01) LABEL(MYLABEL), and you later want to restore the objects from the save tape, specify RSTOBJ DEV(TAP01) LABEL(MYLABEL). You cannot restore from the file using the default value of LABEL(*LIB) on the RSTOBJ command. This applies to all save and restore commands that support the LABEL parameter. If you do not enter the correct label, you receive the message 'File label mismatch' in your job log.

Access Path Rebuild during a Manual IPL Time

If the access path for a logical file is not restored, it is automatically rebuilt when the restore operation is performed for a logical file specified as MAINT(*IMMED) or MAINT(*DLY).

Rebuilding access paths after an IPL is usually slow because it is done in the BASE pool (usually the smallest pool). When one or more access paths must be rebuilt, the rebuild operations occur in a separate job called QDBSRV*n*, where *n* is a number. The start control program function (SCPF) job starts these server jobs during the IPL.

Each server job can rebuild one access path at a time. The access path currently being rebuilt can be seen with the Edit Rebuild of Access Paths (EDTRBDAP) command. Sometimes your restore operation is finished before the QDBSRV*n* jobs have finished rebuilding access paths. (Message (CPF3145) is sent to QHST for each access path rebuilt.)

When your restore operation is finished, enter the EDTRBDAP command. If an access path is being rebuilt, the display shows RUN in the *Status* field for the file. The *Advanced Backup and Recovery Guide* has more information about access path rebuild during IPL processing. The *CL Reference* has more information about the EDTRBDAP command.

Using the Save and Restore Commands

The following subtopics show examples of the save and restore commands. The *CL Reference* has more information about these commands.

Entering the Save and Restore Commands

When you enter a save or restore command at a work station, the work station cannot be used until the command completes. To avoid this inconvenience, submit the command to a job queue and run the function in batch mode.

Checking Objects before Saving

Using the parameter PRECHK(*YES) ensures that all objects you intend to save can be saved. (For example, sometimes an object is not saved because it was locked for update at the time of the save operation.) Objects are verified to ensure that:

- They can be allocated during the save operation.
- Those specified on the save command exist.
- Those specified on the save command are not marked as damaged.
- All members of the database files can be allocated during the save operation.
- The person requesting the save operation is authorized to save all of the objects.

If any one of these conditions is not true and PRECHK(*YES) is specified, the save operation stops. When more than one library is specified, PRECHK(*YES) applies to each library independently. The failure to save one library does not affect the saving of other libraries.

Note: PRECHK(*YES) with SAVACT(*SYNCLIB), PRECHK applies to all the libraries specified on the save command.

If PRECHK(*NO) is specified, the save operation continues, but bypasses any object that cannot be saved. The command will complete with an escape message (see "Save and Restore Com-

pletion Messages" on page 9-7 for more information).

Summary of How to Save Object Types

Table 9-2 summarizes how objects of each type can be saved. It includes the variable specified on the OBJTYPE parameter and shows which commands are used with which objects.

Table 9-2 (Page 1 of 3). Objects Saved by Commands According to Object Type

Object	OBJTYPE	SAVOBJ	SAVLIB	SAVSECDTA	SAVSYS	SAVCFG	SAVDLO
Alert table	*ALRTBL	X	X				
Authority holder	*AUTHLR			X[6]	X[6]		
Authorization list	*AUTL			X[6]	X[6]		
Bind directory	*BNDDIR	X	X				
Chart format	*CHTFMT	X	X		X[1]		
C local description	*CLD	X	X		X[1]		
Class	*CLS	X	X		X[1]		
Class of service description	*COSD				X[3]	X	
Command definition	*CMD	X	X		X[1]		
Communications side information	*CSI	X	X		X[1]		
Configuration list[3,4]	*CFGL				X	X	
Connection list[3]	*CNNL				X[3]	X	
Controller description	*CTLD				X[3]	X	
Cross system product map	*CSPMAP	X	X		X[1]		
Cross system product table	*CSPTBL	X	X		X[1]		
Data area	*DTAARA	X	X		X[1]		
Data queue[2]	*DTAQ	X	X		X[1]		
Data dictionary	*DTADCT		X		X[1]		
Device description	*DEVD				X[3]	X	
Distributions	*MAIL[8]						X
Document	*DOC						X
Edit description[4]	*EDTD	X	X		X		
File[2,5]	*FILE	X	X		X[1,7]		
Filter	*FTR	X	X		X[1,7]		
Folder	*FLR						X
Font resource	*FNTRSC	X	X		X[1]		
Forms control table	*FCT	X	X		X[1]		
Forms definition	*FORMDF	X	X		X[1]		
Graphics symbol set	*GSS	X	X		X[1]		
Ideographic table	*IGCTBL	X	X				
Ideographic dictionary	*IGCDCT	X	X				
Ideographic sort table	*IGCSRT	X	X				
Job description	*JOBD	X	X		X[1]		

Table 9-2 (Page 2 of 3). Objects Saved by Commands According to Object Type

Object	OBJTYPE	SAVOBJ	SAVLIB	SAVSECDTA	SAVSYS	SAVCFG	SAVDLO
Job queue[2]	*JOBQ	X	X		X[1]		
Job scheduler	*JOBSCD	X	X		X[1]		
Journal[2]	*JRN	X	X		X[1]		
Journal receiver	*JRNRCV	X	X		X[1]		
Library	*LIB		X[7]				
Line description	*LIND				X[3]	X	
Menu	*MENU	X	X		X[1]		
Message file	*MSGF	X	X		X[1]		
Message queue[2]	*MSGQ	X	X		X[1]		
Mode description	*MODD				X[3]	X	
Module	*MODULE	X	X				
Network interface description	*NWID				X[3]	X	
Node list	*NODL	X	X				
Output queue[2]	*OUTQ	X	X				
Overlay	*OVL	X	X		X[1]		
Page definition	*PAGDFN	X	X		X[1]		
Page segment	*PAGSEG	X	X		X[1]		
Panel group	*PNLGRP	X	X		X[1]		
Printer description group	*PDG	X	X		X[1]		
Product availability	*PRDAVL	X	X		X[1]		
Program	*PGM	X	X		X[1]		
Query definition	*QRYDFN	X	X		X[1]		
Query form	*QMFORM	X	X		X[1]		
Query manager query	*QMQRY	X	X		X[1]		
Reference code translation table	*RCT	X	X		X[1]		
System/36 machine description	*S36	X	X		X[1]		
Service program	*SRVPGM	X	X				
Search index	*SCHIDX	X	X		X[1]		
Session description	*SSND	X	X		X[1]		
Spelling help dictionary	*SPADCT	X	X		X[1]		
SQL package	*SQLPKG	X	X		X		
Subsystem description	*SBSD	X	X		X[1]		
System resource management data	*SRMDATA[8]				X[1]	X	
Table	*TBL	X	X		X[1]		
User index	*USRIDX	X	X		X[1]		
User profile	*USRPRF			X[6]	X[6]		
User queue	*USRQ	X	X		X[1]		
User space	*USRSPC	X	X		X[1]		

Table 9-2 (Page 3 of 3). Objects Saved by Commands According to Object Type

Object	OBJTYPE	SAVOBJ	SAVLIB	SAVSECDTA	SAVSYS	SAVCFG	SAVDLO
Workstation customization	*WSCST	X	X				

Notes:

1 If the object is in library QSYS.

2 For save files, only descriptions are saved when SAVFDTA(*NO) is specified on the save command. For other objects that have only their descriptions saved, see Table 5-2 on page 5-12.

3 These are restored using the RSTCFG command.

4 Edit descriptions and configuration lists reside only in library QSYS.

5 The SAVSAVFDTA command saves only the contents of save files.

6 User profiles are restored using the RSTUSRPRF command. Authorities are restored using the RSTAUT command after needed objects are restored. Authorization lists and authority holders are restored when RSTUSRPRF USRPRF(*ALL) is specified.

7 If there are save files in the library, the save file data is saved by default.

8 Mail and SRM data consists of internal object types.

Examples of Save Library (SAVLIB) Command

The following are examples of using the SAVLIB command.

- To save a single library to tape:

```
SAVLIB LIB(TOM)  DEV(TAP01) LABEL(080989)
```

- To save a library to diskette and free storage of all files, programs, SQL packages, and journal receivers after the save operation:

```
SAVLIB LIB(JOE) DEV(DKT01) VOL(VOLxx1)  STG(*FREE)
```

- To save all user libraries, library QGPL, QUSRSYS, and licensed program libraries (except PAYLIB) to tape, perform data compression, and print a list of what is saved:

```
SAVLIB LIB(*NONSYS) DEV(TAP01) OMITLIB(PAYLIB)
     DTACPR(*YES) OUTPUT(*PRINT)
```

- To save all user libraries, including libraries QGPL and QUSRSYS, to tape and perform data compression:

```
SAVLIB LIB(*ALLUSR) DEV(TAP01) DTACPR(*YES)
```

- To save IBM-supplied libraries, not including libraries QGPL and QUSRSYS, to tape and perform data compression:

```
SAVLIB LIB(*IBM) DEV(TAP01) DTACPR(*YES)
```

- To save a library in a previous release format:

```
SAVLIB LIB(TOM) DEV(TAP01) TGTRLS(*PRV)
```

- To save a library in V2R2M0 format:

```
SAVLIB LIB(JILL) DEV(TAP01) TGTRLS(V2R2M0)
```

Examples of Restore Library (RSTLIB) Command

The following are examples of using the RSTLIB command.

- To restore a single library:

```
RSTLIB SAVLIB(TOM)  DEV(TAP01) LABEL(080989)
```

- To restore all user libraries, QGPL, QUSRSYS, and licensed program libraries except PAYLIB from tape:

```
RSTLIB SAVLIB(*NONSYS) DEV(TAP01)
    OMITLIB(PAYLIB)
```

- To restore all user libraries, including libraries QGPL and QUSRSYS, from tape:

```
RSTLIB SAVLIB(*ALLUSR) DEV(TAP01)
```

- To restore IBM-supplied libraries, not including libraries QGPL and QUSRSYS, from tape:

```
RSTLIB SAVLIB(*IBM) DEV(TAP01)
```

- To restore a single library to user ASP 9:

```
RSTLIB  SAVLIB(TOM) DEV(TAP01) RSTASP(9)
```

Note: When using the RSTASP parameter on the RSTLIB command, the library cannot already exist in a different ASP and the specified ASP cannot contain any isolated objects, such as journals, journal receivers, and save files whose library is in the system ASP.

When restoring libraries to a user ASP, all objects in the library are restored to the specified ASP. Objects that are not allowed in user ASPs are not restored. For a list of objects that are not allowed

in a user ASP, see "Object Types Not Allowed in a User ASP" on page 12-14.

Examples of Save Object (SAVOBJ) Command

The following are examples of using the SAVOBJ command.

- To save a single file:

```
SAVOBJ OBJ(DSTREF) LIB(DSTORDLB) DEV(DKT01)
     OBJTYPE(*FILE) VOL(SAVA1O) STG(*KEEP)
```

  The file in library DSTORDLB remains there because the storage was not freed. It was saved on volume SAVA01, which was loaded in a diskette unit.

- To save a group of objects using a generic name:

```
SAVOBJ OBJ(ORD*) LIB(DSTORDLB) DEV(TAP01)
     OBJTYPE(*FILE) VOL(*MOUNTED) STG(*KEEP)
     ENDOPT(*UNLOAD)
```

  The files are saved on magnetic tape on the volume loaded. Storage for these files is not freed and the objects still exist in library DSTORDLB. The tape will be rewound and unloaded from the tape unit as specified in the ENDOPT parameter.

- To save a group of objects in a previous release format using a generic name:

```
SAVOBJ OBJ(TOM*) LIB(TOM) DEV(TAP01) OBJTYPE(*FILE)
   VOL(*MOUNTED) STG(*FREE) TGTRLS(*PRV)
   ENDOPT(*UNLOAD)
```

  All the files whose names begin with TOM in library TOM are saved to magnetic tape in a previous release format on the volume loaded. Storage for these files is freed and the data no longer exist in library TOM. The tape will be rewound and unloaded from the tape unit as specified in the ENDOPT parameter.

- To save objects in a previous release format:

```
SAVOBJ OBJ(PAY*) LIB(LIB1) DEV(TAP01) TGTRLS(V2R2M0)
```

  This command saves the objects beginning with PAY from library LIB1 in a format compatible with a V2R2M0 system. Only the objects supported on the previous release are saved.

Examples of Restore Object (RSTOBJ) Command

The following are examples of using the RSTOBJ command.

- To restore a single file:

```
RSTOBJ OBJ(DSTREF) SAVLIB(USER1) DEV(DKT01)
     OBJTYPE(*FILE) VOL(SAVA01) OPTION(*OLD)
```

  This command restores the file to the library it was saved from. It was restored from volume SAVA01, which was loaded in a diskette unit.

- To restore a group of files using a generic name:

```
RSTOBJ OBJ(ORD*) SAVLIB(DSTORDLB) DEV(TAP01)
     OBJTYPE(*FILE) VOL(*MOUNTED)
```

  This command restores all files beginning with the characters ORD.

- To restore a journal receiver to user ASP 5 when the library is in the system ASP:

```
RSTOBJ  OBJ(JRNRCV001) SAVLIB(TOM) DEV(TAP01)
     OBJTYPE(*JRNRCV) VOL(*MOUNTED) RSTASP(5)
```

  Note: Only journals, journal receivers, and save files can be restored to an ASP that does not contain their libraries. This can only be done when the library is in the system ASP, and the ASP for the journals, journal receivers, and save files does not contain a library.

Examples of Save Changed Object (SAVCHGOBJ) Command

The SAVCHGOBJ command is like the SAVOBJ command except that the SAVCHGOBJ command saves only *changed* objects or members. When an object is created or changed, the system time-stamps the object in an internal field, indicating a change has occurred.

- To save a group of changed files using a generic name:

```
SAVCHGOBJ OBJ(ORD*) LIB(DSTPRODLB) DEV(TAP01)
       OBJTYPE(*FILE) REFDATE(220793)
```

  This command saves all file with names beginning with ORD in library QDSTPRODLB that have changed since 22 July 1993.

- To save all changed objects in all user libraries:

```
SAVCHGOBJ OBJ(*ALL) LIB(*ALLUSR) DEV(TAP01)
     OBJTYPE(*ALL) VOL(SAVA01)
```

All changed objects in all the user libraries, including libraries QGPL and QUSRSYS, are saved to tape. The objects were saved on volume SAVA01, which was loaded in a tape unit.

Example of Restoring Changed Objects after the RSTLIB Command

One of the following commands can be used to restore all the user libraries including QGPL and QUSRSYS.

```
RSTLIB SAVLIB(*NONSYS) DEV(TAP01)
```

Or

```
RSTLIB SAVLIB(*ALLUSR) DEV(TAP01) VOL(*MOUNTED)
```

Examples of Saving Access Paths

The following are examples of saving access paths using the ACCPTH parameter on the Save Object (SAVOBJ) command.

- To save access paths by specifying a generic name:

  ```
  SAVOBJ OBJ(ORD*) LIB(DSTPRDLB) DEV(TAP01)
       OBJTYPE(*FILE) ACCPTH(*YES)
  ```

  This command saves the access paths for all database files beginning with the characters ORD.

- To save all access paths for a library:

  ```
  SAVLIB LIB(DSTPRDLB) DEV(TAP01) ACCPTH(*YES)
  ```

  This command saves all of the objects and the access paths for library DSTPRDLB.

When you specify ACCPTH(*YES), a message is issued for each physical file saved indicating how many logical file access paths were saved with that physical file.

Examples of Restoring Access Paths

The following is an example of restoring access paths if the logical file does not exist on the system or is in a different library.

1. Restore the physical file first:

   ```
   RSTOBJ OBJ(PAYFILE) SAVLIB(PAYLIB) DEV(TAP01)
          OBJTYPE(*FILE) VOL(*MOUNTED) SEQNBR(*SEARCH)
   ```

2. Clear the physical file members:

   ```
   CLRPFM FILE(PAYLIB/PAYFILE) MBR(*ALL)
   ```

3. Restore the logical file:

   ```
   RSTOBJ  OBJ(PAYLF) SAVLIB(PAYLIB) DEV(TAP01)
           OBJTYPE(*FILE) VOL(*MOUNTED) SEQNBR(*SEARCH)
   ```

4. Restore the physical files again:

   ```
   RSTOBJ OBJ(PAYFILE) SAVLIB(PAYLIB) DEV(TAP01)
          OBJTYPE(*FILE) VOL(*MOUNTED) SEQNBR(*SEARCH)
   ```

When you specify ACCPTH(*YES), a message is sent for each physical file restored indicating how many logical file access paths were restored with that physical file.

Examples of Saving a List of Members

In the following example, DBFA and DBFB are database files with members P1, P2, M1, and M2.

- To save a single, specific member from a specific database file:

  ```
  SAVOBJ OBJ(DBFA) FILEMBR((DBFA (M1))) DEV(TAP01)
       LIB(DSTPRODLB)  OBJTYPE(*FILE)
  ```

  Member M1 from file DBFA will be saved.

- To save a generic set of members from a specific database file:

  ```
  SAVOBJ OBJ(DBFA) FILEMBR((DBFA (P*))) DEV(TAP01)
       LIB(DSTPRODLB)  OBJTYPE(*FILE)
  ```

  Members P1 and P2 from file DBFA will be saved.

- To save a specific set of members from a specific database file:

  ```
  SAVOBJ OBJ(DBFA) FILEMBR((DBFA (M1 M2 P1))) DEV(TAP01)
       LIB(DSTPRODLB)  OBJTYPE(*FILE)
  ```

  Members M1, M2, and P1 from file DBFA will be saved.

- To save a specific set of members from several database files:

  ```
  SAVOBJ OBJ(DBFA DBFB)  FILEMBR((*ALL (M1 P1 P2)))
       DEV(TAP01) LIB(DSTPRODLB) OBJTYPE(*FILE)
  ```

  Members M1, P1, and P2 from both file DBFA and DBFB will be saved.

- In the following example, *NONE indicates that only the file description is saved:

  ```
  SAVOBJ OBJ(DBFA) FILEMBR((DBFA (*NONE))) DEV(TAP01)
       LIB(DSTPRODLB)  OBJTYPE(*FILE)
  ```

None of the members for file DBFA are saved; only the file descriptions are saved.

Examples of Restoring a List of Members

You can restore a list of members for a database file using the FILEMBR parameter of the RSTOBJ command. In the following example, DBFA and DBFB are database files with members P1, P2, M1, and M2.

- To restore a single, specific member from a specific database file:

```
RSTOBJ OBJ(DBFA) FILEMBR((DBFA (M1))) DEV(TAP01)
     SAVLIB(DSTPRODLB)  OBJTYPE(*FILE) MBROPT(*ALL)
```

  Member M1 from file DBFA will be restored.

- To restore a generic set of members from a specific database file:

```
RSTOBJ OBJ(DBFA) FILEMBR((DBFA (P*))) DEV(TAP01)
     SAVLIB(DSTPRODLB)  OBJTYPE(*FILE) MBROPT(*ALL)
```

  Members P1 and P2 from file DBFA will be restored.

- To restore a specific set of members from a specific database file:

```
RSTOBJ OBJ(DBFA) FILEMBR((DBFA (M1 M2 P1))) DEV(TAP01)
     SAVLIB(DSTPRODLB)  OBJTYPE(*FILE) MBROPT(*ALL)
```

  Members M1, M2, and P1 from file DBFA will be restored.

- To restore a specific set of members from several database files:

```
RSTOBJ OBJ(DBFA DBFB)  FILEMBR((*ALL (M1 P1 P2)))
DEV(TAP01) SAVLIB(DSTPRODLB) OBJTYPE(*FILE)
MBROPT(*ALL)
```

  Members M1, P1, and P2 from both files DBFA and DBFB will be restored.

- In the following example, *NONE indicates that only the file description is restored:

```
RSTOBJ OBJ(DBFA) FILEMBR((DBFA (*NONE))) DEV(TAP01)
     SAVLIB(DSTPRODLB)  OBJTYPE(*FILE) MBROPT(*ALL)
```

  None of the members for file DBFA will be restored, only the file descriptions.

Save Save File Data (SAVSAVFDTA) Command Examples

Only one library can be saved to a save file.

- When objects are saved to a save file, they can be saved to tape or diskette using the following command:

```
SAVSAVFDTA  SAVF(ONLINE) DEV(TAP01) SEQNBR(1) CLEAR(*ALL)
```

  This command saves the contents of the save file ONLINE to the first file on the tape device TAP01. Files that already exist on either the first volume or following volumes are overwritten without any inquiry message because CLEAR(*ALL) is specified.

  When the data in a save file is saved to tape or diskette, the data can be restored as though it were saved to tape or diskette.

- If the last save command to save library USERLIB and the save file ONLINE is used as in the previous examples, then the following command must be specified to restore the library from tape.

```
RSTLIB SAVLIB(USRLIB) DEV(TAP01) VOL(*MOUNTED)
```

Save Document Library Object (SAVDLO) Command Examples

The following examples are some possible uses of the SAVDLO command.

- To save a document within a folder:

```
SAVDLO DLO(A) DEV(TAP01) FLR(X)
```

  This command saves document A within folder X.

- To save all documents and folders within a folder:

```
SAVDLO DLO(*ALL) FLR(X/Z) DEV(TAP01)
```

  This command saves all folders and documents within folder X/Z.

- To save all documents and folders:

```
SAVDLO DLO(*ALL) FLR(*ANY) DEV(TAP01)
```

  This command saves all folders and documents on the system. You must have SAVSYS or *ALLOBJ special authority to use the SAVDLO command this way.

- To save all documents not stored in folders:

```
SAVDLO DLO(*ALL) FLR(*NONE) DEV(TAP01)
```

  This command saves all documents that are not stored within folders on the system.

- To save documents for a specific owner:

```
SAVDLO DLO(*SEARCH) DEV(TAP01) OWNER(XYZ)
```

This command saves all filed documents owned by XYZ. If your user profile is not XYZ, you must have *SAVSYS or *ALLOBJ special authority to run this command.

- To save documents that are created between specific dates.

```
SAVDLO DLO(*SEARCH) DEV(TAP01)
     CRTDATE((*AVAIL '02/10/92' *AVAIL '03/10/92'))
```

This command saves all filed documents created between February 10, 1992 and March 10, 1992 (inclusively).

- To save mail objects:

```
SAVDLO DLO(*MAIL) DEV(TAP01)
```

This command saves all the documents referenced in the mail log in addition to all filed documents in library QDOC that are referenced by a distribution.

- To save changed documents:

```
SAVDLO DLO(*SEARCH) DEV(TAP01)
     REFCHGDATE('03/10/92')
```

This command saves all the filed documents changed after March 10, 1992.

- To save a list of documents:

```
SAVDLO DLO(*DOCL) FLR(Y) DEV(TAP01) DOCL(X)
       OUTPUT(*OUTFILE)  OUTFILE(MYFILE)
```

This command saves a list of documents specified by document list X in folder Y and writes information about the saved documents to output file MYFILE.

- To save a document in a previous release format:

```
SAVDLO DLO(A) FLR(X) DEV(TAP01) TGTRLS(*PRV)
```

This command saves document A in folder X in a previous release format.

- To save documents and folders by specifying the type of search:

```
SAVDLO  DLO(*SEARCH) DEV(TAP01) SRCHTYPE(*ALL)
     CRTDATE((*AVAIL '01/01/92' *AVAIL '03/01/92'))
     REFCHGDATE('01/01/92') OWNER(*ALL)
```

This command saves all folders (and all documents and folders within them) created between January 1, 1992 and March 1, 1992 (inclusively), in addition to all documents that were created or changed after January 1, 1992.

- To save all new folders and all new and changed documents:

```
SAVDLO DLO(*CHG) DEV(TAP01)
```

This command saves all folders that are new and all documents that are new and changed since the last SAVDLO DLO(*ALL) FLR(*ANY) operation was run.

- To save folder objects:

```
SAVDLO DLO(*FLRLVL) DEV(TAP01) FLR(X)
```

This command saves the folder object for folder X, documents in folder X, and folder objects for folders with X. However, it does not save the folders or documents with the folders in folder X. For example, folder X contains folder X/Y and documents A, B, and C. Folder X/Y contains folders X/Y/ZZ and documents D, E, and F. This command saves the folder objects for X and X/Y, documents A, B, and C. Folder X/Y/ZZ and documents D, E, and F are not saved.

- To save documents in a folder in a previous release format:

```
SAVDLO  DLO(*ALL) FLR(*ANY) DEV(TAP01)
     TGTRLS(V2R2M0)
```

This command saves all documents and folders on the system in a format compatible with the V2R2M0 operating system. You must have *SAVSYS or *ALLOBJ special authority to use the SAVDLO command in this way.

For more information on the SAVDLO command, see the online information for this command.

When you use the SAVDLO command to save documents and folders in a save file, the save file can be saved to diskette or tape using the SAVSAVFDTA command. The documents and folders can then be restored using the RSTDLO command directly.

Restore Document Library Object (RSTDLO) Command Examples

The following examples show some possible uses of the RSTDLO (Restore Document Library Object) command and describe what it does.

- `RSTDLO DLO(A) SAVFLR(X) DEV(TAP01)`

  This command restores document A from within folder X to folder X.

- `RSTDLO DLO(*ALL) SAVFLR(A) DEV(TAP01)`

This command restores all of folder A (including folders in folder A). If folder A is on the system when you specify the RSTDLO command and new documents are added to this folder, the new documents are merged in with the old documents from the restored folder A.

- `RSTDLO DLO(A,B,C,D) SAVFLR(X/Y) DEV(TAP01) RSTFLR(P/Q)`

  This command restores documents A, B, C, and D from folder X/Y into a different folder named P/Q.

- `RSTDLO DLO(A,B,C,D) SAVFLR(X/Y) DEV(TAP01) NEWOBJ(*NEW)`

  This command restores documents A, B, C, and D from folder X/Y to folder X/Y, and generates new system object names for A, B, C, and D.

- To restore distribution documents:

  ```
  RSTDLO DLO(*MAIL) DEV(TAP01)
  ```

  This command restores all documents that are referenced by distributions at the time they were saved, in addition to all saved distribution documents.

- To restore document A in folder Z:

  ```
  RSTDLO  DLO(A) SAVFLR(Z) DEV(TAP01)
       ALWOBJDIF(*ALL)
  ```

  This command restores document A, saved in folder Z on the media, into folder Z on the system, even if the owner and system object name for document A on the system is not the same as the owner and system object name on the media. The owner and system object name on the system are kept.

- To restore all documents in folder X:

  ```
  RSTDLO DLO(*ALL) SAVFLR(X) DEV(TAP01) RSTFLR(Y)
  ```

  This command restores all documents saved in folder X to folder Y. If the owner and system object names for a document on the system is not the same as the owner and system object names on the media, the document is not restored.

For more information on the RSTDLO command, see the online information for this command.

Save System (SAVSYS) Command Examples

The following are examples of using the SAVSYS command.

- To save the system to tape:

  ```
  SAVSYS DEV(TAP01) CLEAR(*ALL)
  ```

  This command saves the system objects, all user profiles (including private authority for objects), licensed internal code, configuration objects, and system resource management object. They are saved on the tape loaded in tape unit TAP01. Each tape used in the save operation that is not already cleared is automatically written over and the save operation continues without operator intervention.

- To save the system using a specific volume:

  ```
  SAVSYS DEV(TAP01) VOL(SAVA02)
  ```

  This command saves the system data on the TAP01 tape unit, starting with the tape volume labeled SAVA02. If the save operation exceeds the storage capacity of one tape, a message is sent to the operator requesting another volume be loaded in tape unit TAP01.

- To save the system using two tape units:

  ```
  SAVSYS DEV(TAP01 TAP02)
  ```

  This command saves the system data on tape units TAP01 and TAP02 in alternating order. If the save operation exceeds the storage capacity of two tapes, a message is sent to the operator requesting another volume be loaded in tape unit TAP01. The tapes rewind at the end of the save operation.

Save Security Data (SAVSECDTA) Command Examples

The following are examples of using the SAVSECDTA command.

- To save security information to tape:

  ```
  SAVSECDTA  DEV(TAP01)
  ```

  This command saves the user profiles, private authorities, authorization lists, and authority holders to tape.

- To save the security data to a save file:

  ```
  SAVSECDTA  DEV(*SAVF) SAVF(ONLINE)
  ```

This command saves the user profiles, private authorities, authorization lists, and authority holders to the ONLINE save file.

Restore User Profiles (RSTUSRPRF) Command Examples

The following are examples of using the RSTUSRPRF command.

- To restore all user profiles, authorization lists, and authority holders.

```
RSTUSRPRF DEV(TAP01) USRPRF(*ALL)
```

  This command restores all user profiles saved on the tape loaded on tape unit TAP01.

- To restore specific user profiles and also specify a generic name:

```
RSTUSRPRF DEV(TAP01) USRPRF(BURK BROWNS USER*)
```

  This command restores from tape unit TAP01 user profiles BURK, BROWNS, and all other user profiles beginning with the characters USER.

Restore Authority (RSTAUT) Command Examples

The following are examples of using the RSTAUT command:

- To restore authority to each user profile restored:

```
RSTAUT
```

  This command restores the private authorities that the user profile had at the time the system was saved. The user profiles and the associated libraries and objects must be restored before the RSTAUT command is run.

- To restore specific user profiles and their authorities:

```
RSTUSRPRF USRPRF(BURK SMITHP THOMPSON SANDERS)

RSTLIB  SAVLIB(USERLIB)

RSTAUT USRPRF(BURK SMITHP THOMPSON)
```

  To each user profile that was successfully restored, the RSTAUT command restores the private authorities that the user profile had at the time the security data or system was saved. The user profile and the associated objects and libraries must be restored before the RSTAUT command is run. Because SANDERS was not specified on the RSTAUT command, the authorities are still available and can be restored at a later date.

- To restore all user profiles and their authorities from the media:

```
RSTUSRPRF USRPRF(*ALL)
RSTLIB  SAVLIB(USERLIBA)

RSTLIB  SAVLIB(USERLIBB)

RSTLIB  SAVLIB(USERLIBC)

RSTAUT USRPRF(*ALL)
```

  The RSTAUT command restores private authorities for all user profiles restored by the RSTUSRPRF commands.

Save Configuration (SAVCFG) Command Examples

The following are examples of using the SAVCFG command. If the objects are damaged or exclusively locked, they will not be saved

- To save all device configuration and system resource management objects to a save file:

```
SAVCFG DEV(*SAVF) SAVF(SAVCFG)
```

  This command saves all the configuration and system resource management objects to save file SAVCFG.

- To save all device configuration and system resource management objects to tape.

```
SAVCFG DEV(TAP01)
```

  This command saves all the device configuration objects to the tape loaded on TAP01.

Restore Configuration (RSTCFG) Command Examples

The following are examples of using the RSTCFG command.

- To restore all device configuration and system resource management objects:

```
RSTCFG OBJ(*ALL) DEV(TAP01)
```

  This command restores all the device configuration objects and system resource management objects from the tape loaded on TAP01.

- To restore all configuration objects from a different system:

```
RSTCFG OBJ(*ALL) DEV(TAP01) OBJTYPE(*ALL)
    SRM(*NONE)
```

This command restores all configuration objects from the tape loaded on TAP01. The system resource management objects are not restored.

- To restore a specific device configuration object:

```
RSTCFG OBJ(PRT01) DEV(TAP01) OBJTYPE(*DEVD)
     VOL(SAVA02)
```

This command restores the device description PRT01 that was saved on tape volume SAVA02 to the system. If the device description PRT01 already exists on the system, it must be varied off before it can be restored. If there is an existing device description PRT01, the device description on the system is replaced with the one on the media.

System resource management objects are not restored when a specific object type is specified.

- To restore all system resource management objects:

```
RSTCFG OBJ(*SRM) DEV(TAP01) OBJTYPE(*ALL)
    VOL(SAVA01)
```

This command restores all the system resource management objects that were saved on tape volume SAVA01.

- To restore all the configuration lists from a V2R2 save tape.

```
RSTCFG OBJ(*ALL) DEV(TAP01) OBJTYPE(*CFGL)
```

- To restore all the *CFGL objects from a save tape created before V2R2. These *CFGL objects were saved with a SAVOBJ or SAVLIB command.

```
RSTOBJ OBJ(*ALL) DEV(TAP01) OBJTYPE(*CFGL)
```

- To restore only hardware system resource management objects.

```
RSTCFG OBJ(*SRM) DEV(TAP01) SRM(*HDW)
```

Or,

```
RSTCFG OBJ(*ALL) DEV(TAP01) SRM(*HDW)
```

Save Licensed Program (SAVLICPGM) Command Examples

The following are examples of using the SAVLICPGM command. An option also exists on the Work with Licensed Programs menu that allows you to save licensed programs from a list.

- To save an individual licensed program:

```
SAVLICPGM LICPGM(5738WP1) DEV(TAP01) CLEAR(*ALL)
```

This command saves the Office licensed program on the tape put on tape unit TAP01. Each tape that is not cleared is automatically cleared during the save operation, and the save operation continues without operator intervention.

- To save a licensed program to a specific tape volume:

```
SAVLICPGM LICPGM(5738WP1) DEV(TAP01) VOL(SAVA02)
```

This command saves the Office licensed program on the tape loaded on tape unit TAP01, starting with the tape volume labeled SAVA02. If the save operation exceeds the storage capacity of the tape, a message is sent to the operator asking that the next tape volume be loaded on tape unit TAP01.

- To save the online help option:

```
SAVLICPGM LICPGM(5738SS1) OPTION(2) DEV(TAP01 TAP02)
```

This command saves the online help option of the OS/400 licensed program to tape units TAP01 and TAP02 in alternating order. If the save operation exceeds the storage capacities of the tapes, a message is sent to the operator asking that the another tape be loaded in tape unit TAP01. The tape rewinds when the save operation completes.

Restore Licensed Program (RSTLICPGM) Command Example

The following is an example of using the RSTLICPGM. An option also exists on the Work with Licensed Programs menu that allows you to restore licensed programs from a list.

- To restore a licensed program:

```
RSTLICPGM LICPGM(5738SS1) OPTION(2) DEV(TAP01)
```

This command restores the online help option of the OS/400 licensed program from tape unit

TAP01. The licensed program objects must exist on the tape loaded in tape unit TAP01. Because no other parameters are specified on this command, the defaults are used.

Example of Saving Spooled Output Files Using the Copy Spooled File (CPYSPLF) Command

The system does not directly support saving spooled files on an output queue, but you can accomplish the same thing by following these steps:

1. To save spooled output files:

```
CPYSPLF  FILE(QPRINT) JOB(PAYROLL01) SPLNBR(4)
         TOFILE(MYLIB/SP4) TOMBR(MYMBR) CTLCHAR(*FCFC)
```

2. To save the database file using a save command such as the SAVOBJ, SAVLIB, or SAVCHGOBJ command:

```
SAVOBJ OBJ(MYLIB/SP1) OBJTYPE(*FILE) DEV(TAP01)
```

This approach saves the textual data in the file. However, advanced functions such as graphics and variable fonts are not saved.

Two tools in library QUSRTOOL can help you save and restore spooled output files. For more information about these tools, see "Save Spool Control (SAVSPLCTL) Command" on page D-7 and "Save/Restore Spooled File (SAVRSTSPLF) Command" on page D-7.

Example of Restoring Spooled Output Files Using the Copy File (CPYF) Command

If you used the CPYSPLF command to save spooled files on an output queue, you can then restore the spooled files using the following procedure:

1. Restore the database file:

```
RSTOBJ  OBJ(SP4) SAVLIB(MYLIB) DEV(TAP01)
```

2. Copy the database file member back to spooled output files:

```
OVRPRTF FILE(QSYSPRT) CTLCHAR(*FCFC) CHLVAL(*NORMAL)

CPYF  FROMFILE(MYLIB/SP4) TOFILE(QSYSPRT)
```

This approach restores SP4 to library MYLIB, then prints the file using QSYSPRT.

Chapter 10. Working with the Save and Restore Procedures

This chapter contains the following procedures:

- Using the Save and Restore menus
- Saving security data
- Saving the entire system
- Installing or restoring the licensed internal code
- Restoring the operating system
- Restoring user profiles, device configuration objects, user libraries and authorities
- Restoring program temporary fixes (PTF)

Note: If you want to use Operational Assistant to back up information, see Appendix E, "Using Operational Assistant to Back Up Information" on page E-1.

Attention!

The procedures in this chapter are designed as stand-alone procedures. If you are trying to recover the system after a disk unit failure, see Chapter 13, "Working with Disk Recovery" on page 13-1. If you are trying to recover from a disaster (site or system loss), see "Total System Restore" on page B-20.

Before you begin any save procedure, it is recommended that you initialize enough tapes to complete the save operation. The number of tapes required depends on the size of the system, the number of objects being saved and the capacity of the tape. Use Table 4-2 on page 4-4 to determine tape capacities.

Initialize at least three more tapes than you think you will need. Each tape should have a volume ID and an external label that allows you to easily identify the tape.

Note: When initializing an 8-mm tape, the INZTAP command can take two to three hours when CLEAR(*YES) is specified.

An external label on the tape should identify the date and time of the save operation and what was saved. If an object needs to be restored, the tape that contains the object can be located quickly. A backup log should be provided to write down important information. Output (OUTPUT(*PRINT or *OUTFILE)) from the save commands can also be used as a backup log.

To initialize tapes that are new, do the following:

```
INZTAP DEV(TAP01) NEWVOL(BACKUP) NEWOWNID(user-profile-name)
      CHECK(*NO) ENDOPT(*UNLOAD)
```

To initialize tapes that have data on them, display the tape to verify that you do not want to keep the data; then do the following:

```
INZTAP DEV(TAP01) NEWVOL(BACKUP) NEWOWNID(user-profile-name)
      CHECK(*NO) ENDOPT(*UNLOAD)
```

If you are using tapes for the save operation that have data on them, you can use the CLEAR parameter to specify that data be cleared from the tape during the save operation. For example:

```
SAVSYS  DEV(TAP01) VOL(*MOUNTED) CLEAR(*ALL)
```

Or

```
SAVLIB LIB(library-name) DEV(TAP01) CLEAR(*ALL) SEQNBR(1)
```

For more information about using tapes, see the topic Chapter 4, "Save and Restore Media Considerations" on page 4-1.

Using the Save and Restore Menus

The options on the Save and Restore menus allow you to perform save and restore operations without entering the commands. The following provides information about the save and restore menus and some of the options used in this guide.

Save Menu Options

Figure 10-1 and Figure 10-2 show the options available on the save menu.

```
SAVE                                Save
                                                    System:   RCHASLLZ
Select one of the following:

  Save Data
     1. Files
     2. Libraries
     3. Documents and folders
     4. Programs
     5. Other objects
     6. Changed objects only
     7. Licensed programs
     8. Security data
     9. Storage
    10. Configuration
```

Figure 10-1. Save Menu, Part 1

Options 1 through 10: You are prompted with the appropriate command for each option. Use the help function to get a description of each option.

```
SAVE                                Save
                                                    System:   RCHASLLZ
Select one of the following:

  Save System Data
    20. All libraries other than system library
    21. Entire system
    22. All IBM libraries other than system library
    23. All user libraries
    24. All changed objects in user libraries

  Save Office Data
    30. All documents, folders, and mail
    31. New and changed documents, new folders, all mail
    32. Documents and folders
    33. Mail only
    34. Calendars
```

Figure 10-2. Save Menu, Part 2

Option 20. All libraries other than system library

- This option:

- Ends all subsystems.
- Changes the QSYSOPR message queue to *BREAK or *NOTIFY mode.
- Saves all libraries other than the system library.
- Saves all access paths.
- Starts the controlling subsystem.

- This option does not:
  - Save the contents of some objects. See Table 5-2 on page 5-12 for a list of objects.
  - Save libraries QSYS, QDOC, QSPL, QTEMP, QSRV, QRECOVERY, and QRPLOBJ.

You can replace the system programs that support option 20 with your own CL programs to tailor your save procedure. However, it is important that the commands be specified in the correct order. You can use the Retrieve CL Source (RTVCLSRC) command and specify the QCLSRC parameter to retrieve the CL source of the program you want to change. You can then use an editor to change the source CL program.

The menus currently call the following programs in library QSYS.

QMNSRBND Determines if you are running in the current controlling subsystem and asks you for the ENDSBS command.

QMNSAVN Prompts you for the SAVLIB command.

Option 21. Entire system

- This option:
  - Ends all subsystems.
  - Changes QSYSOPR message queue to *BREAK or *NOTIFY mode.
  - Saves the licensed internal code.
  - Saves the operating system.
  - Saves the security data.
  - Saves the configuration objects and system resource management information.
  - Saves all libraries (including libraries for licensed programs and access paths).
  - Saves all documents, folders, and mail.
  - Starts the controlling subsystem.

- This option does not:
  - Save the contents of some objects. See Table 5-2 on page 5-12 for a list of objects.

  Note: You can do an unattended save using option 21. However, communications messages with a severity of 99 that require a reply can stop an unattended save operation. If you have communication messages that can stop an unattended save operation, you can specify *NOTIFY for the *Message queue delivery* prompt on the Specify Command Defaults display. This will send the communication messages to the QSYSOPR message queue without interrupting the save operation.

  You can replace the system programs that save the entire system with your own CL programs to tailor your system's save procedure. However, it is important that the commands be specified in the correct order. You can use the

Retrieve CL Source (RTVCLSRC) command and specify the QCLSRC parameter to retrieve the CL source of the program you want to change. You can then use an editor to change the source CL program.

The menus currently call the following programs in library QSYS.

QMNSRBND Determines if you are running in the current controlling subsystem and asks you for the ENDSBS command.

QMNSAVE Prompts you for the SAVSYS, SAVLIB LIB(*NONSYS) and SAVDLO DLO(*ALL) commands.

Option 22. All IBM libraries other than system library

- This option:
  - Saves all the IBM-supplied libraries that contain only IBM objects and user defined libraries that begin with a Q. See Table 5-1 on page 5-4.
- This option does not:
  - Save user profiles.
  - Save configuration objects and system resource management information.
  - Save the system library (QSYS).
  - Save documents or folders.

Option 23. All user libraries

- This option:
  - Saves all libraries that contain user data except user-defined libraries that begin with a Q.
- This option does not:
  - Save the IBM-supplied libraries and user libraries beginning with a Q. See Table 5-1 on page 5-4.

Option 24. All changed objects in user libraries

- This option:
  - Saves all changed objects in all user libraries.
- This option does not:
  - Save the IBM-supplied libraries.

Option 30 through 34. You are prompted for the appropriate command for each option.

Using the Restore Menu Options

Figure 10-3 on page 10-5 shows the options available on the restore menu.

```
RESTORE                              Restore
                                                        System:   RCHASLLZ
Select one of the following:

  Restore Data
     1. Files
     2. Libraries
     3. Documents and folders
     4. Programs
     5. Other objects
     6. Licensed programs
     7. Configuration
     8. User profiles

  Restore System Data
    20. All libraries other than system library
    21. The system
```

Figure 10-3. Restore Menu

Options 1 through 8: You are prompted with the appropriate command for each option. Use the help function to display a description of each option.

Option 20. All libraries other than system library

- This option:
  - Ends all subsystems.
  - Changes the QSYSOPR message queue to *BREAK or *NOTIFY mode.
  - Restores the data that was saved by option 20 (All libraries other than system library) on the SAVE menu.
  - Starts the controlling subsystem.
- This option does not:
  - Restore library QSYS.
  - Restore user profiles.
  - Restore authorities.

  You can replace the system programs used by option 20 with your own CL programs to tailor your restore procedure. However, it is important that the commands be specified in the correct order.

  The menus currently call the following programs in library QSYS.

  QMNSRBND — Determines if you are running in the current controlling subsystem and asks you for the ENDSBS command.

  QMNRSTN — Prompts you for the RSTLIB command.

Option 21. The system

This option is intended for use immediately after installing the Licensed Internal Code and OS/400 in a recovery scenario.

- This option:
  - Ends all subsystems.
  - Changes QSYSOPR message queue to *BREAK or *NOTIFY mode.
  - Restores the security data.
  - Restores configuration objects. and system resource management information.
  - Restores all user libraries.

  - Restores documents, folders, and mail.
  - Restores authorities.
  - Starts the controlling subsystem.

- This option does not:
  - Restore library QSYS.
  - Restore any line, controller, or device descriptions that are varied on.

Note: You can do an unattended restore operation using option 21. However, communications messages with a severity of 99 that require a reply can stop an unattended restore operation. If you have communication messages that can stop an unattended save operation, you can specify *NOTIFY for the *Message queue delivery* prompt on the Specify Command Defaults display. This sends the communication messages to the QSYSOPR message queue without interrupting the restore operation.

You can replace the system programs used by option 21 with your own CL programs to tailor your system's restore procedure. However, it is important that the commands be specified in the correct order. For example, the RSTCFG or RSTLIB command cannot be run before the RSTUSRPRF command.

The menus currently call the following programs in library QSYS.

QMNSRBND Determines if you are running in the current controlling subsystem and asks you for the ENDSBS command.

QMNRSTE Prompts you for the RSTUSRPRF, RSTCFG, RSTLIB SAVLIB(*NONSYS), RSTDLO DLO(*ALL), and RSTAUT commands.

```
RESTORE                              Restore
                                                          System:   RCHASLLZ
Select one of the following:

    22. All IBM libraries other than system library
    23. All user libraries

  Restore Office Data
    30. All documents, folders, and mail
    31. Documents and folders
    32. Mail only
    33. Calendars

  Restore from Different Systems
    50. Restore from System/36 format
```

Option 22. All IBM libraries other than system library

- This option:
  - Restores all the IBM-supplied libraries that contain only IBM objects and user-defined libraries that begin with a Q.
- This option does not:
  - Restore user profiles.
  - Restore device configuration objects and system resource management information.
  - Restore the system library (QSYS).
  - Restore documents or folders.

- Restore authorities.

Option 23. All user libraries

- This option:
  - Restores all libraries that contain user data except user-defined libraries that begin with a Q.
- This option does not:
  - Restore the IBM-supplied libraries including user-defined libraries beginning with a Q.

Option 30 through 33. You are prompted for the appropriate command for each option. Use the Help function to display a description of each option.

Saving the Security Data

You should save the security data when users are added or deleted on the system or if user authorities change.

You can use this procedure without the system being in a restricted state.

To save the security data, do the following:

1. To change the system operator message queue so all messages will appear on the display, type the following and press the Enter key.

   ```
   CHGMSGQ MSG(QSYSOPR) DLVRY(*BREAK) SEV(60)
   ```

2. To change the system operator message queue so the procedure is not interrupted by messages, type the following and press the Enter key.

   ```
   CHGMSGQ MSB(QSYSOPR) DLVRY(*NOTIFY) SEV(99)
   ```

3. Load the first tape, and make the tape device ready.
4. To save the security data, type the following and press the Enter key.

   ```
   SAVSECDTA DEV(TAP01)
   ```

   The following may occur:

For the procedure to restore the security data, see the topic "Restoring User Profiles, Device Configurations, User Libraries, and Authority" on page 10-41.

Saving the Entire System

Task Overview

Use the following procedure to save the entire system. Saving the entire system includes:

- Licensed internal code
- Operating system
- Security data
- Configuration objects and system resource management information
- All libraries (including libraries for licensed programs)
- All documents, folders, and mail

Note: The contents of output queues, job queues, data queues, and message queues are not saved with the SAVLIB LIB(*NONSYS) command. Only their descriptions are saved. The contents of save files are not saved if you specify SAVFDTA(*NO) on the save command. The default for the SAVFDTA parameter is *YES. See Table 5-2 on page 5-12 for a list of objects that do not have their contents saved.

Before You Begin . . .

_ When saving the system using option 21, it is absolutely necessary that this procedure not be run from a personal computer using PC Support/400.

_ To save the entire system, you must have save system (*SAVSYS) and job control (*JOBCTL) special authority and change (*CHANGE) authority to the QSYSOPR message queue. The QSYSOPR and QSECOFR user profiles have these authorities by default. Make sure you have not changed these authorities in the QSYSOPR and QSECOFR user profiles.

_ Correctly initialize the tapes as standard-labeled tapes.

_ Clean the read and write head of the tape unit.

_ If you are going to use the SAVSYS tapes to restore the entire system, the SAVSYS operation must be done using a tape device compatible (same density type) with the IPL tape device. If your IPL tape device cannot read the SAVSYS tapes, you may not be able to restore the Licensed Internal Code using the SAVSYS tapes.

_ If you are saving the entire system to prepare for a model upgrade, and you are using mirrored protection, you must print the current level of mirrored protection on your system. The service representative will need this information in case the level of mirrored protection is reduced by the model upgrade. To print the level of protection, do the following:

1. Type STRSST on a command line and press the Enter key. You must have authority to use this command.
2. Select option 3 (Work with disk units) on the System Service Tools (SST) display.
3. Select option 1 (Display disk configuration) on the Work with Disk Units display.
4. Select option 3 (Display disk configuration protection) on the Display Disk Configuration display.
5. Print the displays (there may be several) using the PRINT key for each display. Keep the output with your save tapes. Your service representative will need them when he performs a model upgrade.

Use one of the following methods to save the entire system:

- "Method 1. Using option 21 (Entire system) on the Save Menu" allows you to save the entire system without entering the commands.
- "Method 2. Using the Save Commands" allows you to save the entire system by entering the commands from the command line.

Method 1. Using Option 21 (Entire system) on the Save Menu

Attention!

Saving access paths can significantly reduce recovery time. However, saving access paths increases the time it takes to save the system. If you do not want to save access paths, specify a Y for the *Prompt for commands* prompt on the Specify Command Defaults display. When you are prompted for the SAVLIB LIB(*NONSYS) command, change the access path parameter to *NO. If you prompt for commands, you cannot do an unattended save.

1. Sign on the system as QSYSOPR or QSECOFR.

   Notes:

   a. The system operator (QSYSOPR) and security officer (QSECOFR) user profiles are shipped with save system (*SAVSYS) and job control (*JOBCTL) special authorities. Ensure that you have not changed these special authorities in the QSYSOPR or QSECOFR user profiles.

   b. To delete QHST history files, you must sign on as QSECOFR or have object management authority to the QHST history files.

2. Verify that no users are on the system and that no batch jobs are running:

   ```
   WRKACTJOB
   ```

3. When you have determined that there are no active batch jobs, enter the following command to place the system in a restricted state:

   ```
   ENDSBSD * ALL *IMMED
   ```

4. Display the system log QHST to verify it is up to date:

   ```
   DSPLOG LOG(QHST)
   ```

   Displaying the QHST log automatically brings it up to date.

5. Display all copies of the system log:

   ```
   WRKF FILE(QSYS/QHST*)
   ```

   Look at the list to verify that you saved all copies of the log that will be needed later.

   Note: To get more information about the QHST log, such as date created and the last change date and time, select option 8 (Display file description) on the Work with Files display.

6. To prevent confusion about the date of the log, select the Delete option on the Work with Files display to delete all but the current copies of the system log. This step improves the performance of the SAVSYS command.

7. Print a list of all the libraries on the system. You can use this list later if you need to restore a single library:

   ```
   DSPOBJD OBJ(QSYS/*ALL) OBJTYPE(*LIB) OUTPUT(*PRINT)
   ```

8. Print a list of the current system values:

   ```
   WRKSYSVAL OUTPUT(*PRINT)
   ```

9. Print a list of the current network attributes:

   ```
   DSPNETA OUTPUT(*PRINT)
   ```

10. Print a list of the current configuration lists:

    ```
    WRKCFGL
    ```

Select option 6 (Print) for each configuration list.

11. Print a list of all the edit descriptions (5 through 9) currently on the system:

    ```
    DSPEDTD EDTD(edit-description-number) OUTPUT(*PRINT)
    ```

12. Print a list of all the PTFs currently on the system:

    ```
    DSPPTF LICPGM(*ALL) OUTPUT(*PRINT)
    ```

13. Print a list of all reply list entries currently on the system:

    ```
    WRKRPYLE OUTPUT(*PRINT)
    ```

14. Print a list of all the IBM-supplied subsystem descriptions currently on the system. Do the following:

    a. Display the list of subsystem descriptions:

       ```
       WRKSBSD SBSD(*ALL)
       ```

       Write down the names of the descriptions.

    b. Print each subsystem description by entering the following command, where XXXX is the subsystem name:

       ```
       DSPSBSD SBSD(XXXX) OUTPUT(*PRINT)
       ```

    Keep these lists with your backup log or your save system tapes for future reference.

15. Go to the Save menu:

    ```
    GO SAVE
    ```

    The Save menu is shown.

```
SAVE                                Save
                                                  System:   RCHASLLZ
Select one of the following:

  Save Data
     1. Files
     2. Libraries
     3. Documents and folders
     4. Programs
     5. Other objects
     6. Changed objects only
     7. Licensed programs
     8. Security data
     9. Storage
    10. Configuration
```

16. Press the Page Down key to show the following display.

```
SAVE                                Save
                                                    System:   RCHASLLZ
Select one of the following:

  Save System Data
    20. All libraries other than system library
    21. Entire system
    22. All IBM libraries other than system library
    23. All user libraries
    24. All changed objects in user libraries

  Save Office Data
    30. All documents, folders, and mail
    31. New and changed documents, new folders, all mail
    32. Documents and folders
    33. Mail only
    34. Calendars
```

Doing an Unattended Save

To prevent an interrupted save caused by incomplete save messages, run the following commands before selecting option 21 from the Save menu:

1. To display the reply list sequence numbers currently used, type the following and press the Enter key.

   ```
   WRKRPYLE
   ```

2. To add a reply list entry, type the following (where xxxx is an unused sequence number from 1 through 9999) and press the Enter key.

   ```
   ADDRPYLE SEQNBR(xxxx) MSGID(CPA3708) RPY('G')
   ```

3. To change the job, type the following and press the Enter key.

   ```
   CHGJOB INQMSGRPY(*SYSRPYL)
   ```

4. After running these commands, the following messages are displayed:

   a. `CPF0994  ENDSBS(*ALL) command being processed`

   b. Press the Enter key.

   c. `CPF0968  System ended to restricted condition`

   d. Press the Enter key.

   After performing step d, the first message, `ENDSBS(*ALL) command being processed`, will return to the screen. Repeat steps b through d before moving on to select option 21.

17. Select option 21 (Entire system) from the Save menu and press the Enter key. The following display is shown.

```
                        Specify Command Defaults

Type choices, press Enter.

  Tape devices . . . . . .  TAP01       Names
                            _____
                            _____
                            _____

  Prompt for commands . . . . .  N       Y=Yes, N=No
  Check for active files . . . .  Y      Y=Yes, N=No
  Message queue delivery . . . .  *BREAK *BREAK, *NOTIFY
```

Tape devices

You can specify up to four tape device names. If you specify more than one device, the system automatically switches to the next tape device when the current tape is full.

Prompt for commands

You can specify whether or not to be prompted for the commands. If you specify `Y`, the prompt display is shown and you can change the defaults on the commands.

Note: If `Yh` is specified, you cannot do an unattended save.

Check for active files

You can specify whether or not to check for active files on tape. If you specify `Y`, the system sends a message when active files on tape are encountered. You can end the checking process or clear the existing files and continue. If `N` is specified, all active files encountered during the save are cleared.

Option 21 guides you through the following commands if you select `Y` on the *Prompt for commands* prompt on the Specify Command Defaults display.

a. `ENDSBS SBS(*ALL) OPTION(*IMMED)`

b. `SAVSYS`

c. `SAVLIB LIB(*NONSYS) ACCPTH(*YES)`

d. `SAVDLO DLO(*ALL) FLR(*ANY)`

e. `STRSBS SBSD(controlling-subsystem)`

18. Continue loading tapes when the system sends a message asking you to load the next volume.

If a media error occurs...

If an unrecoverable media error occurs during the SAVLIB procedure, you can restart the procedure using the STRLIB parameter on the SAVLIB command. The STRLIB parameter is valid only when *NONSYS, *ALLUSR, or *IBM is specified for the SAVLIB or SAVCHGOBJ command.

The basic recovery steps for a save operation are:

1. Check the job log to determine the library where the previous SAVLIB LIB(*NONSYS, *IBM, or *ALLUSR) failed. Find the last library saved, which is indicated by a successful save completion message.
2. Load the next tape and ensure the tape is initialized.
3. Type the following and press the Enter key:

   ```
   SAVLIB LIB(*NONSYS, *IBM or *ALLUSR) DEV(tape-device-name)
          ENDOPT(*LEAVE) STRLIB(library-name) ACCPTH(*YES)
          OMITLIB(library-name)
   ```

   where the *library-name* for the STRLIB and the OMITLIB parameters is the last library successfully saved. This starts the save operation on the library after the last successfully saved library. Specify the value for the ACCPTH parameter that was specified on the previous SAVLIB command.

   Note: Restoring the system using this set of media requires two RSTLIB SAVLIB(*NONSYS, *ALLUSR, or *IBM) commands to restore the libraries.

19. The job log contains information about the save operation. To verify that all objects were saved, you should spool the job log for printing, along with the job's remaining spooled output, if any.

    ```
    DSPJOBLOG * *PRINT
    ```

    Or

    ```
    SIGNOFF *LIST
    ```

Method 2. Using the Save Commands

If you prefer not to use option 21, you can do the following steps from the command line of a menu:

1. Sign on the system as QSYSOPR or QSECOFR.

   Notes:

   a. The system operator (QSYSOPR) and security officer (QSECOFR) user profiles are shipped with save system (*SAVSYS) and job control (*JOBCTL) special authorities. Ensure that you have not changed these special authorities in the QSYSOPR or QSECOFR user profiles.

   b. To delete QHST history files, you must sign on as QSECOFR or have object management authority to the QHST history files.

2. Verify that no users are on the system and that no batch jobs are running:

   ```
   WRKACTJOB
   ```

3. Display the system log QHST to verify it is up to date:

   ```
   DSPLOG LOG(QHST)
   ```

Displaying the QHST log automatically brings it up to date.

4. Display all copies of the system log:

   ```
   WRKF FILE(QSYS/QHST*)
   ```

   Look at the list to verify that you saved all copies of the log that will be needed later.

   Note: To get more information about the QHST log, such as date created and the last change date and time, select option 8 (Display file description) on the Work with Files display.

5. To prevent confusion about the date of the log, select the Delete option on the Work with Files display to delete all but the current copies of the system log. This step improves the performance of the SAVSYS command.

6. Print a list of all the libraries on the system. You can use this list later if you need to restore a single library:

   ```
   DSPOBJD OBJ(QSYS/*ALL) OBJTYPE(*LIB) OUTPUT(*PRINT)
   ```

7. Print a list of the current system values:

   ```
   WRKSYSVAL OUTPUT(*PRINT)
   ```

8. Print a list of the current network attributes:

   ```
   DSPNETA OUTPUT(*PRINT)
   ```

9. Print a list of the current configuration lists:

   ```
   WRKCFGL
   ```

   Select option 6 (Print).

10. Print a list of all the edit description currently on the system:

    ```
    WRKEDTD EDTD(*ALL)
    ```

11. Print a list of all the PTFs currently on the system:

    ```
    DSPPTF LICPGM(*ALL) OUTPUT(*PRINT)
    ```

12. Print a list of all reply list entries currently on the system:

    ```
    WRKRPYLE OUTPUT(*PRINT)
    ```

13. Print a list of all the IBM-supplied subsystem descriptions currently on the system:

    ```
    DSPOBJD OBJ(QSYS/*ALL) OBJTYPE(*LIB) OUTPUT(*PRINT)
    ```

    Keep these lists with your backup log or your save system tapes for future reference.

14. Change the QSYSOPR message queue:

    ```
    CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(60)
    ```

15. End all subsystems:

    ```
    ENDSBS SBS(*ALL) OPTION(*IMMED)
    ```

    Messages are sent to the QSYSOPR message queue indicating that the subsystems have ended and the system is in a restricted state.

16. Change the QSYSOPR message queue:

    ```
    CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(99)
    ```

Note: Communications messages with a severity of 99 that require a reply can interrupt save operations. To avoid having the communications messages interrupting the save operation, add them to the reply list or specify DLVRY(*NOTIFY) on the CHGMSGQ command. *NOTIFY does not interrupt the interactive save job with the communications messages. Only messages associated with the save operation can interrupt the save operation. A message is shown on the console display indicating that a message associated with the save operation needs a reply. You will be notified by the message indicator light and a distinct sound (if your system has this feature). When this happens, press the Sys Req key and then select option 6 to display the QSYSOPR message queue messages.

17. Load the first tape and make the tape device ready.
18. Save the system:

    ```
    SAVSYS DEV(tape-device-name) ENDOPT(*LEAVE)
    ```

19. When a message similar to the following appears, load the next tape or make the device ready, and then enter G.

    ```
    Device was not ready or next volume was not loaded (C G)
    ```

20. Save all user and IBM-supplied libraries:

    ```
    SAVLIB LIB(*NONSYS) DEV(tape-device-name) ENDOPT(*LEAVE)
           ACCPTH(*YES)
    ```

    Or, if you use *IBM and *ALLUSR in your save strategy, type the following two commands. The first command must complete before entering the second command.

    ```
    SAVLIB LIB(*IBM) DEV(tape-device-name ENDOPT)(*LEAVE)
         ACCPTH(*YES)

    SAVLIB LIB(*ALLUSR) DEV(tape-device-name) ENDOPT(*LEAVE)
         ACCPTH(*YES)
    ```

    Note: If you do not want to save access paths, do not use the ACCPTH parameter. If you do not use this parameter it automatically uses the default, ACCPTH(*NO).

If a media error occurs...

If an unrecoverable media error occurs during the SAVLIB procedure, you can restart the procedure using the STRLIB parameter on the SAVLIB command. The STRLIB parameter is valid only when *NONSYS, *ALLUSR, or *IBM is specified for the SAVLIB or SAVCHGOBJ command.

The basic recovery steps for a save operation are:

1. Check the job log to determine the library where the previous SAVLIB LIB(*NONSYS, *IBM, or *ALLUSR) command failed. Find the last library saved, which is indicated by a successful save completion message.
2. Load the next tape and ensure the tape is initialized.
3. Type the following and press the Enter key:

   ```
   SAVLIB LIB(*NONSYS, *IBM or *ALLUSR) DEV(tape-device-name)
          ENDOPT(*LEAVE) STRLIB(library-name) ACCPTH(*YES)
          OMITLIB(library-name)
   ```

   where the *library-name* for the STRLIB and the OMITLIB parameters is the last library successfully saved. This starts the save operation on the library after the last successfully saved library. Specify the value for the ACCPTH parameter that was specified on the previous SAVLIB command.

   Note: Restoring the system using this set of media requires two RSTLIB SAVLIB(*NONSYS, *ALLUSR, or *IBM) commands to restore the libraries.

21. Save the documents, folders, and mail:

    ```
    SAVDLO DLO(*ALL) FLR(*ANY) DEV(tape-device-name) ENDOPT(*UNLOAD)
    ```

22. When the save operation is complete, start the controlling subsystem and any other subsystems that need to be started:

    ```
    STRSBS SBSD(subsystem-name)
    ```

23. Start the print writers and vary on the communication lines, if necessary.
24. The job log contains information about the save operation. To verify that all objects were saved, you should spool the job log for printing, along with the job's remaining spooled output, if any:

    ```
    DSPJOBLOG * *PRINT
    ```

    Or

    ```
    SIGNOFF *LIST
    ```

If you are installing a new release of the OS/400 licensed program, continue with the manual *Licensed Programs and New Release Installation Guide*.

Restoring Licensed Internal Code Using the SAVSYS or Distribution Tapes

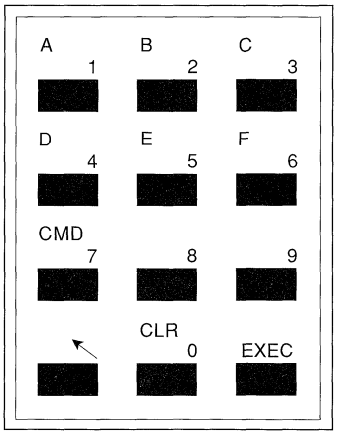
Are You Using a 2440 Tape Unit?

If you have a 2440 tape unit with the high-speed feature enabled, it must be disabled before restoring the Licensed Internal Code. See "Disabling and Enabling the High-Speed Feature on the 2440 Tape Unit" for information on disabling the high-speed feature. Otherwise, continue with "Procedure for Restoring the Licensed Internal Code" on page 10-19.

Disabling and Enabling the High-Speed Feature on the 2440 Tape Unit

If you have a 2440 tape unit with the high-speed feature enabled, it must be disabled before you can install or restore the Licensed Internal Code. After the restore operation, you can enable the high speed again. The high-speed feature is disabled or enabled from the control panel on the 2440 tape unit.

To find the control panel, open the front door of the 2440 tape unit. The control panel is located in the upper right hand corner. The following figure illustrates the control panel.



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Disabling the High-Speed Feature: To disable the high-speed feature before the restore operation, do the following from the control panel.

1. Press the arrow key and then the CMD 7 key.
2. Press the 9 key and then the 2 key.
3. Press the EXEC key.
4. Press the arrow key and then the CMD 7 key.
5. Press the 9 key and then the 3 key.
6. Press the EXEC key.
7. Press the arrow key and then the CMD 7 key.
8. Press the 6 key twice.
9. Press the EXEC key.
10. Press the 1 key.
11. Press the EXEC key.

Enabling the High-Speed Feature: To enable the high-speed feature after the restore operation, do the following from the control panel.

1. Press the arrow key and then the CMD 7 key.
2. Press the 9 key and then the 2 key.
3. Press the EXEC key.
4. Press the arrow key and then the CMD 7 key.
5. Press the 9 key and then the 3 key.
6. Press the EXEC key.
7. Press the arrow key and then the CMD 7 key.
8. Press the 6 key twice.
9. Press the EXEC key.
10. Press the CLR 0 key.
11. Press the EXEC key.

Procedure for Restoring the Licensed Internal Code

Restoring the Licensed Internal Code is done using function code 23 (Restore), which is run completely from the control panel. Because it is run completely from the control panel, this function is referred to as **stand-alone** function. The following is a description of this function.

Function Code Description

23 (Restore) Copies all Licensed Internal Code from tape and replaces the Licensed Internal Code found on disk. This option is used to:

- Replace an existing system's Licensed Internal Code without losing user data already on the system.
- Update a system's Licensed Internal Code to a new release. See the *Licensed Programs and New Release Installation Guide*, SC41-9878, for the procedures to install a new release of the AS/400 system.
- A disk unit failure other than unit 1 in the system ASP requires that you restore the Licensed Internal Code. The system configuration will not be lost. Go to "Summary of Disk Recovery Actions" on page 13-2 for more information about recovering from a disk unit failure.

When you perform this function, the system continuously displays system reference codes (SRCs) in the control panel display lights. The yellow System Attention light will be on whenever user input is needed. SRCs that start with A6 are indicating that the system is waiting for you to do something, such as answer a question or make a tape device ready. When xx is shown in the SRC (such as A6xx 6001), a variety of characters may be shown in the place where the xx appears. The Appendix A, "Licensed Internal Code SRCs That Require User Input (A6xx xxxx)" has a description of the SRCs. All other SRCs are discussed in the associated device manual.

The documentation for this function makes reference to a **Licensed Internal Code tape**. This is the **first** volume of the distribution tapes provided by IBM or the first volume of your most recent set of SAVSYS tapes.

If restoring the Licensed Internal Code from the distribution tapes, you must also restore all PTFs after restoring the operating system. For information about restoring the remaining parts of the system, including program temporary fixes, see

the topic "Restoring User Profiles, Device Configurations, User Libraries, and Authority" on page 10-41.

Before You Begin ...

_ Under certain circumstances, it may be necessary for you to restore the Licensed Internal Code from the SAVSYS or distribution tapes.

- After a failure of a disk unit (that is not unit 1) in the system ASP if it does not have checksum protection. Go to "Summary of Disk Recovery Actions" on page 13-2 for information about the procedure to use to recover from this type of failure.
- When a new release of the operating system requires you to restore a new release of the Licensed Internal Code. See the *Licensed Programs and New Release Installation Guide*, SC41-9878, for the procedure to install a new release.
- When a restore of the Licensed Internal Code is recommended by the IBM Software Support Center.

_ Find the most recent SAVSYS tape or distribution tapes supplied by IBM if no SAVSYS tape exist. If you use the distribution tapes to restore the licensed internal code, some system information may be lost.

_ Find all program temporary fix tapes if you are restoring the Licensed Internal Code from the distribution tapes.

_ Find the list of all the Licensed Internal Code fixes applied to your system at the time you saved the entire system. This list should be attached to your backup log or found with the tapes used to save the entire system.

Print a list of all the Licensed Internal Code fixes currently on the system. Type the following and press the Enter key:

```
DSPPTF LICPGM(*ALL) OUTPUT(*PRINT)
```

_ Find the key for the keylock switch if it is not already in the keylock switch on the control panel.

_ Clean the read and write head of the tape unit.

Attention

The following procedure is intended to be used for restoring only the Licensed Internal Code. If you are recovering from a disk unit failure, see Chapter 13, "Working with Disk Recovery." If you are restoring the entire system after a system loss or site loss, see "Total System Restore" on page B-20.

Use the latest SAVSYS tapes to restore the Licensed Internal Code. **Do not use** the distribution tapes to restore the Licensed Internal Code unless no SAVSYS tapes exist. Perform the following steps to install or restore the Licensed Internal Code.

1. Sign on the system as QSECOFR.
2. Change the QSYSOPR message queue:

   ```
   CHGMSGQ  MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(60)
   ```

3. End all jobs before installing or restoring the Licensed Internal Code:

```
ENDSBS SBS(*ALL) OPTION(*IMMED)
```

Press the Enter key. Messages are displayed indicating when the subsystems have ended and the system is in a restricted state. After the subsystems have ended, continue with the next step.

4. Change the QSYSOPR message queue:

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(99)
   ```

   Note: Communications messages with a severity of 99 that require a reply can interrupt your restore operation. You can either identify these messages and add them to the system reply list, or you can change the delivery of the QSYSOPR message queue to *NOTIFY. This prevents the communications messages from interrupting the interactive restore operation.

5. Power down the system before restoring the Licensed Internal Code:

   ```
   PWRDWNSYS OPTION(*IMMED)
   ```

   Note: When the Power On light goes off on all racks of the 9406, or the control panel of the 9402 or 9404, continue with the next step.

6. Ensure the key is in the keylock switch on the control panel.
7. Turn the key in the keylock switch until it points to the Manual position.
8. Press the Function Select switch to display `02` in the Function display on the control panel.
9. Press the Enter button on the control panel.
10. Select IPL type D (this specifies that the IPL source comes from tape) by pressing the Function Select switch on the control panel until **D** is shown on the Data display.
11. Press the Enter button on the control panel.
12. For the 9406 system unit, ensure that the power switches for the tape unit used for the IPL and all disk units are in the On position.
13. Find the Licensed Internal Code tape, which is the first volume of the most current set of SAVSYS tapes or the first volume of the distribution tapes.

    Warning!

    Use the distribution tapes only if no SAVSYS tape exists. If you use the distribution tapes, some system information will be lost. This includes, but is not limited to, PTFs and PTF packages. All cumulative PTF packages and individual PTFs applied after the initial installation of your system must be installed again.

14. Place the tape in the tape unit used for the IPL. For more information on loading the tape, see the setup manual for the device.

    Note: If your tape unit cannot be loaded when the power is off, continue with the next step. You will be prompted later by an SRC code for the tape.

15. Turn on the power to the system by pushing the Power switch on the control panel up. The switch returns to center after you push it. The 9402 system unit has a green button labeled Power On on the control panel.

16. If you could not load your tape in a previous step, load the first tape volume into the tape unit used for the IPL. Make the device ready and then continue with the next step.

    Note: If your system was not powered down after ending the subsystems, do the following:

    a. Press the Function Select switch to display 03 (continue the IPL) in the Function display on the control panel.

    b. Press the Enter button on the control panel.

17. If the system attention light is on and one of the SRC codes shown in the following table is displayed in the Data display, complete the instructions for that SRC code. Otherwise, continue with the next step.

Table 10-1. SRC codes

Symptom	Action
A100 1933 **A12x 1933** ('x' is any character)	This SRC is shown if the tape device for the alternate IPL is not ready. Make sure the correct tape is loaded and make the tape device ready. Wait for the System Attention light to go off. Then, continue with the next step. If the System Attention light stays on for more than 5 minutes, check to see if you have the correct tape loaded in the tape device for the alternate IPL and make the tape device ready. Then continue with the next step.
B1xx 1803 **B1xx 1806** **B1xx 1938**	These SRCs are shown if the tape device for the alternate IPL was not found or was not ready. Make sure the tape device is powered on, the correct tape is loaded, and ready. Then continue with the next step.
B1xx 1934	This SRC is shown if the wrong tape is loaded. Load the correct tape and make the tape device ready. Then continue with the next step. This SRC is also shown if the high speed feature is enabled on the 2440 tape unit. The high speed feature must be disabled before installing or restoring the Licensed Internal Code.
2507 0001 **2642 0001** **2643 0001**	These SRCs are shown if a tape is not loaded in the tape device for the alternate IPL. Make sure the correct tape is loaded in the correct drive and then continue with the next step.

Note:

If any SRC listed in the table does not disappear from the control panel, do the following:

1. Press the Function Select switch to display 03 (continue the IPL) in the Function display on the control panel.
2. Press the Enter button on the control panel.

18. Ensure that the tape is online or ready. No action is required for tape units that perform this step automatically (such as the tape cartridge unit).
19. Ensure that the console display is turned on.
20. Wait for the yellow System Attention light on the control panel to light up.

    There is a delay while the system loads information from the tape. SRCs showing status are continuously updated on the control panel while processing occurs. This can take from 5 to 20 minutes; the time varies depending on the speed of the tape unit and the processor speed for the specific system model.

When SRC A6xx 6001 is displayed, the system is prepared to start installing or restoring the Licensed Internal Code on the disk unit containing unit 1. Continue with the next step.

21. Select function code 23 (Restore) by pressing the Function Select switch on the control panel until 23 is shown in the Function display on the control panel.
22. Press the Enter button on the control panel.

    Note: If another SRC is displayed after A6xx 6001 that is not in the A6xx xxxx format, then the system needs additional attention. Call your service representative.

    If the following SRCs are displayed after SRC A6xx 6001 is displayed, see Appendix A, "Licensed Internal Code SRCs That Require User Input (A6xx xxxx)" for an explanation of these SRCs and the steps to follow.

    A6xx 6002 Disk unit may contain a valid system
    A6xx 6003 Disk unit not currently a load source
    A6xx 6004 Disk unit not currently a load source
    A6xx 6005 Disk unit not found

23. After pressing the Enter button on the control panel, the system starts displaying status SRCs again, which will be continuously updated to show the status of the install or restore operation. An example of a status SRC is D6xx 6201 (stand-alone install operation is running).
24. If the yellow system attention light is on again, and SRC A6xx 6048 (New tape volume needs to be loaded) is displayed, the system needs the next tape. The *xx* tells which volume needs to be loaded. Load the correct tape and make the device ready. The install or restore operation automatically continues.

    If SRC A6xx 6051 appears, the stand-alone function is requesting the Model-Unique Licensed Internal Code tape found inside the back cover of the system unit or on the side of the 9402 Model C04, D02, and E02 system units. Unload the current tape from the tape device and load the Model-Unique Licensed Internal Code tape.

    - A6xx 6051 Model-Unique Licensed Internal Code tape needs to be loaded.
    - A6xx 6052 Tape loaded was not the Model-Unique Licensed Internal Code.

    If another SRC A6xx xxxx is displayed, look up the displayed SRC in Appendix A, "Licensed Internal Code SRCs That Require User Input (A6xx xxxx)" on page A-1 and follow the instructions. For all other SRCs call your service representative.
25. If you do not have other restore steps to perform, this completes the restore operation.
    a. Select option 1 (Perform an IPL) on the Use Dedicated Service Tools (DST) menu. When the IPL completes, the Sign On display is shown.
    b. Turn the key in the keylock switch to the normal position.
    c. Sign on the system as QSECOFR.
    d. Type the following on a command line:

       ```
       PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
       ```

    e. Press the Enter key.

Restoring the Operating System

The following procedure is used to restore only the OS/400 licensed program from tape. The procedure for restoring the operating system assumes that the Licensed Internal Code is already installed or restored on the system. Normally, the Licensed Internal Code is installed. However, if you must restore the Licensed Internal Code, first follow the procedure described in the topic "Restoring Licensed Internal Code Using the SAVSYS or Distribution Tapes" on page 10-18 before restoring the operating system.

To restore the operating system without previously restoring the licensed internal code, you must perform a manual IPL of the system.

Performing a Manual Initial Program Load (IPL)

Attention

The following procedure is intended to be used for restoring only the OS/400 Licensed Program. If you are recovering from a disk unit failure, see Chapter 13, "Working with Disk Recovery." If you are restoring the entire system after a system loss or site loss, see "Total System Restore" on page B-20.

Use the following steps to perform a manual IPL. These steps are done only if you have not restored the licensed internal code.

To perform a manual IPL, use the following steps:

1. Ensure the tape unit is ready. For more information on loading the tape, see the setup manual for the device.
2. Load the SAVSYS or distribution tape in the tape unit.

   Warning: Use the distribution tapes only if no SAVSYS tape exists. If you use the distribution tapes, some system information will be lost. This includes, but is not limited to, PTFs and PTF packages. All cumulative PTF packages and individual PTFs applied after the initial installation of your system must be installed again.

   Restoring the operating system from the distribution tapes resets some values back to the IBM-supplied defaults. These values must be changed back to the values that were in effect at the time the operating system was lost.
3. Ensure the key is in the keylock switch on the control panel.
4. Turn the key in the keylock switch until it points to the Manual position.
5. Power down the system:

   ```
   PWRDWNSYS OPTION(*IMMED) RESTART(*YES) IPLSRC(B)
   ```

Procedure for Restoring the OS/400 Licensed Program

Attention

The following procedure is intended to be used for restoring only the OS/400 Licensed Program. If you are recovering from a disk unit failure, see Chapter 13, "Working with Disk Recovery." If you are restoring the entire system after a system loss or site loss, see "Total System Restore" on page B-20.

Before You Begin....

__ Clean the read and write head of the tape unit.

__ Find your most recent set of save tapes. If you have not performed a complete save operation, use the first volume of your distribution tapes.

Warning: Use the distribution tapes only if no SAVSYS tape exists. If you use the distribution tapes, some system information will be lost. All cumulative PTF packages and individual PTFs applied after the initial installation of your system must be installed again.

Restoring the operating system from the distribution tapes resets some values back to the IBM-supplied defaults. These values must be changed back to the values that were in effect at the time operating system was lost.

The following may need to be changed:

- System values
- Network attributes
- Configuration lists
- Edit descriptions
- Reply list entries
- IBM-supplied subsystem descriptions

Note: Configuration lists, edit descriptions, reply list entries, and IBM-supplied subsystem descriptions can be changed after the operating system is restored.

The following network attributes may be lost if you use the distribution tapes for the restore operation:

- System name
- Local network ID
- Local control point name
- Default local location name
- Default node
- Default type
- Maximum number of intermediate sessions
- Route addition resistance
- Network node servers
- Alert primary focal point
- Alert default focal point

Use this procedure if:

- You are restoring only the operating system and have performed a manual IPL. If you have not performed an IPL, see the topic "Performing a Manual Initial Program Load (IPL)" on page 10-24. If you have already performed a manual IPL, go to task 1.
- If you restored the Licensed Internal Code (function code 23) and want to restore the operating system, go to "Task 1. Start Restoring the Operating System."

When the IPL completes, the IPL or Install the System display is shown. Continue with the following:

Task 1. Start Restoring the Operating System

Attention

Under most circumstances, use your most recent set of complete save tapes to restore the operating system. The distribution tapes are used **only** if a current complete save tapes do not exist. Ensure the most recent SAVSYS tape is loaded in the tape unit. If you use the distribution tapes, some system information maybe lost.

You use two displays to select the install options. The IPL or Install the System display allows you to restore the operating system or work with the service tools. The Install the Operating System display allows you to set the options to be used for restoring the system, and for the system date and time.

1. At the IPL or Install the System menu:

```
                        IPL or Install the System

Select one of the following:

          1. Perform an IPL
          2. Install the operating system
          3. Use Dedicated Service Tools (DST)
          4. Perform automatic installation of the operating system
```

2. Type a 2 (Install the operating system).

   Note: **Do not** use option 4 (Perform automatic installation of the operating system) to restore the operating system.

3. Press the Enter key.

   The Confirm Install of the Operating System display is shown.

```
                    Confirm Install of Operating System

Press Enter to confirm your choice to install the operating system.
Press F12 to return and cancel your choice to install the
  operating system.
```

4. Press the Enter key.
5. The following display **may** be shown if your system is set up to prevent unauthorized installation of the operating system:

```
                    Dedicated Service Tools (DST) Sign On

Type choice, press Enter.

  DST password . . . . . .  _____
```

6. If the Dedicated Service Tools (DST) Sign On display is shown, enter the DST password and press the Enter key. For more information about preventing unauthorized installation of the operating system, see the *Basic Security Guide*.
7. The Select a Language Group display is shown. This display shows the primary language currently on the system or on the save tapes.

   The value specified on the display must be the same as the national language that is on the distribution media, or on your most recent SAVSYS tape.

```
                         Select a Language Group

Note:  The language feature shown is the language feature
installed on the system.

Type choice, press Enter.

  Language feature . . . . . .  2924
```

8. Press the Enter key.

   After the language feature is entered, the Confirm Language Feature Selection display is shown. If you need to change your system's primary language, see the *Licensed Programs and New Release Installation Guide* for more information.

```
                    Confirm Language Feature Selection

Language feature  . . . . . . . . . . . . . . . . . :   2924

Press Enter to confirm your choice for language feature.
  Installing the system will continue.
Press F12 to return to change your choice for
  language feature.
```

9. Press the Enter key to confirm the information.
10. The following display is shown only if disk units are in nonconfigured status.

    Note: If function code 24 was used and the recover configuration was not run, all disk units except unit 1 are in nonconfigured status.

```
                    Add All Disk Units to the System

Select one of the following:

          1. Add all disk units to the system auxiliary storage pool
          2. Keep the current disk configuration
          3. Perform disk configuration using DST
```

    Note: You may receive a message at the top of the display indicating that the disk unit configuration information may have been damaged. There is currently only one disk unit configured on the system.

11. Select the correct option using the following information:

    Option 1 (Add all disk units to the system auxiliary storage pool)

    Select this option if you want to add all of the nonconfigured units to the system auxiliary storage pool.

    Attention!

    If you used Function Code 24 to install the Licensed Internal Code, and the service representative did not use Recover Configuration in DST, you must select this option. If you are restoring to the same system and have mirrored protection, checksum protection, or user ASPs configured, the service representative must use the Recover Configuration option in Dedicated Service Tools (DST) to recover the configuration.

    Before adding the units to the system, all data stored on the non-configured units is deleted.

    Note: Adding units can change the checksum set configuration of the system ASP. You can use option 3 (Perform disk configuration using DST) to calculate the effect of adding units to the system ASP.

    Option 2 (Keep the current disk configuration)

This option continues the IPL without adding units to the system configuration. The disk units that are in nonconfigured status will remain so.

Select this option if:

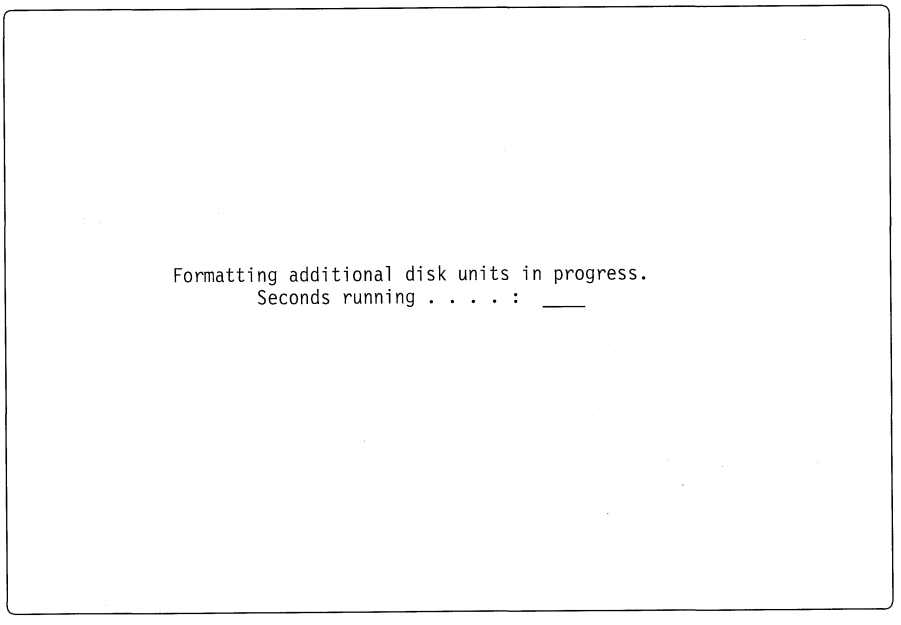
- You are recovering from a disk unit failure in the system ASP and you had user ASPs configured.
- You plan to add the nonconfigured units to user ASPs.
- You plan to use them as spare units.

Option 3 (Perform disk configuration using DST)

This option starts the Dedicated Service Tools (DST). On the DST main menu, select option 4 (Work with Disk Units).

12. Press the Enter key.

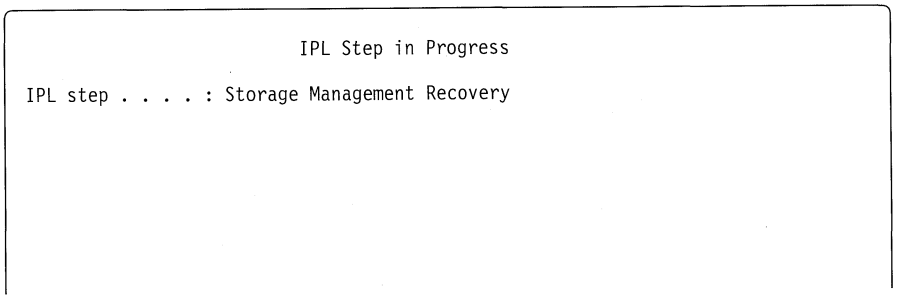
    As the disk units are configured, the following display is shown:



Adding disk units takes several minutes. The time it takes depends on the size of each unit and the ability of the system to do multiple adds at the same time.

13. Status messages are displayed.

    The following is an example of a status display shown before the Install the Operating System display is shown. The status messages shown do not require any action by the user.



After the IPL steps complete, the Install the Operating System menu appears.

```
                        Install the Operating System

Type options, press Enter.

     Install
       option . . . .  __              1=Take defaults (No other
                                         options are displayed)
                                       2=Change install options

     Date:
       Year . . . . .  __              00-99
       Month  . . . .  __              01-12
       Day  . . . . .  __              01-31

     Time:
       Hour . . . . .  __              00-23
       Minute . . . .  __              00-59
       Second . . . .  __              00-59
```

14. When the Install the Operating System display is shown, continue with the task to select Install options.

Task 2. Select the Install Options

When the Install the Operating System display is shown, do one of the following.

1. Select option 2 (Change installing options) if you have not installed the Licensed Internal Code (using function code 24); or if the operating system is already installed on the system and you want to restore system values, edit descriptions, or message reply lists, change the *Default option* to 2. Select this option to do an abbreviated install of the operating system.

   Do the following:

   a. Fill in the date and time.

      Date

      The system inserts the date based on the internal clock. If the date is incorrect, you can type over the date to change it.

      Time

      The system inserts the time based on the internal clock. If the time is incorrect, you can type over the time to change it.

   b. Press the Enter key.

   c. The Specify Install Options display is shown.

```
                          Specify Install Options

Type choices, press Enter.

     Restore option . . . . __          1=Restore programs and language
                                          objects from current tape
                                        2=Do not restore programs or
                                          language objects
                                        3=Restore only language objects
                                          from current tape
                                        4=Restore only language objects
                                          from a different tape



     Job and output
       queue option . . . . 1           1=Clear,  2=Keep
```


d. When the Specify Install Options display is shown, use the following information to respond to the prompts.

Restore Option

Value	Description
1	Type a 1 if you want to restore the system objects from tape. Use this option if damage to a system user profile is found.
2	Type a 2 to leave the current programs and language objects on the system. Select this option to do an abbreviated install of the operating system.

Notes:

1) When option 2 (Do not restore programs or language objects) is selected during the restore of the operating system on install, nothing is restored from tape.

2) All libraries on the system are checked for damage. A library is deleted and then created again if it is damaged.

3) All system libraries (including QSYS) are created if they do not exist, or they are deleted and created again if they are damaged.

4) Information associated with the user profiles is created if it does not exist, or it is created again if it is damaged.

5) The system entry-point table is created again.

3 or 4 Type a 3 or 4 if you want to change the system's primary language.

Value	Description
3	Entering a 3 loads only those objects that make up the national language. The search for the language files begins on the same tape.

4 Entering a 4 for this option loads only those objects that make up the system language. In this case, the language files are on a different tape. You will receive a message prompting you to insert the other tape. You can use option 4 to update the system language from a new (and separate) language tape.

Clear Job and Output Queues

When you are performing system updates, you will be directed to clear the output and job queues when it is necessary. If the output queues are damaged, you should clear the job and output queues.

1=Clear You want to clear all job queues and output queues on the system.

2=Keep You do not want to clear all job queues and output queues; any entries on the queues remain after installing. Select this option to perform an abbreviated install of the operating system.

Notes on Clearing Job and Output Queues

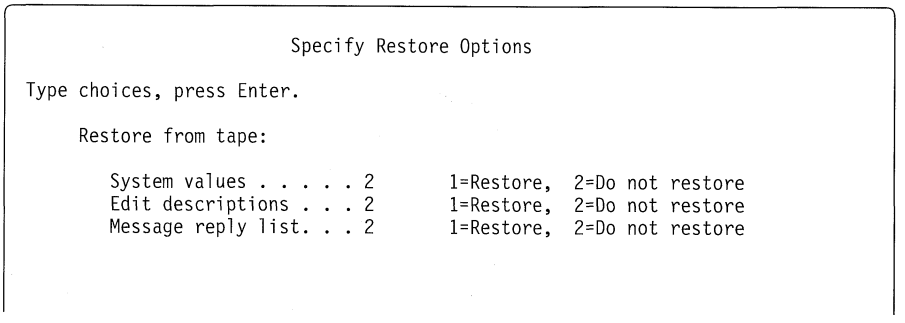
The first time you install the OS/400 program on your system, the OS/400 program creates a number of objects (such as the system operator message queue).

If you install the OS/400 program again later with *Clear job and output queues*=2 (Keep), the OS/400 program creates the job and output queues if they were damaged.

If you install the OS/400 program with *Clear job and output queues*=1 (Clear), it creates the job and output queues again automatically if it finds they were damaged or not.

Selecting *Clear job and output queues*=1 (Clear) will also start the counter used to assign unique job numbers.

If you entered 1 for *Restore option*, the Specify Restore Options display appears.



```
                        Specify Restore Options

Type choices, press Enter.

     Restore from tape:

        System values . . . . . 2       1=Restore,  2=Do not restore
        Edit descriptions . . . 2       1=Restore,  2=Do not restore
        Message reply list. . . 2       1=Restore,  2=Do not restore
```

e. Using the following information, respond to the prompts on the Restore Options display.

System Values Entering a 1 (Restore) for this option restores the system values from tape. If you received a message during a previous IPL stating that the system value object was created again, select 1.

If you select a 2 (Do not restore), the system is installed with no change to the system values that are currently on the system.

A system value object must always be present on an operational system. Therefore, if the system value object does not exist on the system, it will be restored from tape regardless of what was selected for this option.

Also consider the language-sensitive system values. These are the system values that have different defaults depending on the system's primary language. These system values are:

QCCSID	Default system code character set
QCHRID	Default system code page
QCNTRYID	Country identifier
QCURSYM	Currency symbol
QDATFMT	Date editing format
QDATSEP	Date separator character
QDECFMT	Decimal data editing format
QKBDTYPE	Default work station keyboard type
QIGCCDEFNT	Double-byte coded font name
QLANGID	Language identifier
QLEAPADJ	Leap year adjustment
QTIMESEP	Time separator

These system values will be set to default values for the system's primary language if you are changing the primary language or doing an initial install procedure. You can override these values by entering 1 (Restore) on this display. This will cause the system to restore the system values from the tape and not reset the language-sensitive system values to the defaults.

For more information about system values, see the *Work Management Guide*.

Edit Descriptions

Value	Description
1=Restore	This option loads the edit descriptions from tape. If the edit descriptions are damaged on your system, or if you want to put them back the way they were when you saved your system, select 1. If you cleared the disks before installing the operating system, you should also select 1.
2=Do not restore	The operating system is installed with no change to the edit descriptions currently on the system.

For more information about edit descriptions, see the *Programming: Reference Summary*, SX41-0028.

Message Reply List

Value	Description
1=Restore	This option loads the reply list from tape. If the message reply list is damaged on your system, or if you want to put it back the way it was when you saved your system, select 1. If you cleared the disks before installing the operating system, you should also select 1.
2=Do not restore	The operating system is installed with no change to the reply list currently on the system.

For more information about message reply lists, see the *Programming: Reference Summary*, SX41-0028.

The defaults for these options will be 2 if the operating system is loaded on the system. The defaults will be 1 if the operating system is not already loaded.

f. Press the Enter key.

Messages are shown to indicate how many program or language objects are restored. They are for your information only and require no response.

g. Continue loading tapes in sequence when messages are shown that ask you to load the next tape. The system searches through the tapes and loads the necessary programs and language information. After processing all the system save tapes, the following message may be displayed at the bottom of a blank display:

```
Operating system has been installed.  IPL in progress.
```

When the IPL is complete, the IPL Sign On display is shown and the system in ready to complete the IPL. Continue with the next task.

Task 3. Select IPL Options

1. Type `QSECOFR` in the *User* prompt and the password required for that user ID in the *Password* prompt (if password security is active) on the Sign On display.

   Note: If function code 23 was used to restore the Licensed Internal Code, before restoring the operating system, the password is the special one you assigned to QSECOFR user profile after the system was installed.

   If function code 24 was used to install the Licensed Internal Code, no password is required at this time. The system security level will be restored after the operating system is installed and the IPL completes.

2. Press the Enter key. Informational messages are displayed.
3. If the Select Product to Work with PTFs display appears, press F3 (Exit) to continue.

```
                    Select Product to Work with PTFs
                                                                  RCHASTTX
Position to . . . . . .____________ Product


Type options, press Enter.  Press F21 to select all.
   1=Select


                Product
Opt  Product    Option  Release
 _   5738999    *BASE   V2R3M0
 _   5738SS1    *BASE   V2R3M0
```

4. When the IPL Options display is shown, respond to the prompts using the following information.

```
                                IPL Options

Type choices, press Enter.

  System date  . . . . . .  07 / 26 / 88   MM / DD / YY
  System time  . . . . . .  12 : 00 : 00   HH : MM : SS
  Clear job queues . . . . . .  N          Y=Yes,  N=No
  Clear output queues  . . . . .  N        Y=Yes,  N=No
  Clear incomplete job logs  . . . . . .  N  Y=Yes,  N=No
  Start print writers  . . . . . .  N      Y=Yes,  N=No
  Start this device only . . . . . .  Y    Y=Yes,  N=No


  Set major system options . . . . . .  Y  Y=Yes,  N=No
  Define or change system at IPL . . . . .  N  Y=Yes,  N=No
```

Figure 10-4. IPL Options Display

5. Enter the value for the system date.

   The date is displayed. The system date format shown can be YY/MM/DD, DD/MM/YY, or MM/DD/YY where MM means month, DD means day, and YY means year. For English, the default is MM/DD/YY; the default value differs according to the primary language.

   If the date is not correct, you can type over the date to change it. The system date must have a year value in the range of 87 to 99, or 00 to 22.

6. Enter the value for system time.

   The current time is displayed. The time format is HH : MM : SS; HH means hour, MM means minutes, and SS means seconds. If you want to change the time, type it in accordance with the 24-hour clock. For example, for an IPL at 4:30 p.m., type 163000 for the time.

7. Enter the value for start print writers.

   If you are going to continue restoring user profiles, device configuration objects, user libraries, and authorities, type an `N` to not start the print writers. Otherwise, type a `Y` to start print writers.

8. Enter the value for start this device only.

   If you are going to continue restoring user profiles, device configuration objects, user libraries, and authorities, type a `Y` to start this device only. Otherwise, type an `N` to start all devices.

9. Enter the value for set major system options.

The default is different, depending on the type of restore operation. If you restored the Licensed Internal Code using function code 23 (Restore), the default value is set to N. If you installed the Licensed Internal Code using function code 24 (Install), the default value is set to Y.

Type a Y to set the major system options.

10. Enter the value for the define or change system at IPL.

    If the System/36 environment is your main operating system environment or you are restoring from the distribution tapes, then type a Y to define or change the system at IPL.

    If you are doing a partial recovery, you must ensure that all the libraries in the library list (QSYSLIBL and QUSRLIBL system values) are restored or remove the libraries not being restored from the library list. To change the QSYSLIBL and QUSRLIBL system values, type a Y to define or change the system at IPL.

11. Press the Enter key.

    The Set Major System Options display is shown.

    Ensure enable automatic configuration is set to Yes, unless you are using the System/36 environment as your main operating environment. If you are using the System/36 environment as your main operating environment, ensure enable automatic configuration is set to No.

    If enable automatic configuration is set to No, you will receive SRC A900 2000 on the control panel later in the restore operation. The instructions to recover from SRC A900 2000 are provided, if necessary.

12. Press the Enter key.

    The Define or Change System at IPL is shown if you specified a *Y* for define or change system at IPL on the IPL options display. If you specified an *N* on the IPL options display, go to step 13.

    Note: The following sets of instructions (prior to step 13) deal with three distinct topics:

    - Enabling the automatic configuration setting
    - Restoring from the distribution tapes
    - Changing the QSYSLIBL and QUSRLIBL system values

    The restoration process may require you to proceed through any, all, or none of the topics. If you do not need to proceed through any of them, you may go on to step 13.

    Was enable automatic configuration set to No?

    If it is set to No, do the following:

    a. Select option 3 (System value commands) and press the Enter key.

    b. Select option 3 (Work with system values) and press the Enter key.

    c. Type a 2 in the *Option* column next to the system value QIPLTYPE and press the Enter key.

    d. Change the value to 2 and press the Enter key. Press F12 until you return to the Define of Change the System at IPL menu.

    e. If you are not restoring from the distribution tapes and you do not need to change the QSYSLIBL or QUSRLIBL system values, press F3 (Exit) to continue the IPL.

Are you restoring from the distribution tapes?

If you are restoring the operating system from the distribution tapes, the system has reset some values back to the IBM-supplied defaults. These values must be changed back to the values that were in effect at the time of save operation. You should have lists of these values that were created at the time you performed a complete save operation.

The following may need to be changed:

- System values
- Network attributes
- Configuration lists
- Edit descriptions
- Reply list entries
- IBM-supplied subsystem descriptions

Note: Configuration lists, edit descriptions, reply list entries, and IBM-supplied subsystem descriptions can be changed after the operating system is restored.

To change the system values, do the following:

a. Select option 3 (System value commands) and press the Enter key.

b. Select option 3 (Work with system values) and press the Enter key.

c. Type a 2 in the *Option* column next to the system value values you want to change and press the Enter key.

d. Change the values to the correct values and press the Enter key. Press F12 to return to the Define or Change the System at IPL menu.

If you had changed the network attributes from the IBM-supplied defaults, do the following:

a. Select option 4 (Network attributes commands) and press the Enter key.

b. Select option 2 (Change network attributes) and press the Enter key to display a list of network attributes.

c. Change the values to the correct network attributes and press the Enter key.

d. Press F12 (Cancel) to return to the Define or Change the System at IPL menu.

e. If the enable automatic configuration was set to *Yes*, and you do not need to change the QSYSLIBL or QUSRLIBL system values, press F3 (Exit) to continue the IPL.

Are you changing the QSYSLIBL or QUSRLIBL system values?

If you are changing the QSYSLIBL or QUSRLIBL system values, do the following:

a. Select option 3 (System value commands) and press the Enter key.

b. Select option 3 (Work with system values) and press the Enter key.

c. Type a 2 in the *Option* column next to the system value values you want to change and press the Enter key.

d. Change the values to the correct values and press the Enter key.

e. Press F12 to return to the Define or Change the System at IPL menu.

f. Press F3 to continue the IPL.

13. The following display is shown during the IPL process (attended mode) when system access paths are marked for rebuild:

```
                  Edit Rebuild of Access Paths                RCHAS331
                                                    05/12/90  13:49:34

IPL threshold . . . . . . . . . . . . . 50   0-99

Type sequence, press Enter.
Sequence:  1-99, *OPN, *HLD

                  ------------Access Paths----------  Unique  Rebuild
Seq   Status      File        Library     Member      Keyed   Time
25__  IPL         QAPZSYM2    QSYS        QAPZSYM2    NO      00:00:01
25__  IPL         QAPZREQ2    QSYS        QAPZREQ2    NO      00:00:01
25__  IPL         QAPZPTF3    QSYS        QAPZPTF3    NO      00:00:01
25__  IPL         QAPZPTF2    QSYS        QAPZPTF2    NO      00:00:01
25__  IPL         QAPZOBJ2    QSYS        QAPZOBJ2    NO      00:00:01
*OPN  OPEN        QTWALL      QSYS        QTWALL      NO      00:00:06
*OPN  OPEN        QASULTEL    QSYS        QASULTEL    NO      00:00:01
*OPN  OPEN        QASULE05    QSYS        QASULE05    NO      00:00:01
*OPN  OPEN        QASULE03    QSYS        QASULE03    NO      00:00:01
*OPN  OPEN        QASULE01    QSYS        QASULE01    NO      00:00:01
                                                          More...
F5=Refresh   F11=Display member text   F13=Change multiple  F15=Sort by
F16=Repeat position to   F17=Position to
```

This display does not support the F3 and F12 keys.

- A status message is sent to notify the user that the system is performing access path recovery.
- The *IPL threshold* is a value from 1 through 99 that can be set by the user (default is 50), which indicates that access paths with a sequence less than or equal to the number specified will be rebuilt at IPL time. If the IPL threshold changes, all access paths with a status of IPL and AFTIPL will be changed to reflect the new status of the IPL threshold.
- Sequence
  - *IPL threshold*-1 represents the sequence of the access paths that are to be rebuilt prior to completion of the IPL. A rebuild sequence of 25 is initially set by the system to set the sequence of access paths for the files that have MAINT(*IMMED) and RECOV(*IPL) specified. The access paths with the same sequence are built first according to rebuild time (the access paths that take the longest to rebuild are rebuilt first if the priorities are the same). The access paths are displayed in the same order.
  - *IPL threshold*-99 represents the sequence in which the access paths are rebuilt after the IPL. A rebuild sequence of 75 is initially set by the system to set the sequence of the access paths for the files that have MAINT(*IMMED) and RECOV(*AFTIPL) specified.
  - *OPN indicates the access path is to be rebuilt when the file is opened. The *OPN must be changed to 1 through 99 before the system job will initiate the rebuild. The system initially sets the sequence to *OPN for the files that have MAINT(*IMMED) and RECOV(*NO) specified.

- *HLD indicates the access path is not to be rebuilt until the user changes the sequence from *HLD to a *OPN, or 1 through 99. *HLD will also cancel the rebuilding of any access path.

- Status
  - RUN indicates that the access path is being rebuilt.
  - IPL indicates that the access path is to be rebuilt before the system completes the IPL process.
  - AFTIPL indicates that the access path is to be rebuilt after the system completes the IPL process.
  - HELD indicates that the access path is not to be rebuilt until the user changes the sequence from *HLD to a *OPN, or 1 through 99.
  - OPEN indicates that the access path is to rebuilt when the file is opened.
- Rebuild Time
  - The time the access path will take to be rebuilt when the system is running without any other jobs on the system. For example, at IPL time. This is an estimate of rebuild time based on the file size and key length. No time for journaled access paths is displayed.

14. Do one of the following:
    - Make changes and press the Enter key. After changing the fields on the display and pressing the Enter key, the change is made, if possible. For example, if the user attempts to change the sequence from 9 to 50, but the sequence cannot be changed because the access path has already been rebuilt, the user is sent an error message for each improper input.
    - Press the Enter key. If you press the Enter key without making any changes to the display, the Display Access Path Status display is shown (only if access paths remain to be rebuilt). If no access paths need to be rebuilt, the status display is not shown and the IPL continues.

    The following display is shown during the IPL process when the user finishes with the Edit Rebuild of Access Paths display.

```
                    Display Access Path Status

IPL Threshold . . . . . . : 50

          ----------Access Paths----------   Rebuild     Current
Status    File        Library    Member      Build Time  Run Time
RUN       QAPZSYM2    QSYS       QAPZSYM2    00:00:01    00:00:01
JRN       QAPZREQ2    QSYS       QAPZREQ2    00:00:01
JRN       QAPZPTF3    QSYS       QAPZPTF3    00:00:01
JRN       QAPZPTF2    QSYS       QAPZPTF2    00:00:01
JRN       QAPZOBJ2    QSYS       QAPZOBJ2    00:00:07
JRN       QTWALL      QSYS       QTWALL      00:00:01
JRN       QASULTEL    QSYS       QASULTEL    00:00:01
SYS       QASULE05    QSYS       QASULE05    00:00:01
SYS       QASULE03    QSYS       QASULE03    00:00:01
IPL       QASULE01    QSYS       QASULE01    00:00:01
                                                        More...




F3=Exit and continue IPL   F12=Cancel
```

Every 5 seconds the display is updated with the current run time.

After all the access paths have been rebuilt (access paths with a sequence less than or equal to the *IPL threshold*), the IPL process continues and this display is removed.

F12 (Cancel) calls the Edit Rebuild of Access Paths display. If the user returns to the Edit Rebuild of Access Paths display using F12 (Cancel), the user must exit the Edit Rebuild of Access Paths again. Even if all the access paths are rebuilt, the user remains at the Edit Rebuild of Access Paths display until the user exits the display.

If F12 (Cancel) is pressed and there are only SYS/JRN access paths to be recovered, the edit display is shown without any access paths to be edited.

Status

- RUN–indicates that the access path is being rebuilt.
- SYS–indicates the access path is a system access path and is waiting to be rebuilt.
- JRN–indicates that the access path is being recovered from its associated journal.
- IPL–indicates that the access path will be rebuilt before the system completes the IPL and is waiting to be rebuilt.

15. Press F3 (Exit and continue the IPL) to continue.
16. Press the Enter key to continue.

Restoring User Profiles, Device Configurations, User Libraries, and Authority

Attention

This procedure is designed to restore only the user profiles, device configurations, user libraries, document library objects, and authority. Do not use this procedure if you are recovering from a disk unit failure. Go to "Summary of Disk Recovery Actions" on page 13-2. If you are restoring the entire system to a different system, go to "Total System Restore" on page B-20.

Before You Begin. . .

_ Clean the read and write head of the tape unit.

_ Find the tape volume that contains the user profiles.

You may want to do the following:

Note: Depending on the circumstances and how much of the system you have restored, the DSPTAP command may or may not work. If not enough of the operating system has been restored, refer to the list of libraries you created when you saved the system.

- If you do not know where the user profiles are stored on tape, determine where they are by using the DSPTAP command with DATA(*LABELS) specified. (This is not necessary if you are restoring user profiles from the SAVSECDTA media.)

  Examine each tape until you find the file labeled QFILEUPR containing object type *USRPRF.

- Find the file on tape containing the device configuration objects using the DSPTAP command with DATA(*LABELS) specified. Examine each tape until you find the file labeled QFILEIOC containing object types *DEVD, *CTLD, *LIND, *COSD, *CFGL, *CNNL, *NWID, *SRMSPC and *MODD. (This is not necessary if you are restoring configuration and system resource management information from the SAVCFG media.)

- Ensure any device configuration objects not used in the restore operation are varied off. Ensure that any tape devices, tape controllers, or workstation devices that you are using for the restore operation are varied on. These configuration objects will be excluded from the restore operation (message CPF379C in the job log).

Considerations: There are two options you can use to restore the user profiles, device configuration objects, user libraries, document library objects, and authority:

1. If you are restoring the user profiles from a SAVSYS tape and the following considerations do not apply, go to "Option 1. Using Option 21 on the Restore Menu" in this procedure.
2. If any of the following considerations apply, go to "Option 2. Using the Restore Commands" (not option 21 on the Restore menu) in this procedure.

Use the restore commands (not option 21 on the Restore menu) if:

- You prefer to enter the commands manually.
- You saved changed objects or have journal changes to apply.

  Attention

  To ensure the journaling environment is restored correctly, the libraries containing the journals must be restored before the libraries containing the journaled files. If the journaled files are restored before the journals, journaling is not started again for the files.

- You performed individual save operations instead of using the SAVLIB LIB(*NONSYS) command. You must use a RSTLIB command for each saved library. If you saved individual objects using the SAVOBJ or SAVCHGOBJ command, you must use a RSTOBJ command for each group of saved objects.
- You performed a SAVLIB LIB(*IBM) and a SAVLIB LIB(*ALLUSR). You need to do a RSTLIB SAVLIB(*IBM) and RSTLIB SAVLIB(*ALLUSR).
- You saved the security information with the Save Security Data (SAVSECDTA) command. You must restore the information using the restore commands.
- You saved logical file access paths using either the SAVOBJ or SAVCHGOBJ command. You must restore the logical files the same way you restored the physical files using the RSTOBJ command.

Method 1. Using Option 21 on the Restore Menu

To restore user profiles, configuration objects, system resource management information, user libraries, document library objects, and authority, use the following steps:

1. Sign on the system as the security officer; type QSECOFR in the user prompt and the password for QSECOFR in the *Password* prompt.

   Note: If you restored the Licensed Internal Code (function code 23), it is the user-assigned password. If you installed the Licensed Internal Code (function code 24), it is the default password QSECOFR.

2. Press the Enter key.
3. Ensure that the correct volume of your last set of save tapes is loaded and make the tape device ready. The tape should contain the file labeled QFILEUPR. Run the DSPTAP command and specify DATA(*LABELS) to find the file labeled QFILEUPR.
4. Ensure that any device configuration objects not used in the restore operation are varied off.
5. Ensure that the devices you are using for the restore operation (workstations, tape devices, and tape controllers) are varied on. These configuration objects are excluded from the restore operation (message CPF379C in the job log).
6. Go to the Restore menu:

   GO RESTORE

   The Restore menu is shown.

```
RESTORE                              Restore
                                                    System:   RCHASLLZ
Select one of the following:

  Restore Data
     1. Files
     2. Libraries
     3. Documents and folders
     4. Programs
     5. Other objects
     6. Licensed programs
     7. Configuration
     8. User profiles

  Restore System Data
    20. All libraries other than system library
    21. The system
```

Doing an Unattended Restore

To prevent an interrupted restore caused by incomplete restore messages, run the following commands before selecting option 21 from the Restore menu.

1. To display the reply list sequence numbers currently being used, type the following and press the Enter key.

   ```
   WRKRPYLE
   ```

2. To add message CPA3709 to the reply list, type the following (where xxxx is an unused sequence number 1-9999) and press the Enter key.

   ```
   ADDRPYLE SEQNBR(xxxx) MSGID(CPA3709) RPY('G')
   ```

3. To change the job, type the following and press the Enter key.

   ```
   CHGJOB INQMSGRPY(*SYSRPYL)
   ```

   Note: Communications messages with a severity of 99 that require a reply can stop an unattended restore operation. If you have communication messages that can stop an unattended restore operation, you can specify *NOTIFY for the *Message queue delivery* prompt on the Specify Command Defaults display. This sends the communication messages to the QSYSOPR message queue without interrupting the restore operation.

   After running these commands, the following messages will be displayed:

   a. `CPF0994 ENDSBS(*ALL) command being processed`

   b. Press the Enter key.

   c. `CPF0968 System ended to restricted condition`

   d. Press the Enter key.

After performing step d, the first message, `ENDSBS(*ALL) command being processed`, will return to the screen. Repeat steps b through d before moving on to select option 21.

7. Select option 21 (The system) on the Restore menu and press the Enter key. The following display is shown.

```
                        Specify Command Defaults

Type choices, press Enter.

  Tape devices . . . . . .   TAP01       Names
                             _____
                             _____
                             _____

  Prompt for commands  . . . . .   N          Y=Yes, N=No

  Message queue delivery . . . .   *BREAK     *BREAK, *NOTIFY
```

Tape devices

You can specify up to four tape device names. If you specify more than one device, the system automatically switches to the next tape device after the current tape is read.

Prompt for commands

You can specify whether or not you want to be prompted for the commands. If you specify Y=Yes, the prompt display is shown and you can change the defaults on the commands. If you specify N=No, the system runs the commands without prompting and uses the default values.

Message queue delivery

You can specify whether or not you want messages sent in *BREAK or *NOTIFY mode to the QSYSOPR message queue. If *BREAK is specified, any message of severity 99 that requires a reply interrupts the restore operation. If *NOTIFY is specified, severity 99 messages that are not are associated with restore operation, do not interrupt the restore process. For example, messages that request a new volume to be loaded interrupt the restore operation because they are associated with the job. You cannot continue until the you reply to these messages.

Note: If you are doing an unattended restore operation and communications is active, change the message queue delivery to *NOTIFY mode.

Option 21 will guide you through the following if you selected Y for the *Prompt for commands* prompt on the Specify Command Defaults display.

a. ENDSBS SBS(*ALL) OPTION(*IMMED)

b. RSTUSRPRF USRPRF(*ALL)

c. RSTCFG OBJ(*ALL)

d. RSTLIB SAVLIB(*NONSYS)

e. RSTDLO DLO(*ALL) SAVFLR(*ANY)

Notes:

1) If you specify that the RSTDLO DLO(*ALL) SAVFLR(*ANY) command is to be run, the RSTAUT command will run immediately afterwards. There is no prompt for the RSTAUT command, however.

2) If an unrecoverable error occurs when running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command, see "Media or Device Error When Running the RSTDLO Command" on page 9-11.

8. Press the Enter Key.

9. Continue loading the save tapes in sequence when the system sends a message to load the next volume.

If a media error occurs....

If an unrecoverable media error occurs during the RSTLIB procedure, you can restart the procedure using the STRLIB parameter on the RSTLIB command. The STRLIB parameter is valid only when *NONSYS, *ALLUSR, or *IBM is specified for the restore operation,

The basic recovery steps for a restore operation are:

1. Check the job log to determine the library where the previous RSTLIB SAVLIB(*NONSYS, *IBM, or *ALLUSR) command failed. Find the library that follows the last successfully restored library. It is indicated by a successful restore completion message in the job log. If the library is not identified in the job log, look at the output from the save operation or display the tape file QFILE to determine which library is next.
2. Load the first tape of the SAVLIB LIB(*NONSYS, *ALLUSR, or *IBM) media.
3. Type the following and press the Enter key:

   ```
   RSTLIB SAVLIB(*NONSYS, *IBM or *ALLUSR) DEV(tape-name)
       ENDOPT(*LEAVE) STRLIB(library-name) OMITLIB(library-name)
   ```

   where the *library-name* for the STRLIB and the OMITLIB parameters is the library where the RSTLIB failed. This starts the restore operation on the library after the library where the RSTLIB failed.
4. You will be asked to load the volume containing the starting library.
5. After the restore operation is complete, restore the library that failed using the media from a previous save operation.

   Note: Consider eliminating the tape with the media error from the next save rotation cycle to avoid a tape error again.

10. If you used the distribution tapes to restore the operating system, some information was not restored. You must create or change this information again. You should have lists of this information that were created at the time you performed your save operation.

    The following may need to be created or changed:

    - Configuration lists
    - Edit descriptions
    - Reply list entries
    - IBM-supplied subsystem descriptions

    a. For the configuration lists, do the following:

       Use the Work With Configuration Lists (WRKCFGL CFGL(*ALL)) command to create the configuration lists to match the information in your list.

    b. For edit descriptions, do the following:

       Use the Work with Edit Descriptions (WRKEDTD EDTD(*ALL)) command to create edit descriptions to match the information in your list.

    c. For reply list entries, do the following:

       Use the Add Reply List Entry (ADDRPYLE) command to add reply list entries to match the information in your list.

    d. For IBM-supplied subsystem descriptions, do the following:

Use the Work with Subsystem Descriptions (WRKSBSD SBSD(*ALL)) command to change the IBM-supplied subsystem descriptions to match the information in your list.

11. This completes the restore operation.
12. If you are unsure what the QSECOFR password is, change it now. To see if the password has expired, type the following:

    ```
    DSPUSRPRF QSECOFR
    ```

    If the password expiration is active for the QSECOFR user profile, you will see the expiration date on the Date password expired field. If the date is the current system date or prior, change the password for the QSECOFR user profile.
13. Check the job log to ensure all objects were restored.

    The job log contains information about the restore operation. To verify that all objects were restored, you should spool the job log for printing, along with the job's remaining spooled output, if any.

    ```
    DSPJOBLOG * *PRINT
    ```

    Or

    ```
    SIGNOFF *LIST
    ```

    Message CPC3703 is sent to the job log for each library that was successfully restored. Message CPF3773 is sent to tell you how many objects were restored. It also tells you how many objects were not restored. Objects are not restored for various reasons. Check for any error messages, correct the errors, and then restore those objects from the media.
14. Perform a normal IPL and return the system to normal operations:
    a. Turn the keylock switch to the Normal position.
    b. Type the following on a command line and press the Enter key.

       ```
       PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
       ```
15. When the IPL is complete, sign on the system.
16. Start any other subsystems that need to be started, such as QTCP or QSNADS.

    ```
    STRSBS SBSD(subsystem-name)
    ```

Method 2. Using the Restore Commands

To use the commands to restore the system, do the following:

1. Sign on the system as the security officer; type `QSECOFR` in the User prompt and the password for QSECOFR in the Password prompt.

   Note: If you restored the Licensed Internal Code (function code 23), it is the user-assigned password. If you installed the Licensed Internal Code (function code 24), it is the default password QSECOFOR.
2. Press the Enter key.
3. Type the following command on the command line and press the Enter key.

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(60)
   ```
4. End all subsystems:

```
ENDSBS SBS(*ALL) OPTION(*IMMED)
```

Messages are sent indicating when the subsystems have ended and the system is in a restricted state.

5. Change the QSYSOPR message queue.

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(99)
   ```

   Note: Communications messages with a severity of 99 and that require a reply can stop an unattended restore operation. If you are using communications, you may need to identify the messages that may require a reply and then add them to the reply list or change the delivery of the QSYSOPR message queue to *NOTIFY with a severity of 99.

6. Ensure that the correct volume of your last set of save tapes is loaded and make the tape device ready. The tape should contain file labeled QFILEUPR. Run the DSPTAP command and specify DATA(*LABELS) to find the file labeled QFILEUPR.

   Note: Use the tapes from the most recent complete save operation (SAVSYS), or if the security data was saved since the last complete save operation, use the SAVSECDTA tapes.

   If the SAVSYS tape is used, type the following:

   ```
   RSTUSRPRF DEV(tape-device-name) USRPRF(*ALL) ENDOPT(*LEAVE)
   ```

   If the save security data tape (SAVSECDTA) is used, type the following:

   ```
   RSTUSRPRF DEV(tape-device-name) USRPRF(*ALL) ENDOPT(*UNLOAD)
   ```

   The time that this takes can vary significantly.

7. Ensure any device configuration objects not used in the restore operation are varied off.

8. Ensure that the devices you are using for the restore operation (workstations, tape devices, and tape controllers) are varied on. These configuration objects will be excluded from the restore operation (message CPF379C in the job log).

9. Restore the device configuration objects from your most recent SAVSYS tape or SAVCFG tape:

   If the SAVSYS media is used, type the following:

   ```
   RSTCFG OBJ(*ALL) DEV(tape-device-name) OBJTYPE(*ALL) ENDOPT(*LEAVE)
   ```

   If the SAVCFG media is used, type the following:

   ```
   RSTCFG OBJ(*ALL) DEV(tape-device-name) OBJTYPE(*ALL) ENDOPT(*UNLOAD)
   ```

   The time that this takes can vary significantly.

10. Restore the IBM and user libraries in one of the following ways:

    If you used SAVLIB LIB(*NONSYS) to save the IBM-supplied and user libraries, load the correct volume and then type the following:

    ```
    RSTLIB SAVLIB(*NONSYS) DEV(tape-device-name) ENDOPT(*LEAVE)
    ```

    Or, if you used SAVLIB LIB(*IBM) and SAVLIB LIB(*ALLUSR) to save the IBM and user libraries, load the correct tape and then type the following two commands. The first command must complete before entering the second command.

    ```
    RSTLIB SAVLIB(*IBM) DEV(tape-device-name) ENDOPT(*LEAVE)
          MBROPT(*ALL)
    ```

```
RSTLIB SAVLIB(*ALLUSR) DEV(tape-device-name) ENDOPT(*LEAVE)
      MBROPT(*ALL)
```

Note: If you saved individual libraries and objects with the SAVLIB, SAVOBJ, and SAVCHGOBJ commands, then you will have to restore the individual libraries and objects with the RSTLIB command (not RSTLIB SAVLIB(*NONSYS)) and the RSTOBJ command.

Attention

To ensure the journaling environment is restored correctly, the libraries containing the journals must be restored before the libraries containing the journaled files. If the journaled files are restored before the journals, journaling is not started again for the files.

If a media error occurs....

If an unrecoverable media error occurs during the RSTLIB procedure, you can restart the procedure using the STRLIB parameter on the RSTLIB command. The STRLIB parameter is valid only when *NONSYS, *ALLUSR, or *IBM is specified for the restore operation,

The basic recovery steps for a restore operation are:

1. Check the job log to determine the library where the previous RSTLIB SAVLIB(*NONSYS, *IBM, or *ALLUSR) command failed. Find the library that follows the last successfully restored library. It is indicated by a successful restore completion message in the job log. If the library is not identified in the job log, look at the output from the save operation or display the tape file QFILE to determine which library is next.
2. Load the first tape of the SAVLIB LIB(*NONSYS, *ALLUSR, or *IBM) media.
3. Type the following and press the Enter key:

   ```
   RSTLIB SAVLIB(*NONSYS, *IBM or *ALLUSR) DEV(tape-name)
       ENDOPT(*LEAVE) STRLIB(library-name) OMITLIB(library-name)
   ```

   where the *library-name* for the STRLIB and the OMITLIB parameters is where the RSTLIB failed. This starts the restore operation on the next library after the library where the RSTLIB failed.
4. You will be asked to load the volume containing the starting library.
5. After the restore operation is complete, restore the library that failed using the media from a previous save operation.

   Note: Consider eliminating the tape with the media error from the next save rotation cycle to avoid a tape error again.

11. If you have documents, folders, and mail to restore, load the correct tape and type the following:

    ```
    RSTDLO DLO(*ALL) SAVFLR(*ANY) DEV(tape-device-name) ENDOPT(*UNLOAD)
    ```

    Note: If an unrecoverable error occurs when running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command, see "Media or Device Error When Running the RSTDLO Command" on page 9-11.

Note: If you are not using journaling, or do not have changed objects to restore, continue with the next step. Otherwise, continue with the task "Restore Changed Objects."

12. To restore the authority, type the following:

    ```
    RSTAUT
    ```

    Note: If users have private authority to many objects, the RSTAUT command can take a very long time to run.

13. If you used the distribution tapes to restore the operating system, some information was not restored. You must create or change this information again. You should have lists of this information that were created at the time you performed your save operation.

    The following may need to be created or changed:

    - Configuration lists
    - Edit descriptions
    - Reply list entries
    - IBM-supplied subsystem descriptions

    a. For the configuration lists, do the following:

       Use the Work Configuration List (WRKCFGL CFGL(*ALL)) command to create the configuration lists to match the information in your list.

    b. For edit descriptions, do the following:

       Use the Work with Edit Descriptions (WRKEDTD EDTD(*ALL)) command to create edit descriptions to match the information in your list.

    c. For reply list entries, do the following:

       Use the Add Reply List Entry (ADDRPYLE) command to create reply list entries to match the information in your list.

    d. For IBM-supplied subsystem descriptions, do the following:

       Use the Work with Subsystem Descriptions (WRKSBSD SBSD(*ALL)) command to change the IBM-supplied subsystem descriptions to match the information in your list.

    This completes the restore operation.

14. If you are unsure what the QSECOFR password is, change it now. To see if the password has expired, type the following:

    ```
    DSPUSRPRF QSECOFR
    ```

    If the password expiration is active for the QSECOFR user profile, you will see the expiration date on the Date password expired field. If the date is the current system date or prior, change the password for the QSECOFR user profile.

15. Check the job log to ensure all objects were restored.

    The job log contains information about the restore operation. To verify that all objects were restored, you should spool the job log for printing, along with the job's remaining spooled output, if any.

    ```
    DSPJOBLOG * *PRINT
    ```

    Or

    ```
    SIGNOFF *LIST
    ```

Message CPC3703 is sent to the job log for each library that was successfully restored. Message CPF3773 is sent to tell you how many objects were restored. It also tells you how many objects were not restored. Objects are not restored for various reasons. Check for any error messages, correct the errors, and then restore those objects from the media.

16. Perform a normal IPL and return the system to normal operations:
    a. Turn the keylock switch to the Normal position.
    b. Type the following on a command line and press the Enter key.

       ```
       PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
       ```

17. When the IPL is complete, sign on the system.
18. Start any other subsystems that need to be started, such as QTCP or QSNADS.

    ```
    STRSBS SBSD(subsystem-name)
    ```


Restoring Changed Objects

Attention!

If you are using journaling and need to apply journaled changes, continue with the following steps. Use these recommended steps to avoid a failed restore operation caused by restoring journal receivers with names that conflict with the journal receivers currently attached to the restored journals. Otherwise, ignore these steps and continue with "Restoring Changed Objects."

Note: If you are using OfficeVision/400 or PC Support/400 and are performing daily save operations using SAVDLO and SAVCHGOBJ LIB(QUSRSYS) OBJJRN(*NO) commands, you must perform the steps in "Working with Journals" for the system supplied journal QUSRSYS/QAOSDIAJRN. If you specified OBJJRN(*YES) on the SAVCHGOBJ command, you do not need to apply journal changes.

Working with Journals

1. Type the following and press the Enter key:

   ```
   WRKJRN
   ```

2. The Specify Journal Name display is shown. Specify *ALL for the *Library name* prompt and press the Enter key.
3. The Work with Journals display is shown. To display the name of the currently attached journal receiver, type a 5 (Display journal status) in the *Opt* field for each journal on which you want to apply changes. Write down all the names of the journals and their currently attached journal receivers.

   Notes:

   a. You only need to perform the following steps for those journals you plan to use for recovering journaled files by performing the APYJRNCHG command. If no database files have been journaled to a journal, the system cannot apply any journaled changes using the journal.

   b. If you are using OfficeVision/400 or PC Support/400, you must apply jour-

naled changes to the files journaled to the system-supplied journal QUSRSYS/QAOSDIAJRN.

4. You cannot restore journal receivers from the SAVLIB, SAVOBJ, or SAVCHGOBJ media if they have the same names as the journal receivers that are attached. To later apply all journaled changes that have occurred since the last complete save operation, you must restore the receivers to the system from the save media.

   To avoid a failed restore operation of saved journal receivers because of name conflicts, do the following for each journal identified in the previous step.

   a. Create a journal receiver that will be used as a temporary receiver. Give it a name that will identify it as a temporary receiver, for example, TEMPnn. You can enter a description in the text (TEXT parameter) that identifies it as a temporary receiver for disaster recovery.

      ```
      CRTJRNRCV JRNRCV(library-name/TEMPnn)
            TEXT('temporary journal receiver for journal xxx')
      ```

      Repeat this step for each journal found in step 3.

   b. To detach the current receiver and attach the new TEMPnn receiver, type the following and press the Enter key.

      ```
      CHGJRN JRN(library-name/journal-name) JRNRCV(library-name/TEMPnn)
      ```

      Repeat this step for each journal found in step 3.

   c. Delete the detached journal receiver (identified in step 3 where you wrote down the name of the journal and journal receiver) using the Delete Journal Receiver (DLTJRNRCV) command.

      ```
      DLTJRNRCV JRNRCV(library-name/journal-receiver)
      ```

      Repeat this step for each journal found in step 3.

      If you receive message CPA7025 *Receiver never fully saved*, enter an I to ignore and press Enter to continue the delete.

      This allows the journal receivers on the save media to be restored successfully.

Restoring Changed Objects

1. Load the SAVCHGOBJ tape.

   Note: Several commands found in library QUSRTOOL can help you during save and restore operations. If you create the RSTALLCHG command in library QUSRTOOL, you can use the RSTALLCHG command to restore the libraries with changed objects from the SAVCHGOBJ or SAVALLCHG media without the need to know the names of the saved libraries. You need to run only one RSTALLCHG command to restore all the libraries. For more information about these commands, see "Restore All Changes (RSTALLCHG) Command" on page D-9.

2. If you do not use the RSTALLCHG in library QUSRTOOL and you specified SAVCHGOBJ LIB(*ALLUSR), type the following to determine the libraries that were saved:

   ```
   DSPTAP DEV(device-name) OUTPUT(*PRINT)
   ```

3. To restore changed objects, type the following and press the Enter key:

```
RSTOBJ OBJ(*ALL) DEV(tape-device) SAVLIB(library-name)
          OBJTYPE(*ALL) ENDOPT(*LEAVE) MBROPT(*ALL)
```

You must repeat this step for every library saved using the SAVCHGOBJ command.

4. Do one of the following:
   - If you are using journaling, perform the steps in "Applying Journal Changes" for each journal.
   - If you need to restore changed documents and folders, with the steps in "Restoring Changed Documents and Folders."
   - If you do not have no other restore steps to perform, continue with the following step.
5. Restore users' authority by entering:

   ```
   RSTAUT
   ```

   The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.
6. This completes the restore operation.
7. Perform a normal IPL and return the system to normal operations:
   a. Turn the keylock switch to the Normal position.
   b. Type the following on a command line and press the Enter key.

      ```
      PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
      ```
8. When the IPL is complete, sign on the system.
9. Start any other subsystems that need to be started, such as QTCP or QSNADS.

   ```
   STRSBS SBSD(subsystem-name)
   ```


Applying Journaled Changes

Ensure that all the journal receivers required for the apply journaled changes operation are available on the system. In general, you will need all journal receivers that were attached to the journal for the length of time for which journaled changes are now to be applied to the restored files. Restore all necessary journal receivers, including ones that might have not been restored earlier because of name conflicts with the receivers attached to the restored journals. Use the Display Journal Receiver Attributes (DSPJRNRCVA) command to determine when a journal receiver was attached to and detached from a journal.

1. Determine the name of the last journal receiver (the last receiver restored) by entering the following:

   ```
   WRKJRNA JRN(library-name/journal-name)
   ```
2. Press the Enter key.
3. Press F15 (Work with receiver directory) from the Work with Journal Attributes display to show the last journal receiver with a status of SAVED or PARTIAL. Write down the name of the receiver.

4. Determine the chain of receivers to be used in the APYJRNCHG command from the Work with Receiver Directory display. Write down the first and last receiver that you restored (last receiver is prior to the TEMPnn receiver). Notice that the first and last receiver are the same if only one journal receiver was restored.

   Note: While looking at the receiver directory, you should also look for any receiver chain breaks. You can determine a chain break by looking at the first two digits in the *Number* column on the Work with Receiver Directory display. You cannot apply journaled changes across receiver chain breaks. Therefore, you must write down the beginning and ending receiver names for each receiver chain. Then you need to run a series of apply journaled changes operations, one for each chain using these receivers. The *Advanced Backup and Recovery Guide* has more information about receiver chain breaks.

5. When applying journal changes, if the ending receiver has a status of PARTIAL (saved while attached), the TOENT parameter requires a sequence number to be specified on the APYJRNCHG command. Determine the last entry to be applied for the last receiver (identified in previous step).

   To determine the last receiver in the receiver range, type an 8 (Display attributes) in the *Opt* field next to the receiver name on the Work with Receiver Directory display.

   Write down the value for the *Last Sequence Number* field.

6. To ensure that the files are currently being journaled, do the following from the Work with Journal Attributes display:

   a. Press F13 (Display journaled files) from the Work with Journal Attributes display to show the list of files currently being journaled. To start journaling for a physical file that should be in the list, run the STRJRNPF command for each physical file not in the list.

   b. Press F14 (Display Journaled Access Paths) from the Work with Journal Attributes main display to display the list of currently journaled access paths. To start journaling access paths for a physical or logical file that should be in the list, run the STRJRNAP command for the physical or logical file that is not in the list.

   Notice that before journaling an access path, all physical files over which the access path is built must first be journaled to this journal. When you have ensured all files are correctly journaled, continue with the next step.

7. To continue the naming convention for your journal receivers, create a receiver that follows the same naming convention as the last receiver but assign it a number of one greater.

   ```
   CRTJRNRCV JRNRCV(library-name/journal-receiver-nameNN)
   ```

   By doing this, you are doing what the CHGJRN command would normally do if the last receiver saved was the current receiver being detached with a new receiver name being created.

8. Use the CHGJRN command to detach the temporary receiver and attach the new receiver you just created.

   ```
   CHGJRN JRN(library-name/journal-name)
          JRNRCV(library-name/journal-receiver-nameNN)
   ```

9. Enter the following command to apply the journaled changes using the first and last journal receivers identified on the Work with Receiver Directory display.

```
APYJRNCHG JRN(library-name/journal-name)
          FILE((library-name/*ALL))
          RCVRNG(lib-name/first-receiver lib-name/last-receiver)
          FROMENT(*LASTSAVE) TOENT(last-entry)
```

   Note: If you determined in step 4 of this procedure that this journal had receiver chain breaks, then you must run an APYJRNCHG command for each chain instead of one command as shown. For the RCVRNG parameter, specify the first and last receiver for each chain. For the FROMENT and TOENT parameters, specify:

   a. FROMENT(*LASTSAVE) and TOENT(*LAST) for the first receiver chain.

   b. FROMENT(*FIRST) and TOENT(*LAST) for the middle receiver chains.

   c. FROMENT(*FIRST) and TOENT(last-entry) for the last receiver chain.

   Attention

   You must specify individual files on the FILE parameter instead of *ALL for the QAOSDIAJRN journal in library QUSRSYS. Do not apply journal changes to the document and folder search index database files (QAOSSS10 through QAOSSS15, QAOSSS17, and QAOSSS18) for journal QAOSDIAJRN in library QUSRSYS.

```
APYJRNCHG JRN(QUSRSYS/QAOSDIAJRN)
     FILE((QUSRSYS/QAOKPLCA) (QUSRSYS/QAOSAY05)
          (QUSRSYS/QAOKPX4A) (QUSRSYS/QAOSAY07)
          (QUSRSYS/QAOKP01A) (QUSRSYS/QAOKP02A)
          (QUSRSYS/QAOKP03A) (QUSRSYS/QAOKP04A)
          (QUSRSYS/QAOKP05A) (QUSRSYS/QAOKP06A)
          (QUSRSYS/QAOKP08A) (QUSRSYS/QAOKP09A))
      RCVRNG(lib-name/first-receiver lib-name/last-receiver)
      FROMENT(*LASTSAVE) TOENT(last-entry)
```

   If you need to restore changed documents and folders, with the steps in "Restoring Changed Documents and Folders." Otherwise, continue with the next step.

10. Restore users' authority by entering:

```
RSTAUT
```

    The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.

11. This completes the restore operation.

12. Perform a normal IPL and return the system to normal operations:

    a. Turn the keylock switch to the Normal position.

    b. Type the following on a command line and press the Enter key.

```
PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
```

13. When the IPL is complete, sign on the system.

14. Start any other subsystems that need to be started, such as QTCP or QSNADS.

    ```
    STRSBS SBSD(subsystem-name)
    ```

Restoring Changed Documents and Folders

If you performed daily save operations for documents and folders, do the following steps. Otherwise, continue with the RSTAUT command.

1. Load the last daily SAVDLO tape.
2. If you performed daily save (SAVDLO DLO(*CHG)) operations to back up all new folders, new and changed documents, and mail since the last complete SAVDLO DLO(*ALL) FLR(*ANY) operation, type the following and press the Enter key.

   ```
   RSTDLO DLO(*ALL) DEV(TAP01) SAVFLR(*ANY)
   ```

   Note: If an unrecoverable error occurs when running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command, see "Media or Device Error When Running the RSTDLO Command" on page 9-11.
3. Restore users' authority by entering:

   ```
   RSTAUT
   ```

   The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.
4. This completes the restore operation.
5. Perform a normal IPL and return the system to normal operations:
   a. Turn the keylock switch to the Normal position.
   b. Type the following on a command line and press the Enter key.

      ```
      PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
      ```
6. When the IPL is complete, sign on the system.
7. Start any other subsystems that need to be started, such as QTCP or QSNADS.

   ```
   STRSBS SBSD(subsystem-name)
   ```

Restoring Programming Temporary Fixes (PTFs)

If you are using this procedure to finish restoring the entire system and have applied program temporary fixes (PTFs) after the last save operation, you must restore the PTFs.

If you need to restore program temporary fixes (PTFs) as part of recovering the entire system, find the most recent cumulative program temporary fix tape. This package could be on a distribution tape or on a stand-alone tape.

You can use option 8 (Install program temporary fix package) on the Program Temporary Fix menu to install all of the PTFs. All of the PTFs in the cumulative PTF package will be installed for the licensed programs you have installed on your

system. Refer to the *AS/400 System PTF Shipping Information Letter* for special instructions that are required.

If you are restoring individual PTFs, see the *System Operator's Guide*, SC41-8082, for more information about applying individual PTFs.

1. Print a list of all the licensed internal code PTFs currently on the system. Type the following and press the Enter key:

   ```
   DSPPTF LICPGM(5738999) OUTPUT(*PRINT)
   ```

2. Compare the list of PTFs in the previous step with the list you printed when you saved the system.

   Any PTFs that are not found must be loaded again.

3. If you do not have the PTFs identified in the previous step, order them and then apply them.

Chapter 11. Save and Restore Storage Processes and Procedures

The save storage process copies the Licensed Internal Code and all of the disk unit data to tape. The tape produced is a sector-by-sector copy of all permanent data on configured disk units. This procedure does not allow for single objects to be saved or restored.

Attention

The save and restore storage processes are intended for disaster backup and recovery and are to be used along with the standard save and restore commands. They are not intended for copying or distributing to other systems. IBM does not support using the save and restore storage processes as a means to distribute the Licensed Internal Code and the operating system to other systems.

The save and restore storage processes provide the fastest method for backing up and recovering an entire system that does not have checksum protection. The restore storage process is the fastest method for restoring the entire system. The performance difference is greater on faster tape units for both processes.

You can start the save storage process with the Save Storage (SAVSTG) command or an option on the Save menu. This command can only be started when the system is in a restricted state (no batch or interactive jobs running and all subsystems are ended). When the Save Storage command is run, the save function will cause an IPL of the system.

To use the restore storage function, the system must be in the DST-restricted state. The restore storage process is started by using an option on the Dedicated Service Tools (DST) menu. Understanding of libraries is not required to run the save and restore storage operations. The restore storage operation can only be started when the operating system is not active (before an IPL of the operating system).

When using the save and restore storage processes, the system cannot be used until the save or restore storage is complete.

Considerations When Using the Save Storage Process

The save storage process has the following considerations:

- The save storage media is intended for disaster recovery and cannot be used to restore individual objects. You must complement a save storage approach with the SAVSYS, SAVLIB, and SAVDLO commands.
- To properly implement a save storage approach, you should have multiple levels of your backup media.
- If a tape error occurs, the system attempts to recover from the error by automatically trying the operation again. If the system cannot recover, you can resume the save storage operation on a new tape volume. The operation continues from the last completed tape volume that was saved.

As the amount of storage on the system increases, the chance of an unrecoverable media error increases. Clean the tape unit frequently.

- If the save storage operation is interrupted, it should not be started again using the tape volume that was being written to at the time of the interruption. For example, if the system ends abnormally, the data saved to the tape volume that was loaded is not usable. The save storage operation must be resumed using a new tape to replace the one in use at the time the error occurred.
- The save storage operation can only be run when the system is in a restricted state.
- The user must have save system (*SAVSYS) special authority to use the SAVSTG command.
- The SAVSTG command causes the system to power down and starts the system again as if PWRDWNSYS RESTART(*YES) was specified. An IPL of the system occurs after the command completes. The save storage function implicitly occurs during the IPL of the system from the dedicated service tools (DST) function.
- The first tape can be saved without an operator being present. After the first tape is saved, DST messages appear asking for the next tape so the save operation can continue.
- If the tape unit supports hardware data compression, then hardware data compression is used. If device data compression is not supported, then programming data compression may be used. In general, if the device operates at a faster rate than data compression can be performed, then uncompressed data is written to the device.
- The save storage operation does not save the following:
  - Disk sectors that are not used or that contain temporary data.
  - The Model-Unique Licensed Internal Code. (Tape found in the service kit shipped with the system.)
- Only one tape unit can be used.
- A device name must be specified on the command. Expiration date (EXPDATE) and clear (CLEAR) parameters are optional. No volume ID can be specified.
- The save storage process does not start unless the system console is available. If the console is not available, a system reference code is displayed on the control panel.
- The save storage process does not start unless all of the configured disk units are operating.
- Save storage performance decreases significantly if the system is using checksum protection because of the extra number of checksum sectors that must be copied to tape.
- If the system is using mirrored protection, only one copy of the data from each mirrored pair is saved.
- When the save storage operation completes successfully, a normal IPL occurs.
- If the tape unit used for the save operation does not support a type D IPL, the same tape unit cannot be used to restore the Licensed Internal Code and the Licensed Internal Code PTFs from the save storage tape.

The restore storage process has the following considerations:

- The save storage media is intended for disaster recovery and cannot be used to restore individual objects.
- If a tape error occurs, the system attempts to recover from the error by automatically trying the operation again.

  If an unrecoverable media error occurs, the system cannot be used until you do one of the following:

  - Try the restore storage operation again from the beginning using the same save storage media (consider cleaning the tape heads first).
  - Restore a different level of save storage media. (To properly implement a save storage approach, you should have multiple levels of your backup media.)
  - Restore your last set of SAVSYS, SAVLIB, and SAVDLO tapes using the appropriate restore commands.
  - Use the Resume restore storage option starting with the next tape volume after the tape volume that had the error. Due to loss of data on the tape volume with the error, damaged objects will probably occur.
- If the restore storage operation is interrupted, you can start the process again by using the volume that was being read at the time the restore operation was interrupted. For example, if the system ends abnormally, the data restored from the current tape volume is not usable, and then the restore operation must be started again from the beginning of the volume.
- The user must have the DST security level of full. For a description of the DST security levels, see *Chapter 2. Security Considerations* in the *Security Reference* manual. After the restore storage process completes, the DST passwords are lost and must be entered again.
- The disk configuration of the restoring system must be the same disk configuration of the saving system. The disk types and models must be the same or equivalent with some additional devices. Serial numbers and physical addresses do not have to be the same. All disk units that were saved are required for the restore operation. For example, a 9332 Model 400 is equal to two 9332 Model 200s, or one half of a 9335 Model B01 is equal to another one half of a 9335 Model B01. See "Restoring the Save Storage Media on a Different System" on page 11-4.
- If the disk configuration cannot support mirrored protection because of an insufficient number of units, a restore operation can still be done provided there is one unit for each mirrored pair on the current system. Some mirrored units will now be unprotected because units are missing from the configuration. However, the system is available for operation. Missing units should be repaired or replaced in order for mirrored protection to be effective.
- Restore storage performance decreases significantly if the system is using checksum protection because the write operations must go through the checksum update process of reading old data and old checksum data, and then writing new data and new checksum data.
- If a system using checksum protection is saved, and then restored to a system whose disk configuration does not support checksum protection, then checksum protection is ended. Stopping checksum protection lengthens the next IPL of the system following the restore operation.

- If the system using mirrored protection is saved and then restored, the data is restored to only one unit of each mirrored pair. Each mirrored pair is synchronized again at the next IPL of the system, lengthening the IPL process.

  If the disk configuration has changes since the last save operation, there may be one unit of one or more mirrored pairs missing. The DST/SST Replace Disk Unit function must be used before synchronization can occur.
- To start the restore storage process, the system must be in the DST-restricted state.
- A type D IPL is required as the first step in the restore storage process.

  This will restore the Licensed Internal Code from the save storage tape. The Licensed Internal Code PTFs are restored correctly.
- The Model-Unique Licensed Internal Code must be restored using Option 24 (Install) of the Licensed Internal Code stand-alone utilities unless unit 1 of the system ASP has not been changed between the time of the save operation and the time of the restore operation.
- To restore the rest of the system, the restore storage function must be accessed from the DST function. The DST function cannot be accessed after an IPL of the OS/400 licensed program.
- If the tape unit used during the save operation used hardware data compression, then the tape unit used during the restore operation must use hardware data decompression. If the tape unit used during the save operation did not use hardware data compression, then the tape unit used for the restore operation does not have any hardware data decompression dependencies.
- Only one tape unit can be used.
- The restore storage process does not start unless the console is available. If the console is not available, a system reference code is displayed on the operator control panel.
- If no errors occur during the restore process, it is not necessary to build the database file access paths again.
- When the restore operation completes, and no errors occurred, the system exists at the level when the SAVSTG command was run (including messages, spooled files, message queues, and licensed program PTFs.)

Restoring the Save Storage Media on a Different System

If a disaster occurs and you must restore the SAVSTG media on a different system, the disk unit configuration must be the same or equivalent to the source system. The new system can have additional devices.

When you do an IPL of the new system, the Licensed Internal Code recognizes that the machine serial number is different and will reset the programming value to agree with the equipment value. This can cause the resource names to be different even if the configuration is the same.

If you save storage on one system and restore it on another, you should do the following on the restoring system:

1. On the IPL following the restore storage operation, be sure the value for automatic configuration is set to off.
2. Delete all configuration objects.

3. Create the required configuration objects manually or set the automatic configuration value on to automatically create local configuration objects. You still need to manually create the remote configuration objects, such as the line description for SDLC (CRTLINSDLC command).

Because some of the resources may have been renamed, some functions can be misleading. For example, assume you opened the error log to look at old problems. Some entries for the renamed resource may be meaningless.

Working with the Save and Restore Storage Procedures

Attention

The save and restore storage processes are intended for disaster backup and recovery and are to be used along with the standard save and restore commands. They are not intended for copying or distributing to other systems. IBM does not support using the save and restore storage processes as a means to distribute the licensed internal code and the operating system to other systems.

Before you begin any save procedure, it is recommended that you initialize enough tapes to complete the save operation. The number of tapes required depends on the size of the system, the number of objects being saved and the capacity of the tape. Use Table 4-2 on page 4-4 to determine tape capacities.

Initialize at least three more tapes than you think you will need. Each tape should have a volume ID and an external label that allows you to easily identify the tape.

An external label on the tape should identify the date and time of the save operation and what was saved. If an object needs to be restored, the tape that contains the object can be located quickly. A backup log should be provided to write down important information.

To initialize a new tape, do the following:

```
INZTAP DEV(TAP01) NEWVOL(BACKUP) NEWOWNID(user-profile-name)
       CHECK(*NO)
```

To initialize tapes that have data on them, display the tape to verify that you do not want to keep the data; then do the following:

```
INZTAP DEV(TAP01) NEWVOL(MONWK1) CHECK(*NO)
       ENDOPT(*UNLOAD)
```

If you are using tapes for the save operation that have data on them, you can use the CLEAR parameter to specify that data be cleared from the tape during the save operation. For example:

```
SAVSTG  DEV(TAP01) CLEAR(*ALL)
```

For more information about using tapes, see Chapter 4, "Save and Restore Media Considerations" on page 4-1.

Procedure for Saving Storage

Before You Begin . . .

_ Correctly initialize the tapes as standard-labeled tapes and specify the maximum density for the tape unit you are using.

_ Clean the read and write head of the tape unit.

_ Apply any temporary Licensed Internal Code fixes and then print a list of all the Licensed Internal Code fixes presently applied to your system. See step 1. Keep this list with your backup log or your save storage tapes for future reference.

Note: The system will not be available for use until the save storage process completes.

Use the following procedure to save storage.

1. Print a list of all the Licensed Internal Code fixes currently on the system. Type the following and press the Enter key.

   ```
   DSPPTF LICPGM(5738999) OUTPUT(*PRINT)
   ```

2. Notify users that the system is going down immediately.
3. Change the QSYSOPR message queue to break mode:

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(60)
   ```

4. Type the following to end all subsystems:

   ```
   ENDSBS SBS(*ALL) OPTION(*IMMED)
   ```

   Messages are sent to the QSYSOPR message queue indicating that the subsystems ended and the system is in a restricted state. When the subsystems have ended, continue with the next step.

5. Load the first tape of the SAVSTG media, and make the tape unit ready.
6. Turn the keylock switch to a position other than Manual.
7. Enter the save storage command, such as:

   ```
   SAVSTG DEV(TAP01) CLEAR(*ALL)
   ```

   You can also enter an expiration date (EXPDATE(mmddyy)).

8. Press the Enter key. The system will power down with a restart IPL. This is similar to PWRDWNSYS OPTION(*IMMED) RESTART(*YES). This means that when the command is entered, the system will power down and perform an automatic IPL.

   When the IPL occurs, a dedicated service tools (DST) function starts saving storage. The operator does not need to be present for the first tape if it is positioned correctly and the expiration date checking does not cause an error.

9. If the tape is loaded correctly, the following save status display continually displays the progress of the save operation.

```
                    Save Storage

Status of the save . . . . . . . . . . . . . . . . :  Running

Percent saved. . . . . . . . . . . . . . . . . . . :

Number of sectors not readable . . . . . . . . . . :
```

The *Percent saved* field on the display indicates the percentage of the total amount of disk sectors that have been saved. However, the percentage cannot be used to accurately estimate the time it will take, or the number of tapes needed to complete the save operation, because unused sectors are not saved.

10. One of the following displays may appear during the save operation.

    a. If another tape needs to be loaded, the following display appears:

```
                    Handle Tape or Diskette Intervention

Device:
 Type. . . . . . . . . . . . . . . . . . . . :      ____
 Model . . . . . . . . . . . . . . . . . . . :      ____
 Serial number . . . . . . . . . . . . . . . :      __________
 Address . . . . . . . . . . . . . . . . . . :      ___-________
I/O manager code . . . . . . . . . . . . . . :      ________
Reference code . . . . . . . . . . . . . . . :
   I/O controller . . . . . . . . . . . . . . :      ____
   Device . . . . . . . . . . . . . . . . . . :      ____
Volume or file . . . . . . . . . . . . . . . :
   Loaded . . . . . . . . . . . . . . . . . . :      ____________________
   Requested . . . . . . . . . . . . . . . . . :     ____________________

Type choice, press Enter.

  Action . . . . . . . . . . . . . . . . . . . . . . 1=Cancel
                                                     ____________________
                                                     3=Continue
                                                     ____________________

F3=Exit              F12=Cancel
End of tape encountered.  Load next volume.
```

    Load the next tape, select option 3 (Continue), and press the Enter key.

    b. If a tape with active files is loaded and CLEAR(*NONE) was specified on the SAVSTG command, the following display is shown:

```
                        Device Intervention Required

Device type. . . . . . . . . . . . . . . . . . . . :
Device model . . . . . . . . . . . . . . . . . . . :
Device serial number . . . . . . . . . . . . . . . :
Device address . . . . . . . . . . . . . . . . . . :
I/O manager code . . . . . . . . . . . . . . . . . :
Reference code . . . . . . . . . . . . . . . . . . :
   I/O controller . . . . . . . . . . . . . . . . . :
   Device . . . . . . . . . . . . . . . . . . . . . :

Type choice, press enter

  Action . . . . . . . . . . . . . . . . . . . . . . 1=Cancel
                                                     2=Ignore
                                                     3=Continue

F3=Exit              F12=Cancel
Active files exist on media.
```

To continue the save operation to tape, select option 2 (Ignore) to ignore the active files, and press the Enter key.

c. If the tape unit is not ready, the following display is shown:

```
                        Device Intervention Required

Device type. . . . . . . . . . . . . . . . . . . . :
Device model . . . . . . . . . . . . . . . . . . . :
Device serial number . . . . . . . . . . . . . . . :
Device address . . . . . . . . . . . . . . . . . . :
I/O manager code . . . . . . . . . . . . . . . . . :
Reference code . . . . . . . . . . . . . . . . . . :
   I/O controller . . . . . . . . . . . . . . . . . :
   Device . . . . . . . . . . . . . . . . . . . . . :

Type choice, press enter

  Action . . . . . . . . . . . . . . . . . . . . . . 1=Cancel

                                                     3=Continue

F3=Exit              F12=Cancel
Tape unit not ready.
```

Make the tape unit ready, select option 3 (Continue), and press the Enter key.

d. If the media that is loaded is write-protected, the following display is shown:

```
                        Device Intervention Required

Device type. . . . . . . . . . . . . . . . . . . . :      ____
Device model . . . . . . . . . . . . . . . . . . . :      ____
Device serial number . . . . . . . . . . . . . . . :      ____________
Device address . . . . . . . . . . . . . . . . . . :      ____-________
I/O manager code . . . . . . . . . . . . . . . . . :      ________
Reference code . . . . . . . . . . . . . . . . . . :
   I/O controller  . . . . . . . . . . . . . . . . :      ____
   Device  . . . . . . . . . . . . . . . . . . . . :      ____

Type choice, press enter

  Action  . . . . . . . . . . . . . . . . . . . . . . 1=Cancel
                                                      ____________________
                                                      3=Retry
                                                      ____________________




F3=Exit             F12=Cancel
Media is write protected.
```

Replace the tape with a tape that is not write-protected and select option 3 (Retry). Press the Enter key.

e. If the tape unit cannot process the tape, the following display is shown:

```
                        Device Intervention Required

Device type. . . . . . . . . . . . . . . . . . . . :      ____
Device model . . . . . . . . . . . . . . . . . . . :      ____
Device serial number . . . . . . . . . . . . . . . :      ____________
Device address . . . . . . . . . . . . . . . . . . :      ____-________
I/O manager code . . . . . . . . . . . . . . . . . :      ________
Reference code . . . . . . . . . . . . . . . . . . :
   I/O controller  . . . . . . . . . . . . . . . . :      ____
   Device  . . . . . . . . . . . . . . . . . . . . :      ____

Type choice, press enter

  Action  . . . . . . . . . . . . . . . . . . . . . . 1=Cancel
                                                      ____________________
                                                      3=Continue
                                                      4=Format




F3=Exit             F12=Cancel
Device is not able to process the media format
```

Select option 4 (Format), and press the Enter key.

f. If the tape loaded is not formatted, the following display is shown:

```
                        Device Intervention Required

Device type. . . . . . . . . . . . . . . . . . . . :       ____
Device model . . . . . . . . . . . . . . . . . . . :       ____
Device serial number . . . . . . . . . . . . . . . :       ____________
Device address . . . . . . . . . . . . . . . . . . :       ____-________
I/O manager code . . . . . . . . . . . . . . . . . :       ________
Reference code . . . . . . . . . . . . . . . . . . :
   I/O controller  . . . . . . . . . . . . . . . . :       ____
   Device  . . . . . . . . . . . . . . . . . . . . :       ____

Type choice, press enter

  Action  . . . . . . . . . . . . . . . . . . . . . . 1=Cancel
                                                      ____________________________
                                                      3=Continue
                                                      4=Format




F3=Exit             F12=Cancel
Tape or diskette loaded is blank
```

Select option 4 (Format), and press the Enter key.

g. If the tape unit cannot format the tape to the requested density, the following display is shown:

```
                        Device Intervention Required

Device type. . . . . . . . . . . . . . . . . . . . :       ____
Device model . . . . . . . . . . . . . . . . . . . :       ____
Device serial number . . . . . . . . . . . . . . . :       ____________
Device address . . . . . . . . . . . . . . . . . . :       ____-________
I/O manager code . . . . . . . . . . . . . . . . . :       8000 0001C
Reference code . . . . . . . . . . . . . . . . . . :
   I/O controller  . . . . . . . . . . . . . . . . :       ____
   Device  . . . . . . . . . . . . . . . . . . . . :       ____

Type choice, press enter

  Action  . . . . . . . . . . . . . . . . . . . . . . 1=Cancel
                                                      ____________________________
                                                      3=Retry
                                                      ____________________________




F3=Exit             F12=Cancel
```

Replace the tape with a tape that can be formatted to the requested density and select option 3 (Retry). Press the Enter key.

h. If an unrecoverable tape media error has occurred, the following display is shown:

```
                          Save Storage

Status of save . . . . . . . . . . . . . . . . . :       Waiting

A media error occurred on tape.

To cancel the save storage, press F3 or F12.
To resume the save storage, do the following:
 1.  Remove the tape from the tape device.
 2.  Clean the tape path using the cleaning procedure
     described in the tape device operator's guide.
 3.  Insert a different tape into the tape device.
 4.  Make the tape device ready, if necessary.
 5.  Press Enter to continue.  The system will resume the
     save storage.
 6.  If the error occurs again on this tape, contact your
     next level of support.



F3=Exit             F12=Cancel
```

1) Remove the failing tape from the tape device. Do not put the failing tape with the other tapes that have already been saved during the save storage operation. The failing tape cannot be used during the restore storage operation.

2) Load a different tape in the tape device.

3) Press the Enter key to resume the save storage operation.

   The data that is on the failing tape is written to the next tape so that no data is lost because of the tape media failure.

i. If the save storage operation was cancelled, and the operation can be resumed, the following display is shown.

```
                          Save Storage

Status of save  . . . . . . . . . . . . . . . . . :  Ended

Percent saved . . . . . . . . . . . . . . . . . . :

The save storage was ended before the save was complete.

You may either resume the save storage, or cancel
the save storage and then start the save storage again from
the beginning.

To resume the save storage, press Enter.
To cancel the save storage, press F3 or F12.




F3=Exit          F12=Cancel
```

Press the Enter key to resume the save storage operation. The following display is shown.

```
                              Resume Save Storage

You have selected to resume the save storage.

Do the following:

 1.  Locate the set of tapes created during the save storage
     which was interrupted.  The last tape which was completely
     written before the save storage was interrupted has the
     following identification:
         Volume identifier  . . . . . :  _______
         Sequence number  . . . . . . :  ___

 2.  Ensure that an initialized and write-enable tape is
     loaded and ready in the tape device.  Follow the
     procedures described in the tape device operator's
     guide.

 3.  Press Enter to resume the save storage.


F3=Exit          F12=Cancel
```

Load the tape that was being written to when the save operation was interrupted and press the Enter key.

j. If the save storage operation was cancelled, and the save operation cannot be resumed, the following display is shown.

```
                                Save Storage

Status of save  . . . . . . . . . . . . . . . . . . :  Ended

Percent saved . . . . . . . . . . . . . . . . . . . :  ___

The save storage was ended before the save was complete.

You must start the save storage again from the beginning to
have a complete system save.









F3=Exit          F12=Cancel
```

11. When the last tape is complete and no errors have occurred, the tape automatically rewinds and a normal IPL occurs.
12. The data area QSAVSTG in library QSYS is updated to show the date and time of the save operation. Use the Display Object Description (DSPOBJD) command to display the date and time of the save storage operation.

13. Use the Display Log (DSPLOG) command to display the QHST system log or use the Display Message (DSPMSG) command to display the QSYSOPR messages. Look at the save storage completion message CPC3734: `System storage save at &1. &2 sectors cannot be read.` If any sectors were found damaged and could not be read, call your service representative.

    ```
    DSPLOG QHST
    ```

    or

    ```
    DSPMSG *SYSOPR
    ```

This completes the save storage procedure. If you do not want the system to perform an automatic IPL, you can use an autostart job, which powers down the system.

Procedure for Resuming the Save Storage Operation

You can use this procedure only if the following conditions are true:

1. The save storage operation has finished saving the Licensed Internal Code.
2. The save storage operation has completed writing to at least one tape during the save storage operation.
3. All disk units are attached and operating.

One method of resuming the save storage operation following a tape media error is discussed in step 10h1 on page 11-11 in the topic "Procedure for Saving Storage." If another type of error occurs that causes the save storage operation to end (for example, system power loss, operator error, or tape drive error), the save storage operation can be started again.

To start the save storage operation again after the system ends abnormally (for example power loss to the system), do the following:

1. Turn the keylock switch to the Manual position.
2. Turn the power on the system by pushing the Power switch up. (The switch returns to center after you push it.)
3. The IPL or Install the System menu is shown. Select option 3 (Use dedicated service tools (DST) and press the Enter key.)
4. Sign on DST using the password assigned to your system for full DST authority. The Use Dedicated Service Tools (DST) menu is shown.
5. From the Use Dedicated Service Tools (DST) menu, select option 9 (Work with save storage and restore storage) and press the Enter key.
6. Select option 4 (Resume save storage) and press the Enter key.
7. If resuming the save storage operation is not allowed, a display with an explanation is shown.
8. If the following display is shown, load the tape that was being written to when the save storage operation was interrupted and press the Enter key.

```
                              Resume Save Storage

You have selected to resume the save storage.

Do the following:

 1.  Locate the set of tapes created during the save storage
     which was interrupted.  The last tape which was completely
     written before the save storage was interrupted has the
     following identification:
         Volume identifier  . . . . . . . . :  _______
         Sequence number  . . . . . . . . . :  ___

 2.  Ensure that an initialized and write-enable tape is
     loaded and ready in the tape device.  Follow the
     procedures described in the tape device operator's
     guide.

 3.  Press Enter to resume the save storage.


F3=Exit          F12=Cancel
```

9. If the volume identifier of the tape that is loaded is different from the volume identifier of the first save storage tape, the following display is shown.

```
                          Device Intervention Required

Device type. . . . . . . . . . . . . . . . . . . . :       ____
Device model . . . . . . . . . . . . . . . . . . . :       ____
Device serial number . . . . . . . . . . . . . . . :       __________
Device address . . . . . . . . . . . . . . . . . . :       ___-____
I/O manager code . . . . . . . . . . . . . . . . . :       ________
Reference code . . . . . . . . . . . . . . . . . . :
   I/O controller  . . . . . . . . . . . . . . . . :       ____
   Device  . . . . . . . . . . . . . . . . . . . . :       ____

Type choice, press enter

  Action  . . . . . . . . . . . . . . . . . . . . . . 1=Cancel
                                                      2=Ignore
                                                      3=Continue
                                                      4=Format




F3=Exit              F12=Cancel
Wrong volume loaded
```

To continue the save operation, select option 2 (Ignore) and press the Enter key.

Procedure for Restoring Storage from the Save Storage Media

The restore storage procedure will reset the system back to the point when the save storage operation was run.

Task Overview

You will perform the following tasks during this procedure:

1. Power down the system
2. Install the Licensed Internal Code
3. Restore the remaining save storage tapes
4. Restore the Licensed Internal Code fixes
5. Restore changed objects and apply journal changes

Before You Begin . . .

_ You will use function code 24 to install the Licensed Internal Code.

_ Clean the read and write head of the tape unit.

_ Find the list of program temporary (PTF) fixes that you created when you saved storage. This list should be with your SAVSTG tapes or with your backup log.

_ If you applied any PTFs since the last save storage operation, you will need your most recent cumulative PTF tape.

Use the following procedure to restore storage. The system will verify the sequences of the SAVSTG tapes during the restore operation to verify that the correct tape is loaded.

Note: The system will not be available for use until the restore storage process successfully completes.

If a tape media error occurs that is not recoverable, see the "Procedure for Resuming the Restore Storage Operation" on page 11-34. If the system cannot recover from the tape media error, you will have to load the system again using a previous SAVSTG tapes or restore the system using the standard restore commands with the last tapes used to save the entire system.

Task 1. Power Down the System

1. Type the following to power down the system:

```
PWRDWNSYS OPTION(*IMMED)
```

Do You have a 2440 Tape Unit?

If you have a 2440 tape unit with the high-speed feature enabled, you must disable the high-speed feature before installing the Licensed Internal Code. If the high-speed feature is enabled, continue with with "Disabling and Enabling the High-Speed Feature on the 2440 Tape Unit" on page 10-18 Otherwise, continue with the next task.

Task 2. Install the Licensed Internal Code

1. Ensure the key is in the keylock switch on the control panel.
2. Turn the key in the keylock switch until it points to the Manual position.
3. Press the Function Select switch to display **02** in the Function display on the control panel.
4. Press the Enter button on the control panel.
5. Select IPL type D (this specifies that the IPL source comes from tape) by pressing the Function Select switch on the control panel until **D** is shown on the Data display.
6. Press the Enter button on the control panel.
7. For the 9406 system unit, ensure that the power switches for the tape unit used for the IPL and all disk units are in the On position.
8. Find the Licensed Internal Code tape, which is the first volume of the most recent set of SAVSTG tapes.

   Note: You **must** use the first volume of the SAVSTG media to restore the Licensed Internal Code. If a media error occurs and the Licensed Internal Code cannot be restored from the first volume of the SAVSTG media, the Licensed Internal Code can be installed from the most current set of SAVSYS media or the distribution tapes supplied by IBM.

   Warning!: Use the distribution tapes only if no SAVSYS tape exists. If you use the distribution tapes, some system information will be lost. All cumulative PTF packages and individual PTFs applied after the initial installation of your system must be installed again.
9. Place the tape in the tape unit used for the IPL. For more information on loading the tape, see the setup manual for the device.

   Note: If your tape unit cannot be loaded when the power is off, continue with the next step. You will be prompted later by an SRC code for the tape.
10. Turn on the power to the system by pushing the Power switch up. The switch returns to center after you push it. The 9402 system unit has a green button labeled Power On.
11. If you could not load your tape in a previous step, load the first tape volume into the tape unit used for the IPL. Make the device ready and then continue with the next step.
12. If the system attention light is on and one of the SRC codes shown in the following table is displayed in the Data display, complete the instructions for that SRC code. Otherwise, continue with the next step.

Table 11-1 (Page 1 of 2). SRC codes

Symptom	Action
A100 1933 **A12x 1933** ('x' is any character)	This SRC is shown if the tape device for the alternate IPL is not ready. Make sure the correct tape is loaded and make the tape device ready. Wait for the System Attention light to go off. Then, continue with the next step. If the System Attention light stays on for more than 5 minutes, check to see if you have the correct tape loaded in the tape device for the alternate IPL and make the tape device ready. Then continue with the next step.

Table 11-1 (Page 2 of 2). SRC codes

Symptom	Action
B1xx 1803 **B1xx 1806** **B1xx 1938**	These SRCs are shown if the tape device for the alternate IPL was not found or was not ready. Make sure the tape device is powered on, the correct tape is loaded, and ready. Then continue with the next step.
B1xx 1934	This SRC is shown if the wrong tape is loaded. Load the correct tape and make the tape device ready. Then continue with the next step. This SRC is also shown if the high speed feature is enabled on the 2440 tape unit. The high speed feature must be disabled before installing or restoring the Licensed Internal Code.
2507 0001 **2642 0001** **2643 0001**	These SRCs are shown if a tape is not loaded in the tape device for the alternate IPL. Make sure the correct tape is loaded in the correct drive and then continue with the next step.

Note:

If any SRC listed in the table does not disappear from the control panel, do the following:

1. Press the Function Select switch to display **03** (continue the IPL) in the Function display on the control panel.
2. Press the Enter button on the control panel.

13. Ensure that the tape is online or ready. No action is required for tape units that perform this step automatically (such as the tape cartridge unit).
14. Ensure that the console display is turned on.
15. Wait for the yellow System Attention light on the control panel to light up.

    There is a delay while the system loads information from the tape. SRCs showing status are continuously updated on the control panel while processing occurs. This can take from 5 to 20 minutes; the time varies depending on the speed of the tape unit and the processor speed for the specific system model.

    When SRC A6xx 6001 is displayed, the system is prepared to start installing or restoring the Licensed Internal Code on the disk unit containing unit 1. Continue with the next step.
16. Select function code 24 by pressing the Function Select switch on the control panel until 24 is shown in the function display on the control panel.
17. Press the Enter button on the control panel.

    WARNING.

    Option 24 (Install) is used only to recover from the loss of unit 1 in the system ASP, or to recovery from a disaster. Option 24 (Install) deletes all information on the disk unit containing unit 1, including customer data. All system configuration information is also deleted. All disk units except unit 1 become nonconfigured units during the IPL.

    The System Attention light may appear in one or two minutes and SRC A6xx 6002 is displayed. If you are sure you want to install the Licensed Internal Code, select function code 24 again and press the Enter button. When SRC A6xx 6002 is displayed, option 23 can also be selected. If option 23 is selected, a restore of the Licensed Internal Code is performed (not an install). Data on the disk units will not be lost.

Notes:

a. If another SRC is displayed after A6xx 6001 that is not in the A6xx xxxx format, then the system needs additional attention. Call your service representative.

   If the following SRCs are displayed after SRC A6xx 6001 is displayed, see Appendix A, "Licensed Internal Code SRCs That Require User Input (A6xx xxxx)" for an explanation of these SRCs and the steps to follow.

   A6xx 6002 Disk unit may contain a valid system
   A6xx 6003 Disk unit not currently a load source
   A6xx 6004 Disk unit not currently a load source
   A6xx 6005 Disk unit not found

18. After pressing the Enter button on the control panel, the system starts displaying status SRCs again, which will be continuously updated to show the status of install or restore operation. An example of a status SRC is D6xx 6201 (stand-alone install operations is running).

19. If the yellow system attention light is on again, and SRC A6xx 6048 (New tape volume needs to be loaded) is displayed, the system needs the next tape. The *xx* tells which volume needs to be loaded. Load the correct tape and make the device ready. The install or restore operation automatically continues.

    If SRC A6xx 6051 appears, the stand-alone function is requesting the Model-Unique Licensed Internal Code tape found in inside the back cover of the system unit or on the side of the 9402 C04 system unit. Unload the current tape from the tape device and load the Model-Unique Licensed Internal Code tape.

    - A6xx 6051 Model-Unique Licensed Internal Code tape needs to be loaded
    - A6xx 6052 Tape loaded was not the Model-Unique Licensed Internal code,

    If another SRC A6xx xxxx is displayed, look up the displayed SRC in Appendix A, "Licensed Internal Code SRCs That Require User Input (A6xx xxxx)" on page A-1 and follow the instructions. For all other SRCs call your service representative.

Continue with "Task 3. Restore the Remaining Save Storage Tapes."

Task 3. Restore the Remaining Save Storage Tapes

1. After the IPL completes, the IPL or Install the System display appears.

```
                        IPL or Install the System

Select one of the following:

          1. Perform an IPL
          2. Install the operating system
          3. Use Dedicated Service Tools (DST)
          4. Perform automatic installation of the operating system
```

2. From the IPL or Install the System menu, select option 3 (Use Dedicated Service Tools (DST) and press the Enter key. The Dedicated Service Tools (DST) Sign On display is shown.

```
                    Dedicated Service Tools (DST) Sign On

Type choice, press Enter.

  DST password . . . . . . . . .  _____
```

3. Sign on DST with the DST *security* or *full* level password. *Security Reference*, SC41-8083, has more information about DST passwords. The Use Dedicated Service Tools (DST) menu is shown.

```
                        Use Dedicated Service Tools (DST)

Select one of the following:

          1. Perform an IPL
          2. Install the operating system
          3. Work with licensed internal code
          4. Work with disk units
          5. Work with DST environment
          6. Select DST console mode
          7. Start a service tool
          8. Perform automatic installation of the operating system
          9. Work with save storage and restore storage




Selection
     —

F3=Exit              F12=Cancel
```

4. Select option 9 (Work with save storage and restore storage) on the Use Dedicated Service Tools (DST) menu, and press the Enter key.
5. Select option 1 (Restore storage) and press the Enter key. The Specify Volume Identifier display is shown:

```
                        Specify Volume Identifier

Type choice, press Enter.

 Volume identifier . . . . . .  _____
```

6. Type the volume name in the *Volume Identifier* prompt. This is the volume currently loaded or the next volume in the series of SAVSTG tapes.
7. If the Select Tape or Diskette Unit display appears, select the proper unit and press the Enter key.

```
                        Select Tape or Diskette Unit

Type option, press Enter.
  1=Select

                                    Serial
Option      Type      Model         Number        Address
  -         ____      ____          ________      ____-________
  -         ____      ____          ________      ____-________
  -         ____      ____          ________      ____-________
  -         ____      ____          ________      ____-________
  -         ____      ____          ________      ____-________
  -         ____      ____          ________      ____-________
  -         ____      ____          ________      ____-________
  -         ____      ____          ________      ____-________
  -         ____      ____          ________      ____-________
  -         ____      ____          ________      ____-________
  -         ____      ____          ________      ____-________
  -         ____      ____          ________      ____-________
                                                              More...

F3=Exit          F12=Cancel
```

8. If the wrong volume is loaded, the following display appears:

```
                        Device Intervention Required

Device type. . . . . . . . . . . . . . . . . . . . :       ____
Device model . . . . . . . . . . . . . . . . . . . :       ____
Device serial number . . . . . . . . . . . . . . . :       ____________
Device address . . . . . . . . . . . . . . . . . . :       ___-_____
I/O manager code . . . . . . . . . . . . . . . . . :       _______
Reference code . . . . . . . . . . . . . . . . . . :
   I/O controller  . . . . . . . . . . . . . . . . :       ____
   Device  . . . . . . . . . . . . . . . . . . . . :       ____
Volume or file loaded  . . . . . . . . . . . . . . :       ____

If the wrong volume was loaded, type change, press Enter.

Type choice, press enter
  New volume or file  . . . . . . . . . . . . . .          ________________


F3=Exit             F12=Cancel
Wrong volume loaded
```

Type the name of the correct volume or file, and press the Enter key. The following display is shown:

```
                        Device Intervention Required

Device type. . . . . . . . . . . . . . . . . . . . :       ____
Device model . . . . . . . . . . . . . . . . . . . :       ____
Device serial number . . . . . . . . . . . . . . . :       ____________
Device address . . . . . . . . . . . . . . . . . . :       ___-_____
I/O manager code . . . . . . . . . . . . . . . . . :       _______
Reference code . . . . . . . . . . . . . . . . . . :
   I/O controller  . . . . . . . . . . . . . . . . :       ____
   Device  . . . . . . . . . . . . . . . . . . . . :       ____

Type choice, press enter
  Action  . . . . . . . . . . . . . . . . . . . . . 1=Cancel
                                                    ________________
                                                    3=Retry
                                                    ________________


F3=Exit             F12=Cancel
```

Select option 3 (Retry), and press the Enter key.

9. There is a delay while the tape is read to determine what has been saved on the tape. The Confirm Restore of Storage display is shown.

```
                    Confirm Restore Storage

Warning: A restore of storage will destroy the current
data on the system.  The restore will take several minutes for
each unit saved.  An automatic IPL is part of the restore.

Press F10 to confirm your choice to restore all disk units.
Press F12 to return to change your choice.

----------------- Restore To ----------------------  ------ Saved From ---------
                             Serial                             Serial
Unit  ASP  Type  Model  Number       Address        Number       Address
__    __   ____  ___    _________    ___-_______    _________    ___-_______
__    __   ____  ___    _________    ___-_______    _________    ___-_______
__    __   ____  ___    _________    ___-_______    _________    ___-_______
__    __   ____  ___    _________    ___-_______    _________    ___-_______
__    __   ____  ___    _________    ___-_______    _________    ___-_______
__    __   ____  ___    _________    ___-_______    _________    ___-_______
__    __   ____  ___    _________    ___-_______    _________    ___-_______
__    __   ____  ___    _________    ___-_______    _________    ___-_______
                                                                      More...

F10=Confirm restore         F12=Cancel
```

If the save storage operation was done on a system using checksum protection, and the disk configuration on the restoring system does not match the configuration of the saved system, the following display is shown instead.

```
                  Confirm Restore of All Disk Units

Warning: A restore of all disk units will destroy the current
data on the system.  The restore will take several minutes for
each unit saved.  The saved configuration has checksum protection
that can not be supported on the current disk configuration.
Checksum protection will be stopped.  An automatic IPL is part
of the restore.

Press F10 to confirm your choice to restore all disk units.
Press F12 to return to change your choice.

----------------- Restore To ----------------------  ----- Saved From --------
                             Serial                             Serial
Unit  ASP  Type  Model  Number       Address        Number       Address
__    __   ____  ___    _________    ___-_______    _________    ___-_______
__    __   ____  ___    _________    ___-_______    _________    ___-_______
__    __   ____  ___    _________    ___-_______    _________    ___-_______
__    __   ____  ___    _________    ___-_______    _________    ___-_______
__    __   ____  ___    _________    ___-_______    _________    ___-_______
                                                                      More...

F10=Confirm restore         F12=Cancel
```

10. Press the F10 (Confirm restore) key to confirm.
11. The restore status display on the console continually displays the progress of the restore operation.

```
                          Restore Storage

Status of the restore. . . . . . . . . . . . . . . :  Running

Percent restored . . . . . . . . . . . . . . . . . :
```

The *Percent restored* field on the display indicates the percentage of the total amount of disk sectors that have been restored.

12. If no errors occur, the system performs a programmed IPL when the restore storage process completes.
13. One of the following displays may be shown during the restore storage.
    a. If the tape unit is not ready, the following display is shown:

```
                        Device Intervention Required

Device type. . . . . . . . . . . . . . . . . . . . :       ____
Device model . . . . . . . . . . . . . . . . . . . :       ____
Device serial number . . . . . . . . . . . . . . . :       ________
Device address . . . . . . . . . . . . . . . . . . :       ___-_____
I/O manager code . . . . . . . . . . . . . . . . . :       _______
Reference code . . . . . . . . . . . . . . . . . . :
   I/O controller  . . . . . . . . . . . . . . . . :       ____
   Device  . . . . . . . . . . . . . . . . . . . . :       ____

Type choice, press enter
  Action  . . . . . . . . . . . . . . . . . . . . . 1=Cancel
                                                    ____________________
                                                    3=Continue
                                                    ____________________




F3=Exit              F12=Cancel
Tape unit not ready
```

Make the tape unit ready, select option 3 (Continue), and press the Enter key.

b. When the restore operation for a tape is complete, the tape is rewound and the following display appears:

```
                    Handle Tape or Diskette Intervention

Device:
 Type. . . . . . . . . . . . . . . . . . . :
 Model . . . . . . . . . . . . . . . . . . :
 Serial number . . . . . . . . . . . . . . :
 Address . . . . . . . . . . . . . . . . . :
I/O manager code . . . . . . . . . . . . . :
Reference code . . . . . . . . . . . . . . :
   I/O controller . . . . . . . . . . . . :
   Device . . . . . . . . . . . . . . . . :
Volume or file . . . . . . . . . . . . . . :
   Loaded . . . . . . . . . . . . . . . . :
   Requested . . . . . . . . . . . . . . . :

Type choice, press Enter.

  Action . . . . . . . . . . . . . . . . . . . . . . 1=Cancel
                                                     3=Continue

F3=Exit             F12=Cancel
End of tape encountered.  Load next volume.
```

Load the next tape, select option 3 (Continue), and press the Enter key.

c. The system determines the next tape by the volume identifier you specified at the beginning of the procedure. If the wrong tape is loaded, the following display appears:

```
                        Device Intervention Required

Device type. . . . . . . . . . . . . . . . . . . . :
Device model . . . . . . . . . . . . . . . . . . . :
Device serial number . . . . . . . . . . . . . . . :
Device address . . . . . . . . . . . . . . . . . . :
I/O manager code . . . . . . . . . . . . . . . . . :
Reference code . . . . . . . . . . . . . . . . . . :
   I/O controller . . . . . . . . . . . . . . . . :
   Device . . . . . . . . . . . . . . . . . . . . :

Type choice, press enter
  Action . . . . . . . . . . . . . . . . . . . . . . 1=Cancel
                                                     3=Retry

F3=Exit             F12=Cancel
Wrong volume loaded.
```

Remove the tape, find the correct tape, select option 3 (Retry), and press the Enter key.

d. If the tape could not be read because of a media error, the following display is shown:

```
                          Restore Storage

Status of restore . . . . . . . . . . . . . . . :       Ended

A media error was found on tape.

If this is the first time the restore storage has ended because
a media error occurred on this tape, do the following:
 1.  Remove the tape from the tape device.
 2.  Clean the tape path using the cleaning procedure
     described in the tape device operator's guide.
 3.  Press Enter, F3, or F12 to continue.  The system will
     perform an IPL, an then display either the IPL or Install
     the System menu or the Missing Disk Units display.
 4.  Select the option to use Dedicated Service Tools (DST)
 5.  Select the option to Work with Save Storage and Restore
     Storage.
 6.  Select the option Resume restore storage.
 7.  Insert the tape which had the media error into the tape
     device.
 8.  Make the tape device ready, if necessary.

F3=Exit             F12=Cancel
```

For information on how to recover from a media error, see the "Procedure for Resuming the Restore Storage Operation" on page 11-34.

14. When the IPL completes the restore operation, the IPL or Install the System menu appears.

```
                        IPL or Install the System

Select one of the following:

          1. Perform an IPL
          2. Install the operating system
          3. Use Dedicated Service Tools (DST)
          4. Perform automatic installation of the operating system
```

15. Select option 1 (Perform an IPL).
16. The following display is shown only if disk units have been attached to the system and are in nonconfigured status.

```
                    Add All Disk Units to the System

Select one of the following:

          1. Add all disk units to the system auxiliary storage pool
          2. Keep the current disk configuration
          3. Perform disk configuration using DST









Selection
     __
```

17. Select option 1 (Add all disk devices to the system auxiliary pool) if the disk devices do not have checksum protection or mirrored protection, and press the Enter key.

    As the disk units are configured, the following display is shown:

```
                    Formatting additional disk units in progress.
                           Seconds running . . . . :  ____
```

    Adding disk units takes several minutes. The time it takes depends on the size of each unit and the ability of the system to do multiple adds at the same time.

18. When the IPL completes, the restore history information for data area QSAVSTG in library QSYS is updated to show the date and time of the last restore storage operation. Use the Display Object Description (DSPOBJD) to display the last date and time of the restore storage operation.

19. Use the Display Log (DSPLOG) command to display the QHST log or use the Display Messages (DSPMSG) command to display the QSYSOPR messages. Look at the restore storage message CPC3735 to see if any sectors that could not be read were found during the restore operation, if checksum protection was stopped, and if the restore storage process is complete.

Task 4. Restore the Programming Temporary Fixes

If you applied program temporary fixes to your system after the last save storage operation or used the distribution tapes to restore the licensed internal code, continue with the following steps. Otherwise, continue with "Restoring the Remaining Parts of the System."

If you are using this procedure to finish restoring the entire system and have applied program temporary fixes (PTFs) after the last save operation, you must restore the PTFs.

If you need to restore program temporary fixes (PTFs) as part of recovering the entire system, find the most recent cumulative program temporary fix tape. This package could be on a distribution tape or on a stand-alone tape.

You can use option 8 (Install program temporary fix package) on the Program Temporary Fix menu to install all of the PTFs. All of the PTFs in the cumulative PTF package will be installed for the licensed programs you have installed on your system. Refer to the *AS/400 System PTF Shipping Information Letter* for special instructions that are required.

If you are restoring individual PTFs, see the *System Operator's Guide*, SC41-8082, for more information about applying individual PTFs.

1. Print a list of all the licensed internal code PTFs currently on the system. Type the following and press the Enter key:

   ```
   DSPPTF LICPGM(5738999) OUTPUT(*PRINT)
   ```

2. Compare the list of PTFs in the previous step with the list you printed when you saved the system.

   Any PTFs that are not found must be loaded again.

3. If you do not have the PTFs identified in the previous step, order them and then apply them.

Task 5. Restoring the Remaining Parts of the System

If you have changed objects to restore, use the following steps to restore user profiles, changed objects, and authority.

1. Type QSECOFR in the user prompt and the password (if password security is active) associated with that user ID on the Sign On display.
2. Press the Enter key.
3. Type the following command on the command line and press the Enter key.

   ```
   CHGMSGQ MSGQ(QSECOFR) DLVRY(*BREAK) SEV(60)
   ```

4. Type the following command to end all subsystems.

   ```
   ENDSBS SBS(*ALL) OPTION(*IMMED)
   ```

5. A message will be sent indicating that all subsystems are ended and the system is in a restricted state.
6. Type the following command on the command line and press the Enter key.

   ```
   CHGMSGQ MSGQ(QSECOFR) DLVRY(*BREAK) SEV(99)
   ```

7. Type the following command to restore user profiles from the SAVSECDTA tape file (label QFILEUPR).

   ```
   RSTUSRPRF DEV(TAP01) USRPRF(*ALL) ENDOPT(*UNLOAD)
   ```

Task 6. Restore Changed Objects

Attention!

If you are using journaling and need to apply journaled changes, continue with the following steps. Use these recommended steps to avoid a failed restore operation caused by restoring journal receivers with names that conflict with the journal receivers currently attached to the restored journals. Otherwise, ignore these steps and continue with "Restoring Changed Objects."

Note: If you are using OfficeVision/400 or PC Support/400 and are performing daily save operations using SAVDLO and SAVCHGOBJ LIB(QUSRSYS) OBJJRN(*NO) commands, you must perform the steps in "Working with Journals" for the system supplied journal QUSRSYS/QAOSDIAJRN. If you specified OBJJRN(*YES) on the SAVCHGOBJ command, you do not need to apply journal changes.

Working with Journals

1. Type the following and press the Enter key:

   ```
   WRKJRN
   ```

2. The Specify Journal Name display is shown. Specify *ALL for the *Library name* prompt and press the Enter key.
3. The Work with Journals display is shown. To display the name of the currently attached journal receiver, type a 5 (Display journal status) in the *Opt* field for each journal on which you want to apply changes. Write down all the names of the journals and their currently attached journal receivers.

   Notes:

   a. You only need to perform the following steps for those journals you plan to use for recovering journaled files by performing the APYJRNCHG command. If no database files have been journaled to a journal, the system cannot apply any journaled changes using the journal.

   b. If you are using OfficeVision/400 or PC Support/400, you must apply journaled changes to the files journaled to the system-supplied journal QUSRSYS/QAOSDIAJRN.

4. You cannot restore journal receivers from the SAVLIB, SAVOBJ, or SAVCHGOBJ media if they have the same names as the journal receivers that are attached. To later apply all journaled changes that have occurred since the last complete save operation, you must restore the receivers to the system from the save media.

   To avoid a failed restore operation of saved journal receivers because of name conflicts, do the following for each journal identified in the previous step.

a. Create a journal receiver that will be used as a temporary receiver. Give it a name that will identify it as a temporary receiver, for example, TEMPnn. You can enter a description in the text (TEXT parameter) that identifies it as a temporary receiver for disaster recovery.

```
CRTJRNRCV JRNRCV(library-name/TEMPnn)
      TEXT('temporary journal receiver for journal xxx')
```

Repeat this step for each journal found in step 3.

b. To detach the current receiver and attach the new TEMPnn receiver, type the following and press the Enter key.

```
CHGJRN JRN(library-name/journal-name) JRNRCV(library-name/TEMPnn)
```

Repeat this step for each journal found in step 3.

c. Delete the detached journal receiver (identified in step 3 where you wrote down the name of the journal and journal receiver) using the Delete Journal Receiver (DLTJRNRCV) command.

```
DLTJRNRCV JRNRCV(library-name/journal-receiver)
```

Repeat this step for each journal found in step 3.

If you receive message CPA7025 *Receiver never fully saved*, enter an I to ignore and press Enter to continue the delete.

This allows the journal receivers on the save media to be restored successfully.

Restoring Changed Objects

1. Load the SAVCHGOBJ tape.

   Note: Several commands found in library QUSRTOOL can help you during save and restore operations. If you create the RSTALLCHG command in library QUSRTOOL, you can use the RSTALLCHG command to restore the libraries with changed objects from the SAVCHGOBJ or SAVALLCHG media without the need to know the names of the saved libraries. You need to run only one RSTALLCHG command to restore all the libraries. For more information about these commands, see "Restore All Changes (RSTALLCHG) Command" on page D-9.

2. If you do not use the RSTALLCHG in library QUSRTOOL and you specified SAVCHGOBJ LIB(*ALLUSR), type the following to determine the libraries that were saved:

   ```
   DSPTAP DEV(device-name) OUTPUT(*PRINT)
   ```

3. To restore changed objects, type the following and press the Enter key:

   ```
   RSTOBJ OBJ(*ALL) DEV(tape-device) SAVLIB(library-name)
            OBJTYPE(*ALL) ENDOPT(*LEAVE) MBROPT(*ALL)
   ```

   You must repeat this step for every library saved using the SAVCHGOBJ command.

4. Do one of the following:

   - If you are using journaling, perform the steps in "Applying Journal Changes" for each journal.
   - If you need to restore changed documents and folders, with the steps in "Restoring Changed Documents and Folders."

- If you do not have no other restore steps to perform, continue with the following step.

5. Restore users' authority by entering:

   ```
   RSTAUT
   ```

   The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.

6. This completes the restore operation.
7. Perform a normal IPL and return the system to normal operations:
   a. Turn the keylock switch to the Normal position.
   b. Type the following on a command line and press the Enter key.

      ```
      PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
      ```

8. When the IPL is complete, sign on the system.
9. Start any other subsystems that need to be started, such as QTCP or QSNADS.

   ```
   STRSBS SBSD(subsystem-name)
   ```

Task 7. Apply Journaled Changes

Ensure that all the journal receivers required for the apply journaled changes operation are available on the system. In general, you will need all journal receivers that were attached to the journal for the length of time for which journaled changes are now to be applied to the restored files. Restore all necessary journal receivers, including ones that might have not been restored earlier because of name conflicts with the receivers attached to the restored journals. Use the Display Journal Receiver Attributes (DSPJRNRCVA) command to determine when a journal receiver was attached to and detached from a journal.

1. Determine the name of the last journal receiver (the last receiver restored) by entering the following:

   ```
   WRKJRNA JRN(library-name/journal-name)
   ```

2. Press the Enter key.
3. Press F15 (Work with receiver directory) from the Work with Journal Attributes display to show the last journal receiver with a status of SAVED or PARTIAL. Write down the name of the receiver.
4. Determine the chain of receivers to be used in the APYJRNCHG command from the Work with Receiver Directory display. Write down the first and last receiver that you restored (last receiver is prior to the TEMPnn receiver). Notice that the first and last receiver are the same if only one journal receiver was restored.

   Note: While looking at the receiver directory, you should also look for any receiver chain breaks. You can determine a chain break by looking at the first two digits in the *Number* column on the Work with Receiver Directory display. You cannot apply journaled changes across receiver chain breaks. Therefore, you must write down the beginning and ending receiver names for each receiver chain. Then you need to run a series of apply journaled changes operations, one for each chain using

these receivers. The *Advanced Backup and Recovery Guide* has more information about receiver chain breaks.

5. When applying journal changes, if the ending receiver has a status of PARTIAL (saved while attached), the TOENT parameter requires a sequence number to be specified on the APYJRNCHG command. Determine the last entry to be applied for the last receiver (identified in previous step).

   To determine the last receiver in the receiver range, type an 8 (Display attributes) in the *Opt* field next to the receiver name on the Work with Receiver Directory display.

   Write down the value for the *Last Sequence Number* field.

6. To ensure that the files are currently being journaled, do the following from the Work with Journal Attributes display:

   a. Press F13 (Display journaled files) from the Work with Journal Attributes display to show the list of files currently being journaled. To start journaling for a physical file that should be in the list, run the STRJRNPF command for each physical file not in the list.

   b. Press F14 (Display Journaled Access Paths) from the Work with Journal Attributes main display to display the list of currently journaled access paths. To start journaling access paths for a physical or logical file that should be in the list, run the STRJRNAP command for the physical or logical file that is not in the list.

   Notice that before journaling an access path, all physical files over which the access path is built must first be journaled to this journal. When you have ensured all files are correctly journaled, continue with the next step.

7. To continue the naming convention for your journal receivers, create a receiver that follows the same naming convention as the last receiver but assign it a number of one greater.

   ```
   CRTJRNRCV JRNRCV(library-name/journal-receiver-nameNN)
   ```

   By doing this, you are doing what the CHGJRN command would normally do if the last receiver saved was the current receiver being detached with a new receiver name being created.

8. Use the CHGJRN command to detach the temporary receiver and attach the new receiver you just created.

   ```
   CHGJRN JRN(library-name/journal-name)
          JRNRCV(library-name/journal-receiver-nameNN)
   ```

9. Enter the following command to apply the journaled changes using the first and last journal receivers identified on the Work with Receiver Directory display.

   ```
   APYJRNCHG JRN(library-name/journal-name)
             FILE((library-name/*ALL))
             RCVRNG(lib-name/first-receiver lib-name/last-receiver)
             FROMENT(*LASTSAVE) TOENT(last-entry)
   ```

   Note: If you determined in step 4 of this procedure that this journal had receiver chain breaks, then you must run an APYJRNCHG command for each chain instead of one command as shown. For the RCVRNG parameter, specify the first and last receiver for each chain. For the FROMENT and TOENT parameters, specify:

a. FROMENT(*LASTSAVE) and TOENT(*LAST) for the first receiver chain.

b. FROMENT(*FIRST) and TOENT(*LAST) for the middle receiver chains.

c. FROMENT(*FIRST) and TOENT(last-entry) for the last receiver chain.

Attention

You must specify individual files on the FILE parameter instead of *ALL for the QAOSDIAJRN journal in library QUSRSYS. Do not apply journal changes to the document and folder search index database files (QAOSSS10 through QAOSSS15, QAOSSS17, and QAOSSS18) for journal QAOSDIAJRN in library QUSRSYS.

```
APYJRNCHG JRN(QUSRSYS/QAOSDIAJRN)
     FILE((QUSRSYS/QAOKPLCA) (QUSRSYS/QAOSAY05)
          (QUSRSYS/QAOKPX4A) (QUSRSYS/QAOSAY07)
          (QUSRSYS/QAOKP01A) (QUSRSYS/QAOKP02A)
          (QUSRSYS/QAOKP03A) (QUSRSYS/QAOKP04A)
          (QUSRSYS/QAOKP05A) (QUSRSYS/QAOKP06A)
          (QUSRSYS/QAOKP08A) (QUSRSYS/QAOKP09A))
      RCVRNG(lib-name/first-receiver lib-name/last-receiver)
      FROMENT(*LASTSAVE) TOENT(last-entry)
```

If you need to restore changed documents and folders, with the steps in "Restoring Changed Documents and Folders." Otherwise, continue with the next step.

10. Restore users' authority by entering:

    ```
    RSTAUT
    ```

    The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.

11. This completes the restore operation.

12. Perform a normal IPL and return the system to normal operations:

    a. Turn the keylock switch to the Normal position.

    b. Type the following on a command line and press the Enter key.

    ```
    PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
    ```

13. When the IPL is complete, sign on the system.

14. Start any other subsystems that need to be started, such as QTCP or QSNADS.

    ```
    STRSBS SBSD(subsystem-name)
    ```

Task 8. Restore Changed Documents and Folders

If you performed daily save operations for documents and folders, do the following steps. Otherwise, continue with the RSTAUT command.

1. Load the last daily SAVDLO tape.

2. If you performed daily save (SAVDLO DLO(*CHG)) operations to back up all new folders, new and changed documents, and mail since the last complete

SAVDLO DLO(*ALL) FLR(*ANY) operation, type the following and press the Enter key.

```
RSTDLO DLO(*ALL) DEV(TAP01) SAVFLR(*ANY)
```

Note: If an unrecoverable error occurs when running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command, see "Media or Device Error When Running the RSTDLO Command" on page 9-11.

3. Restore users' authority by entering:

   ```
   RSTAUT
   ```

   The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.

4. This completes the restore operation.
5. Perform a normal IPL and return the system to normal operations:
   a. Turn the keylock switch to the Normal position.
   b. Type the following on a command line and press the Enter key.

      ```
      PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
      ```

6. When the IPL is complete, sign on the system.
7. Start any other subsystems that need to be started, such as QTCP or QSNADS.

   ```
   STRSBS SBSD(subsystem-name)
   ```


Restoring Storage from a Non-IPL Tape Unit

The save storage operation can be used to write to a tape device that is not the IPL tape unit. For example, the 9404 has an optional 9348 tape unit. (The 6346 tape unit is the IPL tape unit on the 9404.)

The tape used for the save storage operation on the 9348 tape unit cannot be used to restore the Licensed Internal Code. However, it can be used to restore the remaining parts of the system.

When the save storage operation is done using a tape unit other than the IPL tape unit, you should perform a SAVSYS operation using the tape unit used for the IPL. It is important that the operations occur without applying PTFs for the Licensed Internal Code between the time of the SAVSTG operation and the SAVSYS operation. Otherwise, the restore operation will cause the PTF index to reflect the time of the SAVSYS and any PTFs applied since the last SAVSYS will have to be installed again.

To recover the entire system, and restore the Licensed Internal Code from the IPL tape unit, use the SAVSYS tapes to restore the Licensed Internal Code from the IPL tape unit. Sign on to DST after the restore of the Licensed Internal Code is complete and request the restore storage function. Specify the non-IPL tape device for the restore storage operation.

Procedure for Resuming the Restore Storage Operation

You can use this procedure to resume the restore storage operation that ended before the entire restore operation of the disk unit data was complete.

To start the restore storage operation again, do the following:

1. From the Dedicated Service Tools (DST) menu, select option 9 (Work with save storage and restore storage) and press the Enter key.
2. Select option 2 (Resume restore storage) and press the Enter key.
3. If the following display is shown, load the tape that is indicated and press the Enter key.

```
                          Resume Restore Storage

Do the following:

 1.  Locate the tape to resume the restore on.  The tape
     that was being read when the restore storage was
     interrupted has the following identification:
         Volume identifier  . . . . . :  _______
         Sequence number  . . . . . . :  ____
 2.  Insert the tape in the tape device.
 3.  Make the tape device ready, if necessary.

Note:
  If the restore storage was interrupted because of a media
  error on a tape, you may want to resume the restore
  storage on the tape following the failing tape.  If you
  resume the restore storage on that tape, the system will
  have damaged objects, and the system might not be able to
  perform and IPL to OS/400 when the restore storage is complete.

Press Enter to continue.

F3=Exit          F12=Cancel
```

4. If the wrong volume is loaded, the following display appears:

```
                        Device Intervention Required

Device type. . . . . . . . . . . . . . . . . . . . :      _____
Device model . . . . . . . . . . . . . . . . . . . :      _____
Device serial number . . . . . . . . . . . . . . . :      ____________
Device address . . . . . . . . . . . . . . . . . . :      ____-_______
I/O manager code . . . . . . . . . . . . . . . . . :      _________
Reference code . . . . . . . . . . . . . . . . . . :
   I/O controller  . . . . . . . . . . . . . . . . :      _____
   Device  . . . . . . . . . . . . . . . . . . . . :      _____
Volume or file loaded  . . . . . . . . . . . . . . :      _____

If the wrong volume was loaded, type change, press Enter.

Type choice, press enter
  New volume or file  . . . . . . . . . . . . . .      ____________________


F3=Exit             F12=Cancel
Wrong volume loaded
```

Type the name of the correct volume or file, and press the Enter key.

5. The restore storage operation starts again.

If the restore storage operation continues to fail on the same tape with a tape media failure, you have three options:

- Use a previous copy of your save storage tapes to completely restore storage.
- Use the most recent copy of your save system tapes used to save the entire system.
- Start the restore storage operation again on the tape following the tape with the media error. If the tape that has the media error is the last tape to restore in the set, option 3 (Force end of an interrupted restore storage) on the Restore Storage menu should be selected.

  Warning: In either instance, some disk unit data is not restored. There may also be many objects damaged on the system when the restore operation completes. An initial program load of the operating system may not occur. You should restore the operating system again.

Part 3. Auxiliary Storage Pools and Disk Recovery

Chapter 12. Auxiliary Storage Pools

The following topics provide general information about single-level storage, allocation of disk space, disk failure, and auxiliary storage pools (ASPs).

Understanding Single-Level Storage

The concept of **single-level storage** is that, at a low level within the machine, a single virtual address space (virtual storage) exists. This storage is large enough to contain all data to be stored on the system. Functions operating above this low level see data as being stored in contiguously addressable locations in this space, no matter how the data may in fact be stored on auxiliary storage and in main storage.

The AS/400 machine interface (MI) instruction set provides an object-related interface. Space for an object is allocated as connected virtual storage. In reality, the data resides on auxiliary storage in disk extents that are not connected. Although programs see this data as being addressed directly in virtual storage, the data is brought into main storage, when needed, for use by programs run by the processing unit.

The internal machine functions that support the virtual address space involve three primary parts:

- **Auxiliary storage management** allocates and deallocates disk space for data placed in virtual storage.
- **Main storage management** copies data into main storage when it is needed, and then back to its permanent home on auxiliary storage after it has been updated.
- **Processing unit addressing** automatically addresses the appropriate location in main storage when a virtual address is used.

Refer to Figure 12-1 on page 12-2 for an illustration of single-level storage.

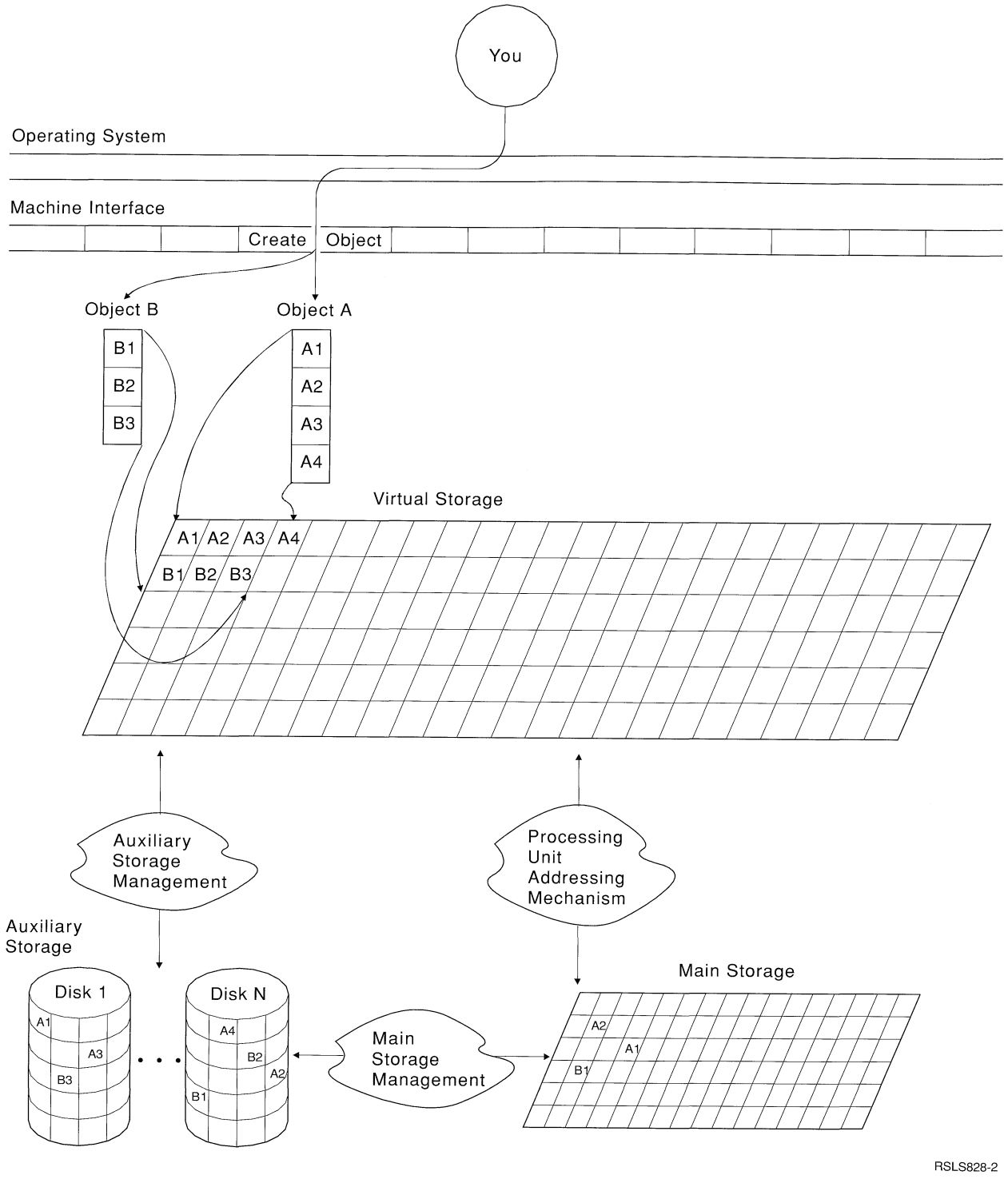


Figure 12-1. Single-Level Storage

Allocation of Space to Store Objects on Disk

When an object is created, you do not have to allocate space for the object. Allocation of space on auxiliary storage is done automatically and is determined by the space required, space available, and by space utilization of each disk attached to the system. To balance space utilization, auxiliary storage management typically allocates space for an object across two or more disks.

As an example of allocation, Figure 12-1 on page 12-2 shows that object A, when created, was allocated into virtual storage units at connected locations A1, A2, A3, and A4. This unit of storage, referred to as a page, is determined by internal machine algorithms. These pages of virtual storage are then physically allocated to auxiliary storage to provide balanced use. The locations in auxiliary storage normally will not be connected. Similarly, locations selected in main storage for these pages of virtual storage (units A1 and A2 in the figure) are not connected.

Disk Failure with Data Loss

Having the system manage disk storage means you do not have to perform this time-consuming function, but it also means you do not know where data for objects resides on disk. Because you do not know this, there is no way for you to tell what was stored on a disk when it fails. Furthermore, because the system spreads the data for an object across many disks, it is likely that pieces of many objects were lost when a disk failed. No functions exist to tell you what piece of an object was lost or how to restore a piece of an object. Because you cannot always determine what was lost, your only recovery option is to reload the entire system from backup media.

If you have not saved all objects on offline media immediately prior to a failure, you will not be able to recover recently entered data. Therefore, when your previously saved objects are restored, the system is operational but the database is not current.

Even if journaling of database files is used, the receiver that contains the recently entered transactions will not be available if it too was lost when the disk failed. You will have to use alternatives to recover recently entered data, and in some cases that may not be possible. The recovery of recently entered data can complicate and lengthen the overall recovery process.

Considering these complications to recovering lost data, it is important to prepare for the possible need for recovery. You can simplify the recovery process by using disk recovery tools.

How the System Addresses Disk Units

The system processor requires information located in main storage. Main storage transfers information to disk (auxiliary storage pools (ASPs)).

Because ASPs are made of many disk units, other hardware is required to manage the transfer of data. Figure 12-2 on page 12-4 illustrates the hardware.

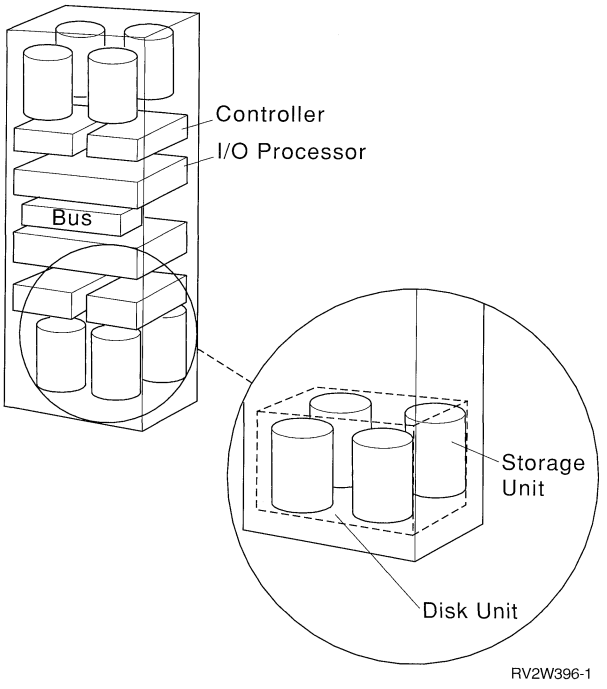


Figure 12-2. Hardware Used for Data Transfer

This hardware includes:

Bus: The bus is the main communications channel for input and output data transfer.

- All system models have at least one bus.
- Models B50 and above have two or three buses.
- 9406 Models D, E and F have up to 7 buses.
- The bus is addressed by the system as 0, 1, or 2.

I/O processor: The I/O processor is attached to the bus and controls information between the bus and specific groups of I/O controllers.

- There are different types of I/O processors, depending on the input and output types to control.
- Disk storage uses the 6110, 6111, 6112, or 2615 I/O processor for the 9406 system unit.
- One 6110 or 6112 I/O processor can control up to:
  - Eight 9332 disk units
  - Eight 9335 B01 disk units
- One 6111 or 6112 I/O processor can control up to two 9336 disk units (four to eight storage units).
- The 9332, 9335, and 9336 disk units cannot be mixed on the same I/O processor.
- I/O processor performance is directly related to the amount of input and output activity it controls.
- The I/O processor is addressed by the system as 0 through F.

Controller: The controller attaches to the I/O processor and handles the information transfer between the I/O processor and the disk units.

- Disk units have different types of controllers based on disk type.
- Disk unit 9332 has its own controller.
- The 9335, model A01, controller is used to control up to four 9335, model B01, disk units. Because of controller contention, performance requirements may dictate that the A01 controllers attach to no more than two B01 disk units.
- The controllers are addressed by the system as 00 through 07 on each bus.

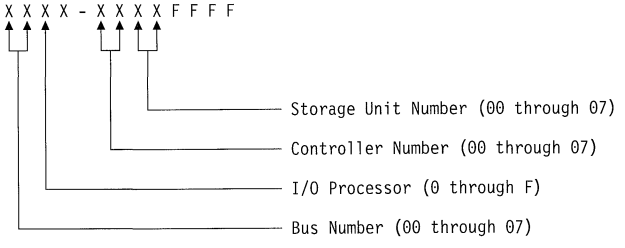
Disk units: Disk units are the actual devices that contain the storage units.

- Disk units are further divided into independently addressed sections known as storage units.
- The number of storage units per disk unit vary by disk unit type and model. For example, the 9332, model 400, has two storage units.
- Storage units are addressable by the system. For example, the 9335 disk unit has 0 through 7, and the 9332 disk unit has 0 through 1.

How the System Addresses Individual Storage Units

For data transfer, the system needs a way to identify a single storage unit. Every hardware component (bus, I/O processor, controller, and storage unit) has a unique address.

The address has eight digits and is identified as follows:



How Disk Units Are Attached to the System

In addition to understanding single-level storage, it is important that you understand how disk units are attached to the system before proceeding to the discussions of the disk recovery tools.

Different models of disk units are attached to the AS/400 system. The storage areas within the disk units are referred to as **storage units**. The number of storage units and the storage capacity per storage unit varies by disk unit type and model. Table 12-1 and Table 12-2 summarizes the characteristics of each disk device type and model.

Table 12-1. Storage Capacity by Disk Unit Type

Disk Unit Type	Model	Storage Units per Disk Unit	MB per Storage Unit
2800	001	2	320.18
2801	001	2	988.80
6100	015	1	315.59
6102	010/30	1	320.18
6103	010/030	1	400.69
6104	030	1	988.80
6105	010/020/030/040	1 or 2	320.18
6107	010/030/020/040	1 or 2	400.69
6109	030/040	1 or 2	988.80
6603	030/040	1 or 2	1967
9332	2xx/4xx	1 or 2	200.28
9332	6xx	2	300.42
9335	B01	2	427.93
9336	010	2 to 4	471.2
9336	020	2 to 4	857.2

Table 12-2. Models and Capacity for the 9337 Disk Unit Subsystems

9337 Model	MB/Unit	MB/Number of Units						
		2	3	4	5	6	7	8
01x[1]	542	1084	1626	2168	2710	3252	3794	N/A
02x[1]	970	1940	2910	3880	4850	5820	6790	N/A
040	1967	N/A	N/A	7868	9835	11802	13769	N/A
21x	542	1084	1626	2168	2710	3252	3794	4336
22x	970	1940	2910	3880	4850	5820	6794	7760
240	1967	3934	5895	7868	9835	11802	13769	15736
11x HA[3,5]	406/542	N/A	N/A	1626	2168	2710	3252	[2]
12x HA[3,5]	728/970	N/A	N/A	2910	3880	4850	5820	[2]
140 HA[3,5]	1475/1967	N/A	N/A	5900	7867	9834	11801	[2]
21x HA[3,4,5]	406/542	N/A	N/A	1626	2168	2710	3252	3794
22x[3,4,5]	728/970	N/A	N/A	2910	3880	4850	5820	6790
240 HA[3,4,5]	1475/1967	N/A	N/A	5900	7867	9834	11801	13769

Notes:

1 This base model comes with two disk units as the base configuration without device parity protection. This model can be upgraded to use device parity protection.

2 This unit is called the write-assist disk unit (WAD). The WAD is an integral part of some of the 9337 high-availability models. The AS/400 system cannot address or manage this disk unit.

3 This model comes with four disk units as the base configuration with device parity protection built in. Disk units 1, 3, 5, and 7 are device parity units. One fourth of four disk units for this model is reserved for parity information and is unavailable for user data. Additional units of the same type can be added and all storage on those units will be available for user data.

5 This model has the write cache feature.

6 This model must have two disk units in the base configuration and a minimum of two feature disk units to support device parity protection.

Disks are assigned to an auxiliary storage pool (ASP) on a storage unit basis. The system treats each storage unit within a disk unit as a separate unit of auxiliary storage. When a new disk unit is attached to the system, the system initially treats each storage unit within it as nonconfigured storage units. Through dedicated service tool (DST) options you can allocate these storage units to either the system ASP or a user ASP of your choosing. When allocating nonconfigured storage units, use the serial number information assigned by the manufacturer to ensure you are selecting the correct physical device. Additionally, the individual storage units within the disk unit can be identified through the *Address* field on the DST Display Disk Configuration display. For more information about displaying disk configuration, see the *Advanced Backup and Recovery Guide*.

When you allocate a nonconfigured storage unit to an ASP, the system assigns a number to the storage unit. The storage unit number can be used instead of the serial number and address.

When a storage unit has mirrored protection, two storage units (mirrored pair) are assigned the same unit number. The serial number and the address distinguish between the two units in a mirrored pair.

You may want to know which physical disk is being identified with each unit number. Make note of the unit number assignment to ensure that correct identification is made. If you need to verify the unit number assignment, use the DST Display Configuration Status display to show the serial numbers and addresses of each unit.

The storage unit addressed by the system as unit 1 is always used by the system to store the Licensed Internal Code. The amount of storage used on unit 1 is quite large and varies depending on the configuration of your system. Because unit 1 contains the initial programs and data used during an IPL of the system, it is also known as the **load source unit**.

The system reserves 1.08 megabytes of storage per storage unit (other than unit 1), reducing the amount of space available by that amount.

General Information about Auxiliary Storage Pools

An **auxiliary storage pool (ASP)** is a group of units defined from all the disk units that make up auxiliary storage. ASPs provide the means of isolating objects on a specific disk unit, or disk units, to prevent the loss of data due to a disk media failure on other disk units not included in the ASP.

If the system experiences a disk unit failure with data loss, recovery is required only for the libraries or objects in the ASP that contained the failed disk. System and user objects in other ASPs are protected from the disk failure.

In addition to the recovery advantage, placing libraries or objects in an ASP can improve performance because the system dedicates the disk units associated with that ASP to the objects in that ASP. In a heavy journaling environment, placing libraries and objects in a user ASP can reduce contention between the journal receivers and the files if they are in different ASPs, and can improve journaling performance.

Auxiliary Storage Limits

During an IPL, the system determines how much auxiliary storage is configured on the system. The total amount is the sum of the capacity of the configured units and their mirrored pairs, if any. Disk units that are not configured are not included. The amount of disk storage is compared to the maximum supported for a particular model (see Table 12-3 on page 12-9). If more than the recommended amount is configured, a message (CPI1158) is sent to the system operator's message queue (QSYSOPR) and the QSYSMSG message queue (if it exists on the system). This message indicates too much auxiliary storage on the system. This message is sent once during each IPL as long as the amount of auxiliary storage on the system is more than the maximum amount supported.

The following information is used to determine the maximum amount of auxiliary storage supported for each system model. The numbers have been rounded to the nearest tenth.

Table 12-3. Auxiliary Storage Limits by System Model	
System Model	**Maximum Auxiliary Storage in GB**
B30, B35, B40, B45	13.7
B50	27.5
F10, F20, F25	19.7
D35, E35, D45, E45, F35,F45	43.0
B60, B70	55.1
D50, E50, F50	78.0
D60, E60, D70, E70, F60	114.0
D80, E80, E90, E95, F70, F80, F90, F95	192.0
Note: For models not shown in the table, no message is sent. Restrictions already exist on the amount of auxiliary storage when ordering on the models not shown.	

System ASP

The system ASP (ASP 1) is automatically created by the system and includes unit 1, as well as all other configured disks that are not assigned to a user ASP. Unlike a disk that is configured, a disk in nonconfigured status is attached to the system, but is not part of an ASP and is not being used. The system ASP contains all system objects for the OS/400 licensed program and all user objects not assigned to a user ASP.

If the system ASP fills to capacity, the system ends abnormally. You must IPL the system again and take the correct steps, such as deleting objects, to reduce the storage utilization within the system ASP.

You can specify a threshold that, when reached, warns the system operator of potential shortage of space.

For example, if you set the threshold value at 80 for the system ASP, the system operator (QSYSOPR) and system message queue (QSYSMSG) are notified when the system ASP is 80% full. This message is sent every hour until the value is changed, or until objects are deleted or transferred out of the system ASP. If this message is ignored and the system ASP fills to capacity, the system stops and you must perform an IPL of the system. The system may have trouble performing another IPL because objects were left in an unusable condition.

Do not wait until your system fills to capacity before you save it. Saving your system may cause it to fill to capacity.

For a description of the details associated with the system ASP filling to capacity while checksum protection is in effect, see the *Advanced Backup and Recovery Guide*.

Notes:

1. For Version 1 hardware, main storage dump space must be contained on unit 1 in the system ASP.
2. For Version 2 hardware on 9406 Model D, the main store dump space must be contained on 2800 Model 001 storage units in the system ASP. Enough 2800 Model 001 storage units must be configured to contain the main storage dump space in the system ASP.
3. If the system contains (or is expected to contain) 224MB or more of main storage, then at least two 2800-001 storage units must be configured to the system ASP (ASP 1). If the system ASP has mirrored protection, then all four 2800-001 storage units must be configured to the system ASP. Failure to provide enough disk units to contain the main storage dump space may result in significantly longer IPLs and will greatly limit problem support.
4. If there is not enough free space to allocate to main store dump space, a message (CPI0987) will be sent to the QSYSOPR message queue and the QHST log.

User ASPs

A user auxiliary storage pool (ASP) is created by grouping together a physical set of disk units and assigning them to an ASP.

You can configure user ASPs 2 through 16. They can contain libraries and associated objects. Associated objects in the library can include journals, journal receivers, and save files. User ASPs (old type) created before Version 1 Release 3 could only contain journals, journal receivers, and save files whose libraries were in the system ASP.

A user ASP must be exclusively one type or the other:

- If the user ASP contains libraries, then all the objects in the user ASP must be contained within these libraries. Their libraries cannot be in the system ASP. This is the recommended way to use user ASPs.
- If the library for the objects in the user ASP exists in the system ASP, then the only objects allowed in the user ASP are journals, journal receiver and save files. This type of user ASP is not recommended.

When using user ASPs in the recommend way, consider the following:

- Journals and the files being journaled **must** be in the same ASP. The journal receivers should be placed in a different ASP. This protects against the loss of both the files and the receivers if a disk media failure occurs.
- Physical file and logical files should be in the same library in the user ASP. If they are in different libraries in the ASP, you must ensure that the physical files are restored before the logical files.
- Journaling cannot be started on an object (STRJRNPF or STRJRNAP command) if the journal (object type *JRN) and the object to be journaled are in different ASPs.
- Journaling cannot be started again for a file that is saved and then restored to a different ASP that does not contain the journal. The journal and the file must be in the same ASP for journaling to be automatically started again for the file.

- If the system ASP is lost, data is preserved in the user ASPs. However, when RCLSTG is run during the recovery procedures, all objects in the user ASP have their ownership transferred to default owner (QDFTOWN). You must transfer ownership for the objects back to the original owners.

Isolating libraries and associated objects in a user ASP protects them from disk failures in other ASPs and reduces recovery time. See "Object Types Not Allowed in a User ASP" on page 12-14 for restrictions.

The advantages are:

- Additional data protection. By separating libraries or objects in a user ASP, you protect them from data loss when a disk unit in the system ASP or other user ASPs fails. For example, if you have a disk unit failure, and data contained on the system ASP is lost, objects contained in user ASPs are not affected and can be used to recover objects in the system ASP. (For information on recovering objects, see "Summary of Disk Recovery Actions" on page 13-2.) Conversely, if a failure causes data contained in a user ASP to be lost, data in the system ASP is not affected.
- Improved system performance. You can place libraries or objects in a user ASP, allowing you to dedicate the disk units in the ASP exclusively for the use of those objects. If you do extensive journaling, a dedicated disk unit for the journal receiver can also improve journaling performance.

  However, placing many active journal receivers in the same user ASP is not productive because the resulting contention between writing to more than one receiver in the ASP can slow system performance. For maximum performance, place each active journal receiver in a separate user ASP.
- All disk types can be allocated to a user ASP, but unit 1 is always allocated to the system ASP (ASP 1).
- User ASPs are configured using the DST display, Work with ASP Configuration. For more information about configuring user ASPs, see the *Advanced Backup and Recovery Guide*.
- As with the system ASP, you can specify individual threshold values for each user ASP. For information on how to do this using dedicated services tool or system service tools, see the topics "Accessing DST Options" on page 12-21 and "Accessing SST Options" on page 12-20. If you do not specify a value, the system uses the default value of 90%.
- You can use mirrored or checksum protection on one or more ASPs.

  Notes:

  1. All ASPs, including the system ASP, must have mirrored protection or consist entirely of disk units with device parity protection. to ensure that the system continues to run after a disk failure in an ASP.
  2. If a disk failure occurs in an ASP that does not have mirrored protection, the system may not continue to run, depending on the type of disk unit and the error.
  3. If a disk failure occurs in an ASP that has mirrored protection, the system continues to run (unless the failed unit has a mirrored unit that has failed).
  4. If a storage unit fails in an ASP that has device parity protection, the system continues running as long as no other storage unit in the disk unit

fails. For more information about device parity protection, see the *Advanced Backup and Recovery Guide*.

Considerations for Using User ASPs

You can create two types of user ASPs.

- Create your libraries in the user ASP by using the ASP parameter on the CRTLIB command. All objects that are created in those libraries are allocated to that user ASP. This type is recommended.
- Create your libraries in the system ASP (ASP 1), and then create the journals, journal receivers, and save files in user ASPs by using the ASP parameter on the corresponding create command (CRTJRN, CRTJRNRCV, or CRTSAVF). This is the old type of ASP. This type of ASP (supported before Version 1 Release 3) is **not recommended** because the recovery steps are more complex.

A user ASP must be exclusively one type or the other. If the library for the objects in the user ASP exists in the system ASP, then the only objects allowed in the user ASP are journals, journal receiver and save files. If the user ASP contains libraries, then all the objects in the user ASP must be contained within these libraries. Their libraries cannot be in the system ASP.

Consider the following when creating the recommended type of user ASPs:

- An IPL cannot be performed with a failed unit in any ASP (unless the failing unit has a mirrored unit that has not failed or the disk unit has device parity protection). (The *Advanced Backup and Recovery Guide* has more information about device parity protection.) The failing unit must be repaired or replaced, or the ASP definition for the failing unit must be removed by changing the disk configuration.
- The system ASP should have checksum protection, device parity protection, or mirrored protection. Using checksum protection, device parity protection, or mirrored protection reduces the chance of the system ASP losing all data. When the system ASP is lost, addressability to objects in every user ASP is lost. The addressability can only be recovered by restoring the entire system or by running the Reclaim Storage (RCLSTG) command.
- There are performance considerations when using checksum protection or mirrored protection. The *Advanced Backup and Recovery Guide*, has more information about performance considerations for mirrored protection and checksum protection.
- When a user ASP becomes full, objects can overflow into the system ASP. If the user ASP overflows, the overflow status for the ASP should be reset as soon as possible for the following reasons:
  - The contents of the user ASP are cleared if a user ASP overflows and a data-loss failure occurs that causes either the user ASP or the system ASP to be cleared.
  - If a user ASP is cleared while in overflow status, the user must run the Reclaim Storage (RCLSTG) command to recover. A reclaim storage operation finds and cleans up any objects or parts of objects that overflowed into the system ASP.

- No database network can cross ASP boundaries. A **database network** consists of a set of related physical and logical files. All logical files built over a single physical file make up a simple network. These simple networks can then be grouped together by a common logical file that is built over the physical files from two or more simple networks. Simple networks are continually grouped until there exists no logical file that can group two smaller networks together. The final result is a database network.
  - Users cannot create a file in one ASP that depends on a file in a different ASP. All based-on physical files for a logical file must be in the same ASP as the logical file. The system builds access paths only for database files in the same ASP as the based-on physical file (temporary queries are not limited). Access paths are never shared by files in different ASPs. Record formats are not shared between different ASPs; a format request is ignored and a new record format is created.
  - SQL collections are not allowed in user ASPs. SQL collections require logical files with based-on physical files in library QSYS. Because the based-on physical files are in the system ASP and the logical files in a user ASP, an SQL collection is not allowed.

    Warning!

    System or product libraries (libraries that begin with a Q or #) must not be created in or restored to a user ASP. Doing so can cause unpredictable results.

  - When using user ASPs in the recommended way, journaling cannot be started on an object (STRJRNPF or STRJRNAP command) if the journal (object type *JRN) and the object to be journaled are in different ASPs.
  - When using user ASPs in the recommended way, journaling cannot be started again for a file that is saved and then restored to a different ASP that does not contain the journal. The journal and the file must be in the same ASP for journaling to be automatically started again for the file.
  - The Reorganize Physical File Member (RGZPFM) command requires sufficient work space to contain a copy of the member being reorganized. The work space must exist in the same ASP.
- Normally, you cannot move objects from a library in one ASP to a library in another ASP using the Move Object (MOVOBJ) command. The one exception to this rule is files in library QRCL can be moved to their original libraries.

  Journals and journal receivers cannot be moved out of the libraries that they were created in. The only way to move an object from one ASP to another is to create a new object. An object can be placed in a different ASP by doing the following:

  1. Save the object.
  2. Delete the existing object.
  3. Create the library using the Create Library (CRTLIB) command.
  4. Restore the object to the library.

Object Types Not Allowed in a User ASP

The Create Library (CRTLIB) command allows you to place a library in a specific user ASP.

Commands that restore or create objects allowed in user ASPs, automatically place the object in the same ASP as the library. The system does not allow a user to create an object in a user ASP if the object type is not allowed in a user ASP.

The following list shows the object types that are not allowed in a user ASP.

Object Type	Description
***AUTL**	Authorization list
***CFGL**	Configuration list
***CNNL**	Connection list
***COSD**	Class-of-service description
***CTLD**	Controller description
***DEVD**	Device description
***DOC**	Documents
***EDTD**	Edit description
***FLR**	Folders
***IGCSRT**	DBCS sort
***IGCTBL**	DBCS table
***JOBSCD**	Job scheduler
***LIND**	Line description
***MODD**	Mode description
***NWID**	Network interface description
***RCT**	Reference code translation table
***S36**	System/36 machine description
***USRPRF**	User profiles

Limiting the Types of Objects in a User ASP

You can limit the types of objects in a user ASP (ASPs 2 through 16) if a library does not exist in the user ASP. However this type of ASP (available before V1R3) is **not recommended** because it requires a complex set of recovery steps.

You can limit the object types to:

- Journals (*JRN)
- Journal receivers (*JRNRCV)
- Save files (*SAVF)

You create any of the object types listed above in a user ASP and have the library in the system ASP. You can isolate the object in a user ASP by specifying a user ASP number in the ASP parameter on the create command for the specific object type (CRTJRN, CRTJRNRCV, or CRTSAVF) will create the object in the specified

ASP. If the user ASP contains any of these isolated objects, no other object types (other than journals, journal receivers, and save files) can be created in that user ASP.

If you want to create a library in a user ASP, but the user ASP contains journals, journal receivers, and save files whose library is in the system ASP, you must first delete all the journals, journal receivers, and save files in the user ASP.

Checksum protection is not recommended for user ASPs containing journals, journal receivers, and save files whose library is in the system ASP for the following reasons:

- Inefficient because the use of journaling and save files is a different form of backup. Checksum protection would be backing up a backup copy.
- Poor performance because of redundancy data.

Use the Display Object description (DSPOBJD) command and specify DETAIL(*FULL) to identify the ASP that the object is in.

Planning the Configuration of User ASPs

Figure 12-3 on page 12-16 illustrates a configuration of system and user auxiliary storage pools.

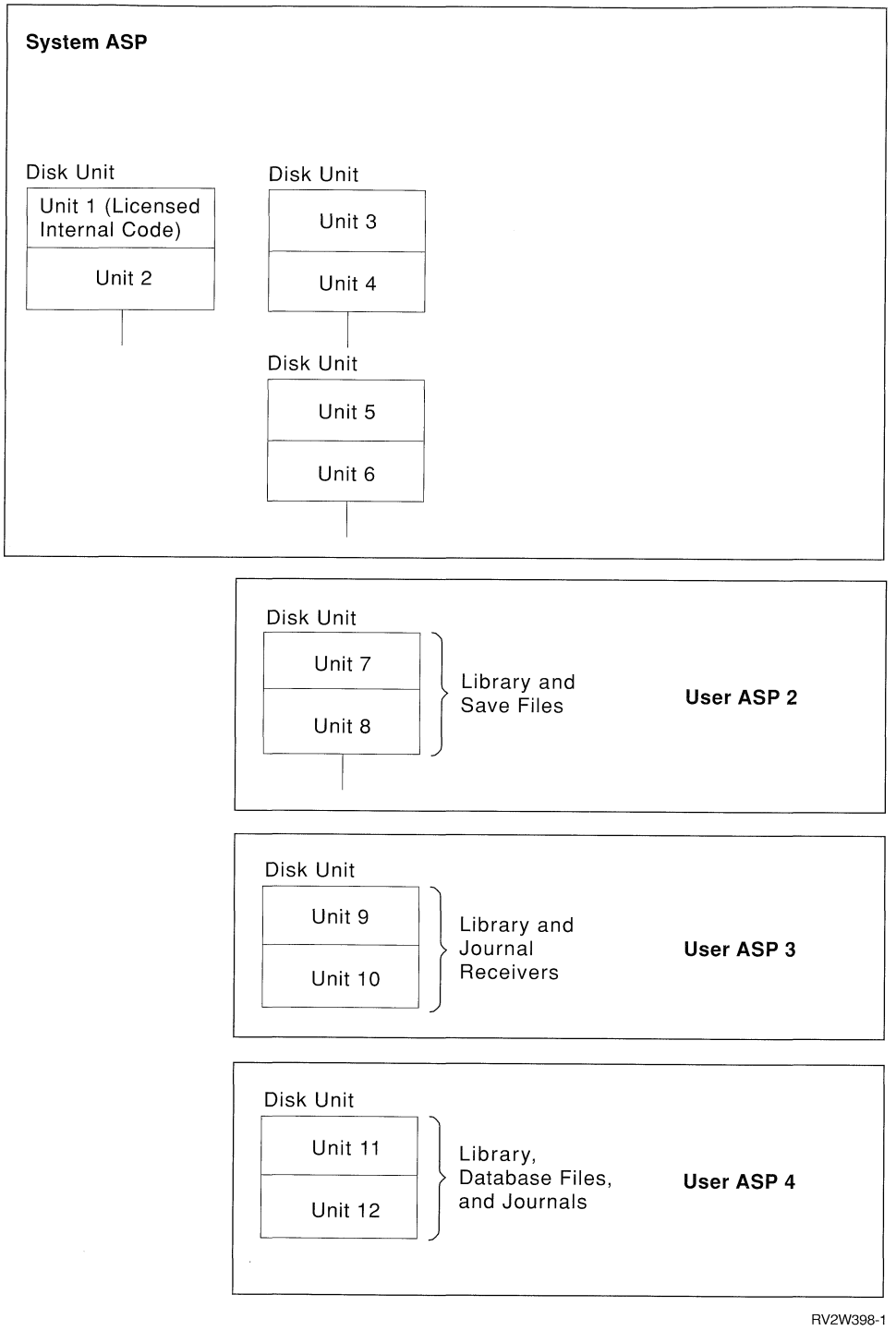


Figure 12-3. Example of System and User ASP Configuration

When planning your user ASP configuration, you must first consider what objects to place in each user ASP. The following list can help you determine the appropriate number of user ASPs for your system:

Recovery: If you are using user ASPs for recovery, configure at least one complete storage device for a single user ASP. Some 9332 or 9335 disk unit failures can damage both storage units in the disk unit. If this type of failure occurs, and the two units are in different unprotected ASPs, you would lose the data on both

ASPs. If you configure one unit in the system ASP containing data files, and the second unit as a user ASP containing the journal receiver, a single device failure could destroy both the data files and journal entries for the file. The exceptions to this rule are the 2800, 9336, and 6107 disk units. The storage units within the 2800, 9336, 9337 models 110 and 120, or 6107 models 20 and 40 disk units are independent of each other.

Improved system performance only: If you are using user ASPs for better system performance, consider dedicating the ASP to one object that is very active. In this case, you can configure the ASP with only one disk unit. It is not recommended that you assign one storage unit to an ASP unless the disk unit type is a 9336 or a 9337 models 110 and 120.

For example, journaling performance can be improved by allocating one user ASP exclusively for journal receivers attached to the same journal. By having the journal and database files in a separate ASP from the attached receivers, there is no contention for journal receiver write operations because the units associated with the ASP do not have to be repositioned before each read or write operation.

Another way to improve performance is to make sure there are enough storage units in the user ASP to support the number of physical input and output operations that are done against the objects in the user ASP. You may have to experiment by moving objects to a different user ASP and then monitoring performance in the user ASP to see if the storage units are used excessively. For more information on working with disk status (WRKDSKSTS command) to determine if the storage units have excessive use, see the *Work Management Guide*. If the units have excessive use, you should consider adding more disk units to the user ASP.

Extensive journaling: If journals and files being journaled are in the same ASP as the receivers and the ASP overflows, you must end journaling of all files and delete all objects in the ASP before clearing the overflowed ASP. However, other recovery procedures, such as deleting unused objects or moving objects to a different ASP, should be tried before clearing the overflowed ASP. If the journal receiver is in a different ASP than the journal, and the user ASP that the receiver is in overflows, you can create a new receiver in a different user ASP, change the journal (CHGJRN command), save the detached receiver, delete it, and then clear the overflowed ASP without ending journaling.

Access path journaling: If you plan to use access path journaling, it is recommended that you first change the journal to a journal receiver in the system ASP (ASP 1) for a few days. Start access path journaling to see storage requirements for the receiver before you allocate the specific size for a user ASP.

User ASPs can be configured with more than one storage unit. The maximum number of storage units allowed is determined by the maximum allowed for the entire system. User ASPs are configured and identified by a user-assigned number, from 2 through 16, and are assigned using the DST Work with ASP Configuration display. The *Advanced Backup and Recovery Guide* has more information on how to create a user ASP and add disk units to the new user ASP.

Meeting Storage Requirements

There are several ways to obtain storage. The following list describes the ways to obtain storage. The first is the most preferable only if the save and restore is avoided. Otherwise, the first and second are the same.

- You can reconfigure some of the storage units in the system ASP. If checksum protection is in effect, you may have units in the checksum protected system ASP that are not eligible to participate in checksum sets. For more information on checksum protection, see the *Advanced Backup and Recovery Guide*.

  Because these units cannot contain data from protected storage, they are probably of limited value in the system ASP that has checksum protection. You can make better use of these units by moving them into user ASPs. The advantages of this reconfiguration include:

  - No additional disks need to be purchased to form the user ASP.
  - A save and restore operation of the ASP that has checksum protection **is not** required to accomplish the reconfiguration.

- You can move a unit from the system or user ASP. This method **does not** require that you save and restore the ASP from which the unit is taken. No additional equipment is required.
- You can purchase new disks and add storage units to your existing user ASPs, or configure them into new user ASPs.

If you choose to reassign a unit from one ASP to another, you must carefully consider the effect that it does have on the capacity of both ASPs. After reviewing the system disk configuration, you must determine which disk units are candidates for reassignment.

Determine the effect of removing disk units from the source ASP by considering the space requirements for the objects to be stored in the source ASP and target user ASPs:

- The current storage requirements for an ASP can be determined from the SST Display Disk Configuration Capacity display.
- If you are planning to start checksum protection for an ASP, consider checksum disk requirements. Checksum protection requires that like types of disk units be grouped in minimum sets of two and can decrease the amount of disk storage available in the ASP. For more information on checksum protection, see "Working with Checksum Protection" in the *Advanced Backup and Recovery Guide*.
- If you are planning to start mirrored protection for an ASP, consider the disk requirements for mirrored protection. Mirrored protection increases the number of disk units required to provide a given amount of disk storage. The topic "Calculating Mirrored Capacity" in the *Advanced Backup and Recovery Guide*, SC41-8079, has more information on disk unit requirements for mirrored protection.
- Determine storage requirements for objects you intend to create in user ASPs by running test applications, programs, or commands and observing the disk space used. From those observations, you can determine overall storage requirements for the target user ASPs.

- If you are going to use checksum or mirrored protection on the system ASP, you must have a sufficient number of storage units to allow for good system performance.

Overview of SST and DST Options

Disk unit storage management procedures are available through system service tools (SST) and dedicated service tools (DST). The SST options are a subset of the DST options.

Full function for Work with Disk Unit options is available only through DST before the IPL step for Storage Management Recovery is started. Once Storage Management Recovery is started, the Work with Disk Units options available through DST are identical to the SST subset of options.

System service tools (SST) and dedicated service tools (DST) provide menus for you to use to display and to change your disk configuration. This topic describes the menus and the procedures to use when working with auxiliary storage pools, checksum protection, and mirrored protection. Some of the disk functions can be done by service personnel. Other functions can be performed by you:

- Display Disk Configuration display:
  - Display disk configuration status
  - Display disk configuration capacity
  - Display disk configuration protection
  - Display nonconfigured units
  - Display device parity status
- Work with ASP Configuration display:
  - Display disk configuration capacity
  - Create user ASP
  - Delete user ASP
  - Add disk units to ASP
  - Delete ASP data
  - Change ASP storage threshold
  - Move unit from one ASP to another
  - Remove unit from configuration
- Work with Checksum Protection display:
  - Display checksum configuration
  - Start checksum protection
  - Stop checksum protection
  - Change unprotected storage
  - Calculate checksum configuration
- Work with Mirrored Protection display:
  - Display disk configuration
  - Start mirrored protection
  - Stop mirrored protection
  - Calculate mirrored capacity
- Work with Device Parity Protection display:
  - Display device parity status
  - Prepare to start device parity protection

- Prepare to stop device parity protection

The following functions are performed by or under the direction of the service representative to analyze and correct hardware problems.

- Analyze disk problem
- Work with Disk Unit Recovery display:
  - Save disk unit data
  - Restore disk unit data
  - Replace configured unit
  - Assign missing unit
  - Recover configuration
  - Disk unit recovery procedures
  - Suspend/resume mirrored protection
  - Copy disk unit data
  - Delete disk unit data
  - Upgrade load source utility
- Work with Disk Unit Information display:
  - Work with vital product data
  - Work with field replacement unit data

Accessing SST Options

SST options are started using the Start System Service Tools (STRSST) command or through the following displays:

- AS/400 Main Menu
- Problem Handling
- SST
- Work with Disk Units from SST menu

The Work with Disk Units display from SST is a different display than the DST full function display because it shows only those options allowed under SST. Figure 12-4 shows the Work with Disk Units display.

```
                          Work with Disk Units

Select one of the following:

    1.  Display disk configuration
    2.  Display checksum configuration
    3.  Calculate checksum configuration
    4.  Work with ASP storage threshold
    5.  Work with disk unit recovery
    6.  Work with disk information
    7.  Calculate mirrored capacity
```

Figure 12-4. Work with Disk Units Display for SST Options

Use SST when your system has already been installed and you want to display your disk configuration, display your checksum configuration (if you have checksum protection), calculate a checksum configuration, plan a system with mirrored protection, or display, change, or calculate storage thresholds. If your system has mirrored protection, you can also suspend or resume mirrored protection and perform other recovery procedures.

Accessing DST Options

The DST options are started manually during an IPL of the system. Because full DST functions are only available during IPL processing, you must first power down your system, if it is currently running, before starting the IPL procedure.

1. Notify the users to sign off the system by sending a break message.
2. Change the QSYSOPR message queue to break mode:

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(60)
   ```

3. End all subsystems:

   ```
   ENDSBS SBS(*ALL) OPTION(*IMMED)
   ```

   Wait until a message is sent to the QSYSOPR message queue indicating that all subsystems have ended and the system is in a restricted state.
4. Ensure the key is in the keylock switch on the control panel.
5. Turn the key until it points to the Manual position.
6. Power down the system:

   ```
   PWRDWNSYS OPTION(*IMMED) RESTART(*YES) IPLSRC(B)
   ```

7. When the system has powered down and then powered back up, the IPL or Install the System display appears.

```
                        IPL or Install the System

Select one of the following:

          1. Perform an IPL
          2. Install the operating system
          3. Use Dedicated Service Tools (DST)
          4. Perform automatic installation of the operating system
```

8. Select option 3 (Use Dedicated Service Tools (DST)) on the IPL or Install the System menu and press the Enter key. The Dedicated Service Tools (DST) Sign On display is shown.

```
                  Dedicated Service Tools (DST) Sign On

Type choice, press Enter.

  DST password . . . . . . . . .  _____
```

9. Sign on DST with the DST security-level or full-level password. *Security Reference*, SC41-8083, has more information about DST passwords.

   The Use Dedicated Service Tools (DST) menu is shown.

```
                    Use Dedicated Service Tools (DST)

Select one of the following:

          1. Perform an IPL
          2. Install the operating system
          3. Work with licensed internal code
          4. Work with disk units
          5. Work with DST environment
          6. Select DST console mode
          7. Start a service tool
          8. Perform automatic installation of the operating system
          9. Work with save storage and restore storage




Selection
     —

F3=Exit           F12=Cancel
```

Adding Units to an Existing ASP

This example adds a new disk unit to the system ASP or a user ASP that does not have checksum or mirrored protection.

Warning: A sufficient number of 2800-001 or 2801-001 storage units must be configured to the system ASP (ASP1) to allow for enough main storage dump space. (See note 3 on page 12-10.)

Your service representative attaches the new disk unit. The new unit is in nonconfigured status.

Task Overview

You will perform the following steps during this task

1. Access DST
2. Display Disk Configuration
3. Add Unit to existing ASP

Task 1. Access DST Options

1. Notify the users to sign off the system by sending a break message.
2. Change the QSYSOPR message queue to break mode:

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(60)
   ```

3. End all subsystems:

   ```
   ENDSBS SBS(*ALL) OPTION(*IMMED)
   ```

   Wait until a message is sent to the QSYSOPR message queue indicating that all subsystems have ended and the system is in a restricted state.

4. Ensure the key is in the keylock switch on the control panel.
5. Turn the key until it points to the Manual position.
6. Power down the system:

   ```
   PWRDWNSYS OPTION(*IMMED) RESTART(*YES) IPLSRC(B)
   ```

7. When the system has powered down and then powered back up, the IPL or Install the System display appears.

```
                        IPL or Install the System

Select one of the following:

          1. Perform an IPL
          2. Install the operating system
          3. Use Dedicated Service Tools (DST)
          4. Perform automatic installation of the operating system
```

8. Select option 3 (Use Dedicated Service Tools (DST)) on the IPL or Install the System menu and press the Enter key. The Dedicated Service Tools (DST) Sign On display is shown.

```
                    Dedicated Service Tools (DST) Sign On

Type choice, press Enter.

  DST password . . . . . .  _____
```

9. Sign on DST with the DST security-level or full-level password. *Security Reference*, SC41-8083, has more information about DST passwords.

   The Use Dedicated Service Tools (DST) menu is shown.

```
                    Use Dedicated Service Tools (DST)

Select one of the following:

          1. Perform an IPL
          2. Install the operating system
          3. Work with licensed internal code
          4. Work with disk units
          5. Work with DST environment
          6. Select DST console mode
          7. Start a service tool
          8. Perform automatic installation of the operating system
          9. Work with save storage and restore storage




Selection
     —

F3=Exit           F12=Cancel
```

Task 2. Display the Disk Configuration

You will use the information in step 6 when adding the units to the existing ASP.

1. Select option 4 (Work with disk units) on the Use Dedicated Service Tools menu.

```
                          Work with Disk Units

Select one of the following:

     1. Work with disk configuration
     2. Analyze disk device problem
     3. Work with disk unit recovery
     4. Work with disk unit information
```

2. Select option 1 (Work with disk configuration) on the Work with Disk Units display after the disk is attached.

```
                      Work with Disk Configuration

Select one of the following:

     1. Display disk configuration
     2. Work with ASP threshold
     3. Work with ASP configuration
     4. Work with checksum protection
     5. Work with mirrored protection
     6. Work with device parity protection
```

3. Select option 1 (Display disk configuration) on the Work with Disk Configuration display.

```
                        Display Disk Configuration

Select one of the following:

     1. Display disk configuration status
     2. Display disk configuration capacity
     3. Display disk configuration protection
     4. Display non-configured units
     5. Display device parity status
```

Note: Disk units on the system are either configured or nonconfigured. Options 1, 2, and 3 on the Display Disk Configuration display show information about the configured units. Option 4 shows the nonconfigured units attached to the system. When you physically attach a unit to the system, it becomes part of the nonconfigured set until you place it in an ASP. Option 5 shows the status of disk units that are using device parity protection.

4. Select option 1 (Display disk configuration status) and press the Enter key.

```
                    Display Disk Configuration Status

                Serial
ASP  Unit       Number      Type  Model  Address         Status
 1                                                      Unprotected
       1    10-00A7529  9332   400   0010-0000FFFF  Configured
       2    10-00A7529  9332   400   0010-0001FFFF  Configured
       3    10-00A4936  9332   400   0010-0100FFFF  Configured
       4    10-00A4936  9332   400   0010-0101FFFF  Configured
       5    10-00A7498  9332   400   0010-0300FFFF  Configured
       6    10-00A7498  9332   400   0010-0301FFFF  Configured
       7    10-00A7530  9332   400   0010-0400FFFF  Configured
       8    10-00A7530  9332   400   0010-0401FFFF  Configured




Press Enter to continue.

F3=Exit   F5=Refresh  F11=Display disk configuration capacity  F12=Cancel
```

The following fields appear on the Display Disk Configuration Status display:

- *ASP*. The auxiliary storage pool number.
- *Unit*. The number assigned by the system to identify a specific disk unit.
- *Serial Number*. The number assigned by the manufacturer to identify a specific disk unit.
- *Type*. The number assigned by the manufacturer to identify a type of disk unit.
- *Model*. The numbers or letters used to identify the feature level of a specific product type.
- *Address*. Identifies the following:

  - Location of the storage device controller card (columns 1 through 4)
  - Functional controller for the disk unit (columns 5 and 6)
  - Disk unit itself (columns 7 and 8)
  - FFFF (columns 9 through 12)

- *Status*. The valid values for this field are:
  - For ASPs:
    - *Unprotected*. No software protection exists for this ASP.
    - *Checksummed*. The units in the ASP are protected by checksum protection if the units are a part of a checksum set.
    - *Mirrored*. Some or all the units in the ASP are protected by mirrored protection. Any unit in a disk unit subsystem that has device parity protection does not participate in mirrored protection provided by the software.

    Note: An ASP that is unprotected or has mirrored protection may contain units with device parity protection. The *Status* field for the unit shows if the ASP contains units with device parity protection. The *Status* field for the ASP shows the level of protection (unprotected or mirrored) for the ASP.
  - For units in an unprotected ASP.
    - *Configured*.
    - *Device parity*.

      The valid status values for the storage units with device parity protection are:

      DPY/Active. Indicates that this unit is part of a disk unit subsystem that has device parity protection. This unit is fully operational.

      DPY/Failed. Indicates that this unit is part of a disk unit subsystem that has device parity protection. This unit has failed. If another unit in the disk unit subsystem fails, data could be lost.

      DPY/Rebuild. Indicates that this unit is part of a disk unit subsystem that has device parity protection. The data on this unit is being rebuilt from other units in the disk unit subsystem. If another unit in the disk unit subsystem fails, data could be lost.

      DPY/Unprotected. Indicates that this unit is part of a disk unit subsystem that has device parity protection. This unit is operational. However, another unit in the disk unit subsystem has failed or is being rebuilt. If another unit in the disk unit subsystem fails, data could be lost.

      DPY/HDW Failure. Indicates that this unit is part of a disk unit subsystem that has device parity protection. A hardware-related failure has occurred. The failure does not affect data or performance. However, an exposure to an outage exists if another failure of a redundant component, such as a power supply, occurs.

DPY/Degraded. Indicates that this unit is part of a disk unit subsystem that has device parity protection. A decrease in performance has occurred because a component that is not critical has failed. The failed component needs to be repaired or replaced.

DPY/Power Loss. Indicates that this unit is part of a disk unit subsystem that has device parity protection. This unit has lost power.

DPY/Not Ready. Indicates that this unit is part of a disk unit subsystem that has device parity protection. The unit is not ready to perform I/O operations.

DPY/Unknown. Indicates that this unit is part of a disk unit subsystem that has device parity protection. The status of this unit is not known to the system.

- For units in an ASP that has checksum protection.
  - *Checksummed.* Indicates that the unit is part of a checksum set.
  - *Configured.* Indicates that the unit is not part of a checksum set.
- For units in a mirrored ASP.
  - *Active.* This unit is capable of having data written to it, or read from it.
  - *Suspended.* This unit is not capable of having data written to it, or read from it. The data on this unit is not current. For example, if the disk needs repair action or has been manually suspended, it would be in a *Suspended* state.
  - *Resuming.* The current data is being copied (or will be copied) to this unit from the other active unit of the mirrored pair.
  - *Unknown.* The system configuration mechanism cannot determine what the valid configuration should be.

Note: Units in an ASP with mirrored protection can have device parity protection. However, these units do not participate in the mirrored protection provided by the system software.

5. Press F11 (Display non-configured unit) three times to display non-configured units.

```
                    Display Non-Configured Units

Serial
Number       Type   Model   Address          Status
10-00A7503   9332    400    0010-0100FFFF    Non-configured
10-00A7503   9332    400    0010-0101FFFF    Non-configured
10-00A3651   9332    400    0010-0400FFFF    Non-configured
10-00A3651   9332    400    0010-0401FFFF    Non-configured
```

6. Write down the serial number and address of the units that you are going to use.

7. Return to the Work with Disk Configuration display by pressing F12 (Cancel) two times.

```
                    Work with Disk Configuration

Select one of the following:

     1. Display disk configuration
     2. Work with ASP threshold
     3. Work with ASP configuration
     4. Work with checksum protection
     5. Work with mirrored protection
     6. Work with device parity protection
```

Task 3. Add Units to an Existing ASP

1. Select option 3 (Work with ASP configuration) on the Work with Disk Configuration display.

```
                        Work with ASP Configuration

Select one of the following:

     1. Display disk configuration capacity
     2. Create user ASP
     3. Delete user ASP
     4. Add units to existing ASP
     5. Delete ASP data
     6. Change ASP storage threshold
     7. Move units from one ASP to another
     8. Remove units from configuration
```

2. Select option 4 (Add units to existing ASP) on the Work with Disk Configuration display.

```
                      Specify ASPs to Add Units to

Specify the ASP to add each unit to.

Specify  Serial
  ASP    Number       Type  Model  Address
   __    10-00A7503   9332    400    0010-0100FFFF
   __    10-00A7503   9332    400    0010-0101FFFF
   __    10-00A3651   9332    400    0010-0400FFFF
   __    10-00A3651   9332    400    0010-0401FFFF
```

3. Enter the ASP number on the Specify ASPs to Add Units to display and press the Enter key.

   Use the serial number of the units you wrote down when you displayed the nonconfigured units to select the units to place within the specified ASP.

   Note: Storage units within the same replaceable disk unit may have the same serial number.

```
                              Confirm Add Units

Add will take several minutes for each unit.  The system will
have the displayed protection after the unit(s) are added.

Press F9=Capacity Information to display the resulting capacity.
Press Enter to confirm your choice for 1=Add units.
Press F12=Cancel to return and change your choice.


             Serial
 ASP  Unit   Number       Type  Model  Address          Protection       CSS
  2                                                    Unprotected
        9    10-00A3651   9332   400   0010-0400FFFF    Unprotected
       10    10-00A3651   9332   400   0010-0401FFFF    Unprotected
```

The Confirm Add Units display shows what the entire system configuration will be when you add the units. Use the serial number of the unit you wrote down when you displayed the disk configuration to verify that you are selecting the correct units to add to the ASP.

4. If you are satisfied with the configuration, press the Enter key to add the disk units to the ASP.

   Adding units can take from several minutes to several hours. During that time, the the system may appear inactive. The time it takes the system to add units depends on the type, model, and size of each unit being added and the ability of the system to do multiple adds at the same time.

5. If you have no other DST functions to perform, press F3 (Exit) until you return to the Use Dedicated Service Tools (DST) menu.
6. Select option 1 (Perform an IPL) on the Use Dedicated Service Tools (DST) menu and press the Enter key.
7. Select option 1 (Perform an IPL) on the IPL or Install the System menu and press the Enter key.

Chapter 13. Working with Disk Recovery

In many cases, a disk unit failure can be corrected by your service representative so that you can continue operations without replacing the disk. Replacing a disk requires a dedicated system and a special IBM program to copy the contents of the disk to either offline media and then back again to the new disk, or directly to the new disk. If data cannot be read, the system may not be able to recover it. In that case, use the OS/400 setup procedure after the disk is prepared and then restore the entire system from your save media using the restore commands. In some cases, the special program is only partially successful because it can correctly copy only some sectors of a disk. The sectors that the program cannot read are reset to zero. Sectors that are reset to zero can produce results that cannot be predicted.

Types of Disk Damage: If you choose to continue operating, the next initial program load (IPL) of your system checks for sectors that were reset to zero and attempts to determine the objects to which they belong. There are two possible types of damage:

- Damage detected by the OS/400 licensed program. The system determines the damaged object, and the damage is marked in the object. Messages are sent to QHST to identify damaged objects. A single message (CPF8196 or CPF8197) is sent to QSYSOPR to notify the system operator that there are messages in QHST about objects that have been damaged.
- Damage not known to the OS/400 licensed program. The system is unable to determine which object was damaged. No message is sent. If you attempt to use this object, the system detects the damage and the object is marked as damaged.

If you try to use either type of damaged object, a damage exception occurs.

See the topic "How the Save Operation Handles Damage" on page 9-2, or "How the Restore Operation Handles Damage" on page 9-3 for more information.

Damage When Checksum or Mirrored Protection Is in Effect: The *Advanced Backup and Recovery Guide*, SC41-8079, has information about recovering from disk unit failures when checksum or mirrored protection is in effect, or when user auxiliary storage pools (ASPs) are used.

Disk recovery has to do with recovering from the loss of data due to failures of the storage media contained within disk units. This chapter describes functions you can use to shorten the time it takes to recover from such failures and minimize the loss of data.

Use the following recovery functions to provide protection from disk failure:

- **Auxiliary storage pools** (ASPs). ASPs allow you to control where certain types of objects are stored on auxiliary storage devices, thus allowing you to isolate libraries and certain objects on physical disk devices of your choice. This isolation protects the libraries and objects from losing data due to disk media failures occurring in other ASPs.
- **Checksum protection**. This protects data stored in an ASP from the failure of a single disk. The system automatically reconstructs data after the disk is replaced. This protection is available for the system and user ASPs.

- **Mirrored protection**. This protects data stored in an ASP from the failure of a single unit that has mirrored protection by storing identical data on another disk unit in the same user ASP. If one of the mirrored units in the mirrored pair fails, the system automatically uses the remaining unit of the mirrored pair until the failed unit can be repaired or replaced.
- **Device parity protection**. This protects data stored in an ASP if a single storage unit fails as long as all disk units in the ASP have device parity protection. The disk unit controller automatically reconstructs the data after the failed unit is repaired or replaced. The *Advanced Backup and Recovery Guide* has more information about device parity protection.

Summary of Disk Recovery Actions

The recovery actions performed by the service representative and you are provided here for your information. **This discussion applies to a disk failure in an ASP when checksum protection, mirrored protection, or device parity protection is not in effect.**

Attention!

If a disk unit in your system fails, your service representative determines whether data loss has occurred. Depending on the amount of data loss that has occurred, you and the service representative may decide that it is impractical to save and restore the data onto a replacement device and try to run your system.

When saving data from a disk unit that failed, data from unreadable sectors is not saved. If you restore the data from the tape to the system and then perform an IPL, you may have some damaged objects on the system.

If the unreadable sector is part of an object description, the object may be unusable. If the sector is part of the data in a file, the file may still be usable except for the records on the sector that were reset to zero. You may have to restore the entire system. Discuss the situation with your service representative. If you decide to use this save media as part of a recovery, **you do so at your own risk**.

There are eight recovery scenarios. If your disk media failure is:

- The load source unit and no unreadable sectors exist on the failed unit, go to "Case 1. Load Source Unit Failure with No Data Loss" on page 13-4.
- The load source unit and some unreadable sectors exist on the failed unit, go to "Case 2. Load Source Unit Failure with Some Unreadable Sectors" on page 13-5.
- The load source unit and all sectors are unreadable on the failed unit, go to "Case 3. Load Source Unit Failure with All Sectors Unreadable" on page 13-6.
- A non-load source unit in the system ASP or a disk unit in a user ASP and no unreadable sectors exist on the failed unit, go to "Case 4. Non-Load Source Unit Failure with No Data Loss" on page 13-7.
- A non-load source unit in the system ASP and some unreadable sectors exist on the failed unit, go to "Case 5. Failure in the System ASP with Some Unreadable Sectors" on page 13-8.

- A non-load source unit in the system ASP all sectors are unreadable on the failed unit, go to "Case 6. Failure in the System ASP with All Sectors Unreadable" on page 13-10.
- A disk unit in a user ASP and some unreadable sectors exist on the failed unit, go to "Case 7. Failure in a User ASP with Some Unreadable Sectors" on page 13-11.
- A disk unit in a user ASP and all sectors are unreadable on the failed unit, go to "Case 8. Failure in a User ASP with All Sectors Unreadable" on page 13-12.

Details of the actions performed by the service representative are not discussed in this guide.

Case 1. Load Source Unit Failure with No Data Loss

Actions Performed by the Service Representative

1. Save the disk unit data.
2. Attach the new disk unit.
3. Install the Licensed Internal Code using function code 24 (Install) to the load source unit.

   Note: If you have a 2440 tape unit with the high-speed feature enabled, it must be disabled before installing the Licensed Internal Code. See "Disabling and Enabling the High-Speed Feature on the 2440 Tape Unit" on page 10-18 for the procedure to disable the high-speed feature on the 2440 tape unit.
4. Restore the disk unit data.
5. Perform an IPL.

Summary of Customer Actions

If journaling is used on the system, recovery may be required after an abnormal system end. See the *Advanced Backup and Recovery Guide* for more information about journaling.

Case 2. Load Source Unit Failure with Some Unreadable Sectors

Attention!

When a sector is damaged, there is no way to identify which objects are damaged. Before you continue, read "Recovering from Unreadable Sectors during a Disk Unit Failure" on page 13-74 for more information about recovering from unreadable sectors.

Actions Performed by the Service Representative

1. Save the disk unit data.

   Attention!

   When data is saved from the disk unit, data from unreadable sectors is not saved. If you restore the data from the tape to the system and then perform an IPL, you may have some damaged objects on the system.

   If the unreadable sector is part of an object description, the object may be unusable. If the sector is part of the data in a file, the file may still be usable except for the records on the sector that were reset to zero. You may have to restore the entire system. Discuss the situation with your service representative. If you decide to use this save media as part of a recovery, **you do so at your own risk**.

2. Attach the new disk unit.
3. Install the Licensed Internal Code using function code 24 (Install) on the load source unit.

   Note: If you have a 2440 tape unit with the high-speed feature enabled, it must be disabled before installing the Licensed Internal Code. See "Disabling and Enabling the High-Speed Feature on the 2440 Tape Unit" on page 10-18 for the procedure to disable the high-speed feature on the 2440 tape unit.

4. Restore the disk unit data.
5. Perform an IPL.

Summary of Customer Actions

1. Restore the operating system.

   Note: You may have some OS/400 objects that are damaged. You may be required to install the operating system again.

2. End all subsystems.
3. Reclaim storage.

   Note: If there are too many damaged objects, you may not be able to reclaim storage. You may be required to restore the entire system again.

4. If damaged objects were found, restore them from the most recent save media.

To restore the operating system, see "Procedure for Restoring the OS/400 Licensed Program" on page 10-24.

To end subsystems and reclaim storage, see "Task 5. Reclaim Storage" on page 13-25.

Case 3. Load Source Unit Failure with All Sectors Unreadable

Actions Performed by the Service Representative

1. Attach the new disk unit.
2. Install the Licensed Internal Code using function code 24 (Install).

   Note: If you have a 2440 tape unit with the high-speed feature enabled, it must be disabled before installing the Licensed Internal Code. See "Disabling and Enabling the High-Speed Feature on the 2440 Tape Unit" on page 10-18 for the procedure to disable the high-speed feature on the 2440 tape unit.
3. Recover the configuration using the *Recover Configuration* option on the Work with Disk Units display. User ASPs remain intact.
4. Perform an IPL.

Summary of Customer Actions

1. Restore the operating system.
2. Reclaim storage.
3. Restore user profiles.
4. Restore device configuration.
5. Restore the user libraries.
6. Restore document library objects.
7. If you have changed objects to restore, continue with step 7. Otherwise go to step 11.
8. Restore changed objects.
9. Apply journaled changes.
10. If you have document library objects that you saved daily, restore them. Otherwise, go to step 11.
11. Restore authority.

For the procedure to recover the system ASP without user ASPs configured, see "Recovering the System ASP without User ASPs Configured" on page 13-12.

For the procedure to recover the system ASP with user ASPs configured, see "Recovering the System ASP with User ASPs Configured" on page 13-44.

Case 4. Non-Load Source Unit Failure with No Data Loss

This case applies to a failure of a non-load source unit in the system ASP or disk unit failure in a user ASP. No unreadable sectors exist on the failed disk unit.

Actions Performed by the Service Representative

1. Attach a new disk unit.
2. Restore data to the new disk unit.
3. Perform an IPL.

Summary of Customer Actions

If journaling is used on the system, recovery may be required after an abnormal system end. See the *Advanced Backup and Recovery Guide* for more information about journaling.

Case 5. Failure in the System ASP with Some Unreadable Sectors

This case applies to a non-load source disk unit failure in the system ASP.

> **Attention!**
>
> When a sector is damaged, there is no way to identify which objects are damaged. Before you continue, read "Recovering from Unreadable Sectors during a Disk Unit Failure" on page 13-74 for more information about recovering from unreadable sectors.

Actions Performed by the Service Representative

1. Save the disk unit data.

   > **Attention!**
   >
   > When data is saved from the disk unit, data from unreadable sectors is not saved. If you restore the data from the tape to the system and then perform an IPL, you may have some damaged objects on the system.
   >
   > If the unreadable sector is part of an object description, the object may be unusable. If the sector is part of the data in a file, the file may still be usable except for the records on the sector that were reset to zero. You may have to restore the entire system. Discuss the situation with your service representative. If you decide to use this save media as part of a recovery, **you do so at your own risk**.

2. Attach the new disk unit.
3. Restore the disk unit data.
4. Restore the Licensed Internal Code using function code 23 (Restore).

   Note: If you have a 2440 tape unit with the high-speed feature enabled, it must be disabled before restoring the Licensed Internal Code. See "Disabling and Enabling the High-Speed Feature on the 2440 Tape Unit" on page 10-18 for the procedure to disable the high-speed feature on the 2440 tape unit.

5. Perform an IPL.

Summary of Customer Actions

1. Restore the operating system.

   Note: You may have some OS/400 objects that are damaged. You may be required to install the operating system again.

2. End all subsystems.
3. Reclaim storage.

   Note: If there are too many damaged objects, you may not be able to reclaim storage. You may be required to restore the entire system again.

4. If damaged objects were found, restore them from the most recent save media.

To restore the operating system, see "Procedure for Restoring the OS/400 Licensed Program" on page 10-24.

To end the subsystems and reclaim storage, see "Task 5. Reclaim Storage" on page 13-25.

Case 6. Failure in the System ASP with All Sectors Unreadable

Actions Performed by the Service Representative

1. Attach the new disk unit.
2. Delete the ASP data.
3. Restore the Licensed Internal Code using function code 23 (Restore). If user ASPs are configured, they remain intact.

   Note: If you have a 2440 tape unit with the high-speed feature enabled, it must be disabled before restoring the Licensed Internal Code. See "Disabling and Enabling the High-Speed Feature on the 2440 Tape Unit" on page 10-18 for the procedure to disable the high-speed feature on the 2440 tape unit.

Summary of Customer Actions

1. Restore the operating system.
2. End all subsystems.
3. Reclaim storage.
4. Restore user profiles.
5. Restore device configuration.
6. Restore user libraries.
7. Restore document library objects.
8. If you have changed objects to restore, continue with step 8. Otherwise, continue with step 12.
9. Restore changed objects.
10. Apply journaled changes.
11. If you have document library objects that you saved daily, restore them. Otherwise, continue with step 12.
12. Restore authority.

For the procedure to recover the system ASP without user ASPs configured, see "Recovering the System ASP without User ASPs Configured" on page 13-12.

For the procedure to recover the system ASP with user ASPs configured. see "Recovering the System ASP with User ASPs Configured" on page 13-44.

Case 7. Failure in a User ASP with Some Unreadable Sectors

Actions Performed by the Service Representative

Attention!

When a sector is damaged, there is no way to identify which objects are damaged. Before you continue, read "Recovering from Unreadable Sectors during a Disk Unit Failure" on page 13-74 for more information about recovering from unreadable sectors.

1. Save the disk unit data.

   Attention!

   When data is saved from the disk unit, data from unreadable sectors is not saved. If you restore the data from the tape to the system and then perform an IPL, you may have some damaged objects on the system.

   If the unreadable sector is part of an object description, the object may be unusable. If the sector is part of the data in a file, the file may still be usable except for the records on the sector that were reset to zero. You may have to restore the entire system. Discuss the situation with your customer. If you decide to use this save media as part of a recovery, **you do so at your own risk**.

2. Attach the new disk unit.
3. Restore the disk unit data.
4. Perform an IPL.

Summary of Customer Actions

1. End all subsystems.
2. Reclaim storage.

   Note: If there are too many damaged objects, you may not be able to reclaim storage. You may be required to restore the entire user ASP again.

3. If damaged objects were found, restore them from the most recent save media.

To end the subsystems and reclaim storage, see "Task 5. Reclaim Storage" on page 13-25.

Case 8. Failure in a User ASP with All Sectors Unreadable

Actions Performed by the Service Representative

1. Attach the new disk unit.
2. Delete the ASP data.
3. Perform an IPL.

Summary of Customer Actions

ASP was in Overflowed Status

1. End all subsystems.
2. Reclaim storage.
3. Delete objects in the ASP.
4. Restore user profiles.
5. Restore objects to the ASP.
6. Restore authority.

ASP was not in Overflowed Status

1. Restore user profiles.
2. Restore objects to the ASP.
3. Restore authority.

For the procedures to perform the following, see "Recovering from a Disk Media Failure in a User ASP" on page 13-70.

Recovering the System ASP without User ASPs Configured

This example describes how to recover from a media disk failure in the system ASP when checksum, mirrored protection, or device parity protection is not in effect, and no user ASPs are configured. It assumes that you have saved your system by using the SAVSYS, SAVLIB(*NONSYS or *IBM and *ALLUSR), and SAVDLO commands, and that you have a complete backup copy of the system. This information is required to restore the system after a failure.

If a unit in the system ASP fails, as described above, you and your service representative determine whether it should be treated as a disk unit media failure. If this is the case, the service representative will replace the failed disk. As a result, the system will clear all units allocated to the system ASP (all objects in the system ASP are destroyed).

After the service representative replaces the failed disk, the Licensed Internal Code is installed or restored. The following procedure assumes that the Licensed Internal Code has been installed or restored and the service representative has recovered the disk configuration using the Recover configuration option in Dedicated Service Tools (DST), if necessary.

Task Overview

You will perform the following tasks during this procedure:

1. Start the restore of the Operating System.
2. Select install options.
3. Select IPL options.
4. Recover from SRC A900 2000, if necessary.
5. Reclaim storage.
6. Restore the remaining parts of the system.
7. Restore changed objects and apply journaled changes.

Note: This procedure assumes the service representative has installed or restored the Licensed Internal Code. If you have not read the disk recovery summary information, go to "Summary of Disk Recovery Actions" on page 13-2 before you perform the following procedure.

Task 1. Start Restoring the Operating System

You use two displays to select the install options. The IPL or Install the System display allows you to restore the operating system or work with the service tools. The Install the Operating System display allows you to set the options to be used for restoring the system, and for the system date and time.

1. At the IPL or Install the System menu:

```
                        IPL or Install the System

Select one of the following:

          1. Perform an IPL
          2. Install the operating system
          3. Use Dedicated Service Tools (DST)
          4. Perform automatic installation of the operating system
```

2. Type a 2 (Install the operating system).

   Note: **Do not** use option 4 (Perform automatic installation of the operating system) to restore the operating system.

3. Press the Enter key.

   The Confirm Install of the Operating System display is shown.

```
                    Confirm Install of Operating System

Press Enter to confirm your choice to install the operating system.
Press F12 to return and cancel your choice to install the
  operating system.
```

4. Press the Enter key.
5. The following display **may** be shown if your system is set up to prevent unauthorized installation of the operating system:

```
                    Dedicated Service Tools (DST) Sign On

Type choice, press Enter.

  DST password . . . . . .  _____
```

6. If the Dedicated Service Tools (DST) Sign On display is shown, enter the DST password and press the Enter key. For more information about preventing unauthorized installation of the operating system, see the *Basic Security Guide*.
7. The Select a Language Group display is shown. This display shows the primary language currently on the system or on the save tapes.

   The value specified on the display must be the same as the national language that is on the distribution media, or on your most recent SAVSYS tape.

```
                          Select a Language Group

Note:  The language feature shown is the language feature
installed on the system.

Type choice, press Enter.

  Language feature . . . . . .  2924
```

8. Press the Enter key.

   After the language feature is entered, the Confirm Language Feature Selection display is shown. If you need to change your system's primary language, see the *Licensed Programs and New Release Installation Guide* for more information.

```
                    Confirm Language Feature Selection

Language feature  . . . . . . . . . . . . . . . . . :   2924

Press Enter to confirm your choice for language feature.
  Installing the system will continue.
Press F12 to return to change your choice for
  language feature.
```

9. Press the Enter key to confirm the information.
10. The following display is shown only if disk units are in nonconfigured status.

    Note: If function code 24 was used and the recover configuration was not run, all disk units except unit 1 are in nonconfigured status.

```
                    Add All Disk Units to the System

Select one of the following:

          1. Add all disk units to the system auxiliary storage pool
          2. Keep the current disk configuration
          3. Perform disk configuration using DST
```

    Note: You may receive a message at the top of the display indicating that the disk unit configuration information may have been damaged. There is currently only one disk unit configured on the system.

11. Select the correct option using the following information:

    Option 1 (Add all disk units to the system auxiliary storage pool)

    Select this option if you want to add all of the nonconfigured units to the system auxiliary storage pool.

    Attention!

    If you used Function Code 24 to install the Licensed Internal Code, and the service representative did not use Recover Configuration in DST, you must select this option. If you are restoring to the same system and have mirrored protection, checksum protection, or user ASPs configured, the service representative must use the Recover Configuration option in Dedicated Service Tools (DST) to recover the configuration.

    Before adding the units to the system, all data stored on the non-configured units is deleted.

    Note: Adding units can change the checksum set configuration of the system ASP. You can use option 3 (Perform disk configuration using DST) to calculate the effect of adding units to the system ASP.

    Option 2 (Keep the current disk configuration)

This option continues the IPL without adding units to the system configuration. The disk units that are in nonconfigured status will remain so.

Select this option if:

- You are recovering from a disk unit failure in the system ASP and you had user ASPs configured.
- You plan to add the nonconfigured units to user ASPs.
- You plan to use them as spare units.

Option 3 (Perform disk configuration using DST)

This option starts the Dedicated Service Tools (DST). On the DST main menu, select option 4 (Work with Disk Units).

12. Press the Enter key.

    As the disk units are configured, the following display is shown:

```
Formatting additional disk units in progress.
        Seconds running . . . . :  ____
```

    Adding disk units takes several minutes. The time it takes depends on the size of each unit and the ability of the system to do multiple adds at the same time.

13. Status messages are displayed.

    The following is an example of a status display shown before the Install the Operating System display is shown. The status messages shown do not require any action by the user.

```
                          IPL Step in Progress

IPL step . . . . : Storage Management Recovery
```

After the IPL steps complete, the Install the Operating System menu appears.

```
                        Install the Operating System

Type options, press Enter.

     Install
       option . . . . __              1=Take defaults (No other
                                        options are displayed)
                                      2=Change install options

     Date:
       Year . . . . . __              00-99
       Month  . . . . __              01-12
       Day  . . . . . __              01-31

     Time:
       Hour . . . . . __              00-23
       Minute . . . . __              00-59
       Second . . . . __              00-59
```

14. When the Install the Operating System display is shown, continue with the task to select Install options.

Task 2. Select the Install Options

Do the following.

1. Select option 1 (Take defaults) to restore objects such as the system values, system reply lists, and the edit descriptions. This option is selected when you are performing a total system restore operation. When you select option 1 (Take defaults), the operating system is installed again and no more install options displays are shown. Do the following:

   a. Fill in the date and time.

      Date

      The system inserts the date based on the internal clock. If the date is incorrect, you can type over the date to change it.

      Time

      The system inserts the time based on the internal clock. If the time is incorrect, you can type over the time to change it.

   b. Press the Enter key.

   c. Messages are shown to indicate how many programs and language objects are restored. These messages are for your information only.

   d. Continue loading tapes in sequence when messages are shown that ask you to load the next tape. The system searches through the tapes and loads the necessary programs and language information. After processing all the system save tapes, the following message may be displayed at the bottom of a blank display:

      ```
      Operating system has been installed.  IPL in progress.
      ```

When the IPL is complete, the IPL Sign On display is shown and the system in ready to complete the IPL. Continue with the next task "Select IPL Options."

Task 3. Select IPL Options

1. Type QSECOFR in the *User* prompt and the password required for that user ID in the *Password* prompt (if password security is active) on the Sign On display.

   Note: If function code 23 was used to restore the Licensed Internal Code, before restoring the operating system, the password is the special one you assigned to QSECOFR user profile after the system was installed.

   If function code 24 was used to install the Licensed Internal Code, no password is required at this time. The system security level will be restored after the operating system is installed and the IPL completes.

2. Press the Enter key. Informational messages are displayed.

3. If the Select Product to Work with PTFs display appears, press F3 (Exit) to continue.

```
                Select Product to Work with PTFs
                                                                RCHASTTX
Position to . . . . . .___________ Product


Type options, press Enter.  Press F21 to select all.
   1=Select


             Product
Opt  Product  Option  Release
 _   5738999  *BASE   V2R3M0
 _   5738SS1  *BASE   V2R3M0
```

4. When the IPL Options display is shown, respond to the prompts using the following information.

```
                                IPL Options

Type choices, press Enter.

  System date  . . . . . . . . . . . . . .   07 / 26 / 88   MM / DD / YY
  System time  . . . . . . . . . . . . . .   12 : 00 : 00   HH : MM : SS
  Clear job queues . . . . . . . . . . . .   N             Y=Yes,  N=No
  Clear output queues  . . . . . . . . . .   N             Y=Yes,  N=No
  Clear incomplete job logs  . . . . . . .   N             Y=Yes,  N=No
  Start print writers  . . . . . . . . . .   N             Y=Yes,  N=No
  Start this device only . . . . . . . . .   Y             Y=Yes,  N=No


  Set major system options . . . . . . . .   Y             Y=Yes,  N=No
  Define or change system at IPL . . . . .   N             Y=Yes,  N=No
```

Figure 13-1. IPL Options Display

5. Enter the value for the system date.

   The date is displayed. The system date format shown can be YY/MM/DD, DD/MM/YY, or MM/DD/YY where MM means month, DD means day, and YY means year. For English, the default is MM/DD/YY; the default value differs according to the primary language.

If the date is not correct, you can type over the date to change it. The system date must have a year value in the range of 87 to 99, or 00 to 22.

6. Enter the value for system time.

   The current time is displayed. The time format is HH : MM : SS; HH means hour, MM means minutes, and SS means seconds. If you want to change the time, type it in accordance with the 24-hour clock. For example, for an IPL at 4:30 p.m., type 163000 for the time.

7. Enter the value for start print writers.

   If you are going to continue restoring user profiles, device configuration objects, user libraries, and authorities, type an N to not start the print writers. Otherwise, type a Y to start print writers.

8. Enter the value for start this device only.

   If you are going to continue restoring user profiles, device configuration objects, user libraries, and authorities, type a Y to start this device only. Otherwise, type an N to start all devices.

9. Enter the value for set major system options.

   The default is different, depending on the type of restore operation. If you restored the Licensed Internal Code using function code 23 (Restore), the default value is set to N. If you installed the Licensed Internal Code using function code 24 (Install), the default value is set to Y.

   Type a Y to set the major system options.

10. Enter the value for the define or change system at IPL.

    If the System/36 environment is your main operating system environment or you are restoring from the distribution tapes, then type a Y to define or change the system at IPL.

    If you are doing a partial recovery, you must ensure that all the libraries in the library list (QSYSLIBL and QUSRLIBL system values) are restored or remove the libraries not being restored from the library list. To change the QSYSLIBL and QUSRLIBL system values, type a Y to define or change the system at IPL.

11. Press the Enter key.

    The Set Major System Options display is shown.

    Ensure enable automatic configuration is set to Yes, unless you are using the System/36 environment as your main operating environment. If you are using the System/36 environment as your main operating environment, ensure enable automatic configuration is set to No.

    If enable automatic configuration is set to No, you will receive SRC A900 2000 on the control panel later in the restore operation. The instructions to recover from SRC A900 2000 are provided, if necessary.

12. Press the Enter key.

    The Define or Change System at IPL is shown if you specified a *Y* for define or change system at IPL on the IPL options display. If you specified an *N* on the IPL options display, go to step 13.

    Note: The following sets of instructions (prior to step 13) deal with three distinct topics:

    - Enabling the automatic configuration setting

- Restoring from the distribution tapes
- Changing the QSYSLIBL and QUSRLIBL system values

The restoration process may require you to proceed through any, all, or none of the topics. If you do not need to proceed through any of them, you may go on to step 13.

Was enable automatic configuration set to No?

If it is set to No, do the following:

a. Select option 3 (System value commands) and press the Enter key.

b. Select option 3 (Work with system values) and press the Enter key.

c. Type a 2 in the *Option* column next to the system value QIPLTYPE and press the Enter key.

d. Change the value to 2 and press the Enter key. Press F12 until you return to the Define of Change the System at IPL menu.

e. If you are not restoring from the distribution tapes and you do not need to change the QSYSLIBL or QUSRLIBL system values, press F3 (Exit) to continue the IPL.

Are you restoring from the distribution tapes?

If you are restoring the operating system from the distribution tapes, the system has reset some values back to the IBM-supplied defaults. These values must be changed back to the values that were in effect at the time of save operation. You should have lists of these values that were created at the time you performed a complete save operation.

The following may need to be changed:

- System values
- Network attributes
- Configuration lists
- Edit descriptions
- Reply list entries
- IBM-supplied subsystem descriptions

Note: Configuration lists, edit descriptions, reply list entries, and IBM-supplied subsystem descriptions can be changed after the operating system is restored.

To change the system values, do the following:

a. Select option 3 (System value commands) and press the Enter key.

b. Select option 3 (Work with system values) and press the Enter key.

c. Type a 2 in the *Option* column next to the system value values you want to change and press the Enter key.

d. Change the values to the correct values and press the Enter key. Press F12 to return to the Define or Change the System at IPL menu.

If you had changed the network attributes from the IBM-supplied defaults, do the following:

a. Select option 4 (Network attributes commands) and press the Enter key.

b. Select option 2 (Change network attributes) and press the Enter key to display a list of network attributes.

c. Change the values to the correct network attributes and press the Enter key.

d. Press F12 (Cancel) to return to the Define or Change the System at IPL menu.

e. If the enable automatic configuration was set to *Yes*, and you do not need to change the QSYSLIBL or QUSRLIBL system values, press F3 (Exit) to continue the IPL.

Are you changing the QSYSLIBL or QUSRLIBL system values?

If you are changing the QSYSLIBL or QUSRLIBL system values, do the following:

a. Select option 3 (System value commands) and press the Enter key.

b. Select option 3 (Work with system values) and press the Enter key.

c. Type a 2 in the *Option* column next to the system value values you want to change and press the Enter key.

d. Change the values to the correct values and press the Enter key.

e. Press F12 to return to the Define or Change the System at IPL menu.

f. Press F3 to continue the IPL.

13. The following display is shown during the IPL process (attended mode) when system access paths are marked for rebuild:

```
                  Edit Rebuild of Access Paths                 RCHAS331
                                                      05/12/90  13:49:34

IPL threshold . . . . . . . . . . . . . 50   0-99

Type sequence, press Enter.
Sequence:  1-99, *OPN, *HLD

                  ------------Access Paths----------  Unique  Rebuild
Seq   Status      File        Library     Member      Keyed   Time
25__  IPL         QAPZSYM2    QSYS        QAPZSYM2    NO      00:00:01
25__  IPL         QAPZREQ2    QSYS        QAPZREQ2    NO      00:00:01
25__  IPL         QAPZPTF3    QSYS        QAPZPTF3    NO      00:00:01
25__  IPL         QAPZPTF2    QSYS        QAPZPTF2    NO      00:00:01
25__  IPL         QAPZOBJ2    QSYS        QAPZOBJ2    NO      00:00:01
*OPN  OPEN        QTWALL      QSYS        QTWALL      NO      00:00:06
*OPN  OPEN        QASULTEL    QSYS        QASULTEL    NO      00:00:01
*OPN  OPEN        QASULE05    QSYS        QASULE05    NO      00:00:01
*OPN  OPEN        QASULE03    QSYS        QASULE03    NO      00:00:01
*OPN  OPEN        QASULE01    QSYS        QASULE01    NO      00:00:01
                                                          More...
F5=Refresh   F11=Display member text   F13=Change multiple  F15=Sort by
F16=Repeat position to   F17=Position to
```

This display does not support the F3 and F12 keys.

- A status message is sent to notify the user that the system is performing access path recovery.
- The *IPL threshold* is a value from 1 through 99 that can be set by the user (default is 50), which indicates that access paths with a sequence less than or equal to the number specified will be rebuilt at IPL time. If the IPL threshold changes, all access paths with a status of IPL and AFTIPL will be changed to reflect the new status of the IPL threshold.

- Sequence
  - *IPL threshold*-1 represents the sequence of the access paths that are to be rebuilt prior to completion of the IPL. A rebuild sequence of 25 is initially set by the system to set the sequence of access paths for the files that have MAINT(*IMMED) and RECOV(*IPL) specified. The access paths with the same sequence are built first according to rebuild time (the access paths that take the longest to rebuild are rebuilt first if the priorities are the same). The access paths are displayed in the same order.
  - *IPL threshold*-99 represents the sequence in which the access paths are rebuilt after the IPL. A rebuild sequence of 75 is initially set by the system to set the sequence of the access paths for the files that have MAINT(*IMMED) and RECOV(*AFTIPL) specified.
  - *OPN indicates the access path is to be rebuilt when the file is opened. The *OPN must be changed to 1 through 99 before the system job will initiate the rebuild. The system initially sets the sequence to *OPN for the files that have MAINT(*IMMED) and RECOV(*NO) specified.
  - *HLD indicates the access path is not to be rebuilt until the user changes the sequence from *HLD to a *OPN, or 1 through 99. *HLD will also cancel the rebuilding of any access path.
- Status
  - RUN indicates that the access path is being rebuilt.
  - IPL indicates that the access path is to be rebuilt before the system completes the IPL process.
  - AFTIPL indicates that the access path is to be rebuilt after the system completes the IPL process.
  - HELD indicates that the access path is not to be rebuilt until the user changes the sequence from *HLD to a *OPN, or 1 through 99.
  - OPEN indicates that the access path is to rebuilt when the file is opened.
- Rebuild Time
  - The time the access path will take to be rebuilt when the system is running without any other jobs on the system. For example, at IPL time. This is an estimate of rebuild time based on the file size and key length. No time for journaled access paths is displayed.

14. Do one of the following:
    - Make changes and press the Enter key. After changing the fields on the display and pressing the Enter key, the change is made, if possible. For example, if the user attempts to change the sequence from 9 to 50, but the sequence cannot be changed because the access path has already been rebuilt, the user is sent an error message for each improper input.
    - Press the Enter key. If you press the Enter key without making any changes to the display, the Display Access Path Status display is shown (only if access paths remain to be rebuilt). If no access paths need to be rebuilt, the status display is not shown and the IPL continues.

The following display is shown during the IPL process when the user finishes with the Edit Rebuild of Access Paths display.

```
                    Display Access Path Status

IPL Threshold . . . . . : 50

          ----------Access Paths----------   Rebuild     Current
Status    File        Library    Member      Build Time  Run Time
RUN       QAPZSYM2    QSYS       QAPZSYM2    00:00:01    00:00:01
JRN       QAPZREQ2    QSYS       QAPZREQ2    00:00:01
JRN       QAPZPTF3    QSYS       QAPZPTF3    00:00:01
JRN       QAPZPTF2    QSYS       QAPZPTF2    00:00:01
JRN       QAPZOBJ2    QSYS       QAPZOBJ2    00:00:07
JRN       QTWALL      QSYS       QTWALL      00:00:01
JRN       QASULTEL    QSYS       QASULTEL    00:00:01
SYS       QASULE05    QSYS       QASULE05    00:00:01
SYS       QASULE03    QSYS       QASULE03    00:00:01
IPL       QASULE01    QSYS       QASULE01    00:00:01
                                                        More...



F3=Exit and continue IPL   F12=Cancel
```

Every 5 seconds the display is updated with the current run time.

After all the access paths have been rebuilt (access paths with a sequence less than or equal to the *IPL threshold*), the IPL process continues and this display is removed.

F12 (Cancel) calls the Edit Rebuild of Access Paths display. If the user returns to the Edit Rebuild of Access Paths display using F12 (Cancel), the user must exit the Edit Rebuild of Access Paths again. Even if all the access paths are rebuilt, the user remains at the Edit Rebuild of Access Paths display until the user exits the display.

If F12 (Cancel) is pressed and there are only SYS/JRN access paths to be recovered, the edit display is shown without any access paths to be edited.

Status

- RUN–indicates that the access path is being rebuilt.
- SYS–indicates the access path is a system access path and is waiting to be rebuilt.
- JRN–indicates that the access path is being recovered from its associated journal.
- IPL–indicates that the access path will be rebuilt before the system completes the IPL and is waiting to be rebuilt.

15. Press F3 (Exit and continue the IPL) to continue.
16. Press the Enter key to continue.

Did You Receive SRC A900 2000?

If you receive A900 2000 on the control panel and message CPF0975: `Console did not vary on`, on the console display, automatic configuration is turned off. However, the system has created device description QCONSOLE to allow you to continue the restore operation. **Do not** create a user-defined device description for the console display. This will cause unpredictable results. Recovery for SRC A900 2000 is provided in the next task.

If you did not receive SRC A900 2000, continue with the task to restore the remaining parts of the system.

Task 4. Recover from SRC A900 2000, If Necessary

If function code 24 (Install) was used to restore the Licensed Internal Code and automatic configuration was turned off during the restore operation of the operating system (SRC A900 2000 is displayed on the console), you must create a tape description and possibly a controller description to finish the restore operation. **Do not** create a user-defined device description for the console display.

Do the following:

1. If your tape unit is a 3422, 3430, 3480, or a 3490, do the following:
   a. Use the Work with Hardware Resource (WRKHDWRSC) command to determine the location of the tape controller.

      ```
      WRKHDWRSC TYPE(*STG)
      ```

   b. Locate the resource name for the tape controller on the Work with Storage Resources display. 2604, 2622, or 2644 will be displayed in the *Type* column.
   c. Type a `9` (Work with) in the *OPT* column next to name and press the Enter key. The Work with Storage Controller Resources display is shown.
   d. Locate the resource for the tape controller (for example, TAPCTL01).
   e. Type a `7` (Create description) in the *Opt* column next to the name and press the Enter key. The Create Controller Description display is shown.
   f. Enter a tape controller name (such as TAPCTL01) in the *New device description* prompt and press the Enter key.
   g. On the Create CTL Desc (Tape) (CRTDEVCTL) display, enter a controller description name and controller type and model.
   h. Use the Create Device Description command to create a device description for each tape unit attached to the controller. For example:

      ```
      CRTDEVTAP DEVD(TAPxx) TYPE(34xx) MODEL(model-number)
           CTLD(tape-controller-description) TEXT('text description')
      ```

      where DEVD is the name of the description, TYPE is tape unit type, MODEL is the model (or *ANY), and CTLD is the name of the controller description created above.
   i. Use the Work with Configuration Status command to vary on the controller and tape unit.

      ```
      WRKCFGSTS *CTL *TAP
      ```

j. Find the controller description and type a 1 in the *Opt* column next to the name. Press the Enter key. This will vary on the controller and any tape units attached to the controller.

2. If you are not using a 34xx tape unit, do the following:

   a. Use the Work with Hardware Resource (WRKHDWRSC) command to determine tape controller name.

      ```
      WRKHDWRSC TYPE(*STG)
      ```

   b. Locate the tape controller.

   c. Type a 9 (Work with) next to tape controller name and press the Enter key.

   d. Locate the resource name for the tape unit (for example, TAP01).

   e. Enter a 7 (Add configuration) in the *Opt* column next to the tape resource name and press the Enter key.

   f. Enter a tape device description name (for example, TAP01) in the *New device description* prompt and press the Enter key.

   g. Use the Work with Configuration Status command to vary on the tape unit.

      ```
      WRKCFGSTS *DEV *TAP
      ```

   h. Find the tape device description and type a 1 in the *Opt* column next to the name. Press the Enter key. This will vary on the tape unit attached to the controller.

SRC A900 2000 remains displayed on the control panel throughout the remaining restore operations. When the final IPL of the system is complete, SRC A900 2000 disappears. The user-defined device description for the console display will be restored when the Restore Configuration (RSTCFG) command is run later in the recovery.

Task 5. Reclaim Storage

Reclaim storage (RCLSTG command) recovers the addressability of lost or damaged objects and places them in library QRCL. This allows you to identify and then restore those objects that were damaged. If an authorization list is found damaged during reclaim storage, the objects secured by the damaged authorization are associated with the system authorization list QRCLAUTL. See the *Security Reference* to find out how to recover from damaged authorization lists.

To reclaim storage, do the following:

1. Sign on the system as the security officer; type `QSECOFR` in the user prompt and the password associated with that user ID on the Sign On display (if password security is active).
2. Press the Enter key.
3. Type the following command on the command line and press the Enter key.

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(60)
   ```

4. End all subsystems:

   ```
   ENDSBS SBS(*ALL) OPTION(*IMMED)
   ```

   Messages are sent indicating when the subsystems have ended and the system is in a restricted state.

5. To prevent being interrupted by messages:

   ```
   CHGJOB BRKMSG(*HOLD)
   ```

6. Reclaim storage:

   ```
   RCLSTG
   ```

7. Continue with "Task 6. Restore the Remaining Parts of the System." If you are using "Option 1. Using Option 21 on the Restore Menu" on page 13-27, start with step 4. If you are using "Option 2. Using the Restore Commands" on page 13-32, start with step 5.

Task 6. Restore the Remaining Parts of the System

Before You Begin. . .

_ Clean the read and write head of the tape unit.

_ Find the tape volume that contains the user profiles.

You may want to do the following:

Note: Depending on the circumstances and how much of the system you have restored, the DSPTAP command may or may not work. If not enough of the operating system has been restored, refer to the list of libraries you created when you saved the system.

- If you do not know where the user profiles are stored on tape, determine where they are by using the DSPTAP command with DATA(*LABELS) specified. (This is not necessary if you are restoring user profiles from the SAVSECDTA media.)

  Examine each tape until you find the file labeled QFILEUPR containing object type *USRPRF.

- Find the file on tape containing the device configuration objects using the DSPTAP command with DATA(*LABELS) specified. Examine each tape until you find the file labeled QFILEIOC containing object types *DEVD, *CTLD, *LIND, *COSD, *CFGL, *CNNL, *NWID, *SRMSPC and *MODD. (This is not necessary if you are restoring configuration and system resource management information from the SAVCFG media.)

- Ensure any device configuration objects not used in the restore operation are varied off. Ensure that any tape devices, tape controllers, or work-station device that you are using for the restore operation are varied on. These configuration objects are excluded from the restore operation (message CPF379C in the job log).

Considerations: There are two options you can use to restore the user profiles, device configuration objects, user libraries, document library objects, and authority:

1. If you are restoring the user profiles from a SAVSYS tape and the following considerations do not apply, go to "Option 1. Using Option 21 on the Restore Menu" in this procedure.
2. If any of the following considerations apply, go to "Option 2. Using the Restore Commands" (not option 21 on the Restore menu) in this procedure.

Use the restore commands (not option 21 on the Restore menu) if:

- You prefer to enter the commands manually.
- You saved changed objects or have journal changes to apply.

> **Attention**
>
> To ensure the journaling environment is restored correctly, the libraries containing the journals must be restored before the libraries containing the journaled files. If the journaled files are restored before the journals, journaling is not started again for the files.

- You performed individual save operations instead of using the SAVLIB LIB(*NONSYS) command. You must use a RSTLIB command for each saved library. If you saved individual objects using the SAVOBJ or SAVCHGOBJ command, you must use a RSTOBJ command for each group of saved objects.
- You performed a SAVLIB LIB(*IBM) and a SAVLIB LIB(*ALLUSR). You need to do a RSTLIB SAVLIB(*IBM) and RSTLIB SAVLIB(*ALLUSR).
- You saved the security information with the Save Security Data (SAVSECDTA) command. You must restore the information using the restore commands.
- You saved logical file access paths using either the SAVOBJ or SAVCHGOBJ command. You must restore the logical files the same way you restored the physical files using the RSTOBJ command.

Option 1. Using Option 21 on the Restore Menu

To restore user profiles, configuration objects, system resource management information, user libraries, document library objects, and authority, use the following steps:

1. Sign on the system as the security officer; type `QSECOFR` in the user prompt and the password for QSECOFR in the *Password* prompt.

   Note: If you restored the Licensed Internal Code (function code 23), it is the user-assigned password. If you installed the Licensed Internal Code (function code 24), it is the default password QSECOFR.

2. Press the Enter key.
3. Ensure that the correct volume of your last set of save tapes is loaded and make the tape device ready. The tape should contain the file labeled QFILEUPR. Run the DSPTAP command and specify DATA(*LABELS) to find the file labeled QFILEUPR.
4. Ensure that any device configuration objects not used in the restore operation are varied off.
5. Ensure that the devices you are using for the restore operation (workstations, tape devices, and tape controllers) are varied on. These configuration objects are excluded from the restore operation (message CPF379C in the job log).
6. Go to the Restore menu:

   ```
   GO RESTORE
   ```

   The Restore menu is shown.

```
RESTORE                              Restore
                                                        System:   RCHASLLZ
Select one of the following:

  Restore Data
     1. Files
     2. Libraries
     3. Documents and folders
     4. Programs
     5. Other objects
     6. Licensed programs
     7. Configuration
     8. User profiles

  Restore System Data
    20. All libraries other than system library
    21. The system
```

Doing an Unattended Restore

To prevent an interrupted restore caused by incomplete restore messages, run the following commands before selecting option 21 from the Restore menu.

1. To display the reply list sequence numbers currently being used, type the following and press the Enter key.

   ```
   WRKRPYLE
   ```

2. To add message CPA3709 to the reply list, type the following (where xxxx is an unused sequence number 1-9999) and press the Enter key.

   ```
   ADDRPYLE SEQNBR(xxxx) MSGID(CPA3709) RPY('G')
   ```

3. To change the job, type the following and press the Enter key.

   ```
   CHGJOB INQMSGRPY(*SYSRPYL)
   ```

   Note: Communications messages with a severity of 99 that require a reply can stop an unattended restore operation. If you have communication messages that can stop an unattended restore operation, you can specify *NOTIFY for the *Message queue delivery* prompt on the Specify Command Defaults display. This sends the communication messages to the QSYSOPR message queue without interrupting the restore operation.

   After running these commands, the following messages will be displayed:

   a. `CPF0994  ENDSBS(*ALL) command being processed`

   b. Press the Enter key.

   c. `CPF0968  System ended to restricted condition`

   d. Press the Enter key.

After performing step d, the first message, `ENDSBS(*ALL) command being processed`, will return to the screen. Repeat steps b through d before moving on to select option 21.

7. Select option 21 (The system) on the Restore menu and press the Enter key. The following display is shown.

```
                          Specify Command Defaults

Type choices, press Enter.

  Tape devices . . . . . .  TAP01       Names
                            _____
                            _____
                            _____

  Prompt for commands  . . . . .   N          Y=Yes, N=No

  Message queue delivery . . . .   *BREAK     *BREAK, *NOTIFY
```

Tape devices

You can specify up to four tape device names. If you specify more than one device, the system automatically switches to the next tape device after the current tape is read.

Prompt for commands

You can specify whether or not you want to be prompted for the commands. If you specify Y=Yes, the prompt display is shown and you can change the defaults on the commands. If you specify N=No, the system runs the commands without prompting and uses the default values.

Message queue delivery

You can specify whether or not you want messages sent in *BREAK or *NOTIFY mode to the QSYSOPR message queue. If *BREAK is specified, any message of severity 99 that requires a reply interrupts the restore operation. If *NOTIFY is specified, severity 99 messages that are not are associated with restore operation, do not interrupt the restore process. For example, messages that request a new volume to be loaded interrupt the restore operation because they are associated with the job. You cannot continue until the you reply to these messages.

Note: If you are doing an unattended restore operation and communications is active, change the message queue delivery to *NOTIFY mode.

Option 21 will guide you through the following if you selected `Y` for the *Prompt for commands* prompt on the Specify Command Defaults display.

a. ENDSBS SBS(*ALL) OPTION(*IMMED)

b. RSTUSRPRF USRPRF(*ALL)

c. RSTCFG OBJ(*ALL)

d. RSTLIB SAVLIB(*NONSYS)

e. RSTDLO DLO(*ALL) SAVFLR(*ANY)

Notes:

1) If you specify that the RSTDLO DLO(*ALL) SAVFLR(*ANY) command is to be run, the RSTAUT command will run immediately afterwards. There is no prompt for the RSTAUT command, however.

2) If an unrecoverable error occurs when running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command, see "Media or Device Error When Running the RSTDLO Command" on page 9-11.

8. Press the Enter Key.
9. Continue loading the save tapes in sequence when the system sends a message to load the next volume.

If a media error occurs....

If an unrecoverable media error occurs during the RSTLIB procedure, you can restart the procedure using the STRLIB parameter on the RSTLIB command. The STRLIB parameter is valid only when *NONSYS, *ALLUSR, or *IBM is specified for the restore operation,

The basic recovery steps for a restore operation are:

1. Check the job log to determine the library where the previous RSTLIB SAVLIB(*NONSYS, *IBM, or *ALLUSR) command failed. Find the library that follows the last successfully restored library. It is indicated by a successful restore completion message in the job log. If the library is not identified in the job log, look at the output from the save operation or display the tape file QFILE to determine which library is next.
2. Load the first tape of the SAVLIB LIB(*NONSYS, *ALLUSR, or *IBM) media.
3. Type the following and press the Enter key:

```
RSTLIB SAVLIB(*NONSYS, *IBM or *ALLUSR) DEV(tape-name)
    ENDOPT(*LEAVE) STRLIB(library-name) OMITLIB(library-name)
```

   where the *library-name* for the STRLIB and the OMITLIB parameters is the library where the RSTLIB failed. This starts the restore operation on the library after the library where the RSTLIB failed.
4. You will be asked to load the volume containing the starting library.
5. After the restore operation is complete, restore the library that failed using the media from a previous save operation.

   Note: Consider eliminating the tape with the media error from the next save rotation cycle to avoid a tape error again.

10. If you used the distribution tapes to restore the operating system, some information was not restored. You must create or change this information again. You should have lists of this information that were created at the time you performed your save operation.

    The following may need to be created or changed:

    - Configuration lists
    - Edit descriptions
    - Reply list entries
    - IBM-supplied subsystem descriptions

    a. For the configuration lists, do the following:

       Use the Work With Configuration Lists (WRKCFGL CFGL(*ALL)) command to create the configuration lists to match the information in your list.

    b. For edit descriptions, do the following:

       Use the Work with Edit Descriptions (WRKEDTD EDTD(*ALL)) command to create edit descriptions to match the information in your list.

    c. For reply list entries, do the following:

Use the Add Reply List Entry (ADDRPYLE) command to add reply list entries to match the information in your list.

d. For IBM-supplied subsystem descriptions, do the following:

Use the Work with Subsystem Descriptions (WRKSBSD SBSD(*ALL)) command to change the IBM-supplied subsystem descriptions to match the information in your list.

11. This completes the restore operation.

12. If you are unsure what the QSECOFR password is, change it now. To see if the password has expired, type the following:

```
DSPUSRPRF QSECOFR
```

If the password expiration is active for the QSECOFR user profile, you will see the expiration date on the Date password expired field. If the date is the current system date or prior, change the password for the QSECOFR user profile.

13. Check the job log to ensure all objects were restored.

The job log contains information about the restore operation. To verify that all objects were restored, you should spool the job log for printing, along with the job's remaining spooled output, if any.

```
DSPJOBLOG * *PRINT
```

Or

```
SIGNOFF *LIST
```

Message CPC3703 is sent to the job log for each library that was successfully restored. Message CPF3773 is sent to tell you how many objects were restored. It also tells you how many objects were not restored. Objects are not restored for various reasons. Check for any error messages, correct the errors, and then restore those objects from the media.

Note: During a full system recovery (control panel function code 24), you may receive diagnostic message CPF7088: `Receiver xxx associated with journal QAUDJRN`, where xxx is the receiver name. No recovery is required for this message when the journal is QAUDJRN.

QAUDJRN was created by the system (if security auditing is turned on) because it did not exist at the time of the restore operation. This causes the creation date of the journal on the system to be different than the creation date of the journal on the media when the receiver was saved. The journal receiver was restored and associated with QAUDJRN.

14. Perform a normal IPL and return the system to normal operations:

a. Turn the keylock switch to the Normal position.

b. Type the following on a command line and press the Enter key.

```
PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
```

15. When the IPL is complete, sign on the system.

16. Start any other subsystems that need to be started, such as QTCP or QSNADS.

```
STRSBS SBSD(subsystem-name)
```

Option 2. Using the Restore Commands

To use the commands to restore the system, do the following:

1. Sign on the system as the security officer; type QSECOFR in the User prompt and the password for QSECOFR in the Password prompt.

   Note: If you restored the Licensed Internal Code (function code 23), it is the user-assigned password. If you installed the Licensed Internal Code (function code 24), it is the default password QSECOFOR.

2. Press the Enter key.
3. Type the following command on the command line and press the Enter key.

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(60)
   ```

4. End all subsystems:

   ```
   ENDSBS SBS(*ALL) OPTION(*IMMED)
   ```

   Messages are sent indicating when the subsystems have ended and the system is in a restricted state.

5. Change the QSYSOPR message queue.

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(99)
   ```

   Note: Communications messages with a severity of 99 and that require a reply can stop an unattended restore operation. If you are using communications, you may need to identify the messages that may require a reply and then add them to the reply list or change the delivery of the QSYSOPR message queue to *NOTIFY with a severity of 99.

6. Ensure that the correct volume of your last set of save tapes is loaded and make the tape device ready. The tape should contain file labeled QFILEUPR. Run the DSPTAP command and specify DATA(*LABELS) to find the file labeled QFILEUPR.

   Note: Use the tapes from the most recent complete save operation (SAVSYS), or if the security data was saved since the last complete save operation, use the SAVSECDTA tapes.

   If the SAVSYS tape is used, type the following:

   ```
   RSTUSRPRF DEV(tape-device-name) USRPRF(*ALL) ENDOPT(*LEAVE)
   ```

   If the save security data tape (SAVSECDTA) is used, type the following:

   ```
   RSTUSRPRF DEV(tape-device-name) USRPRF(*ALL) ENDOPT(*UNLOAD)
   ```

   The time that this takes can vary significantly.

7. Ensure any device configuration objects not used in the restore operation are varied off.
8. Ensure that the devices you are using for the restore operation (workstations, tape devices, and tape controllers) are varied on. These configuration objects will be excluded from the restore operation (message CPF379C in the job log).
9. Restore the device configuration objects from your most recent SAVSYS tape or SAVCFG tape:

   If the SAVSYS media is used, type the following:

   ```
   RSTCFG OBJ(*ALL) DEV(tape-device-name) OBJTYPE(*ALL) ENDOPT(*LEAVE)
   ```

   If the SAVCFG media is used, type the following:

```
RSTCFG OBJ(*ALL) DEV(tape-device-name) OBJTYPE(*ALL) ENDOPT(*UNLOAD)
```

The time that this takes can vary significantly.

10. Restore the IBM and user libraries in one of the following ways:

    If you used SAVLIB LIB(*NONSYS) to save the IBM-supplied and user libraries, load the correct volume and then type the following:

    ```
    RSTLIB SAVLIB(*NONSYS) DEV(tape-device-name) ENDOPT(*LEAVE)
    ```

    Or, if you used SAVLIB LIB(*IBM) and SAVLIB LIB(*ALLUSR) to save the IBM and user libraries, load the correct tape and then type the following two commands. The first command must complete before entering the second command.

    ```
    RSTLIB SAVLIB(*IBM) DEV(tape-device-name) ENDOPT(*LEAVE)
          MBROPT(*ALL)
    ```

    ```
    RSTLIB SAVLIB(*ALLUSR) DEV(tape-device-name) ENDOPT(*LEAVE)
          MBROPT(*ALL)
    ```

    Note: If you saved individual libraries and objects with the SAVLIB, SAVOBJ, and SAVCHGOBJ commands, then you will have to restore the individual libraries and objects with the RSTLIB command (not RSTLIB SAVLIB(*NONSYS)) and the RSTOBJ command.

    Attention

    To ensure the journaling environment is restored correctly, the libraries containing the journals must be restored before the libraries containing the journaled files. If the journaled files are restored before the journals, journaling is not started again for the files.

If a media error occurs....

If an unrecoverable media error occurs during the RSTLIB procedure, you can restart the procedure using the STRLIB parameter on the RSTLIB command. The STRLIB parameter is valid only when *NONSYS, *ALLUSR, or *IBM is specified for the restore operation,

The basic recovery steps for a restore operation are:

1. Check the job log to determine the library where the previous RSTLIB SAVLIB(*NONSYS, *IBM, or *ALLUSR) command failed. Find the library that follows the last successfully restored library. It is indicated by a successful restore completion message in the job log. If the library is not identified in the job log, look at the output from the save operation or display the tape file QFILE to determine which library is next.
2. Load the first tape of the SAVLIB LIB(*NONSYS, *ALLUSR, or *IBM) media.
3. Type the following and press the Enter key:

   ```
   RSTLIB SAVLIB(*NONSYS, *IBM or *ALLUSR) DEV(tape-name)
       ENDOPT(*LEAVE) STRLIB(library-name) OMITLIB(library-name)
   ```

   where the *library-name* for the STRLIB and the OMITLIB parameters is where the RSTLIB failed. This starts the restore operation on the next library after the library where the RSTLIB failed.
4. You will be asked to load the volume containing the starting library.
5. After the restore operation is complete, restore the library that failed using the media from a previous save operation.

   Note: Consider eliminating the tape with the media error from the next save rotation cycle to avoid a tape error again.

11. If you have documents, folders, and mail to restore, load the correct tape and type the following:

    ```
    RSTDLO DLO(*ALL) SAVFLR(*ANY) DEV(tape-device-name) ENDOPT(*UNLOAD)
    ```

    Note: If an unrecoverable error occurs when running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command, see "Media or Device Error When Running the RSTDLO Command" on page 9-11.

    Note: If you are not using journaling, or do not have changed objects to restore, continue with the next step. Otherwise, continue with the task "Restore Changed Objects."

12. To restore the authority, type the following:

    ```
    RSTAUT
    ```

    Note: If users have private authority to many objects, the RSTAUT command can take a very long time to run.

13. If you used the distribution tapes to restore the operating system, some information was not restored. You must create or change this information again. You should have lists of this information that were created at the time you performed your save operation.

    The following may need to be created or changed:

    - Configuration lists

- Edit descriptions
- Reply list entries
- IBM-supplied subsystem descriptions

a. For the configuration lists, do the following:

   Use the Work Configuration List (WRKCFGL CFGL(*ALL)) command to create the configuration lists to match the information in your list.

b. For edit descriptions, do the following:

   Use the Work with Edit Descriptions (WRKEDTD EDTD(*ALL)) command to create edit descriptions to match the information in your list.

c. For reply list entries, do the following:

   Use the Add Reply List Entry (ADDRPYLE) command to create reply list entries to match the information in your list.

d. For IBM-supplied subsystem descriptions, do the following:

   Use the Work with Subsystem Descriptions (WRKSBSD SBSD(*ALL)) command to change the IBM-supplied subsystem descriptions to match the information in your list.

This completes the restore operation.

14. If you are unsure what the QSECOFR password is, change it now. To see if the password has expired, type the following:

    ```
    DSPUSRPRF QSECOFR
    ```

    If the password expiration is active for the QSECOFR user profile, you will see the expiration date on the Date password expired field. If the date is the current system date or prior, change the password for the QSECOFR user profile.

15. Check the job log to ensure all objects were restored.

    The job log contains information about the restore operation. To verify that all objects were restored, you should spool the job log for printing, along with the job's remaining spooled output, if any.

    ```
    DSPJOBLOG * *PRINT
    ```

    Or

    ```
    SIGNOFF *LIST
    ```

    Message CPC3703 is sent to the job log for each library that was successfully restored. Message CPF3773 is sent to tell you how many objects were restored. It also tells you how many objects were not restored. Objects are not restored for various reasons. Check for any error messages, correct the errors, and then restore those objects from the media.

    Note: During a full system recovery (control panel function code 24), you may receive diagnostic message CPF7088: `Receiver xxx associated with journal QAUDJRN`, where xxx is the receiver name. No recovery is required for this message when the journal is QAUDJRN.

    QAUDJRN was created by the system (if security auditing is turned on) because it did not exist at the time of the restore operation. This causes the creation date of the journal on the system to be different than the creation date of the journal on the media when the receiver

was saved. The journal receiver was restored and associated with QAUDJRN.

16. Perform a normal IPL and return the system to normal operations:
    a. Turn the keylock switch to the Normal position.
    b. Type the following on a command line and press the Enter key.

       ```
       PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
       ```

17. When the IPL is complete, sign on the system.
18. Start any other subsystems that need to be started, such as QTCP or QSNADS.

    ```
    STRSBS SBSD(subsystem-name)
    ```

Task 7. Restore Changed Objects

Attention!

If you are using journaling and need to apply journaled changes, continue with the following steps. Use these recommended steps to avoid a failed restore operation caused by restoring journal receivers with names that conflict with the journal receivers currently attached to the restored journals. Otherwise, ignore these steps and continue with "Restoring Changed Objects."

Note: If you are using OfficeVision/400 or PC Support/400 and are performing daily save operations using SAVDLO and SAVCHGOBJ LIB(QUSRSYS) OBJJRN(*NO) commands, you must perform the steps in "Working with Journals" for the system supplied journal QUSRSYS/QAOSDIAJRN. If you specified OBJJRN(*YES) on the SAVCHGOBJ command, you do not need to apply journal changes.

Working with Journals

1. Type the following and press the Enter key:

   ```
   WRKJRN
   ```

2. The Specify Journal Name display is shown. Specify *ALL for the *Library name* prompt and press the Enter key.
3. The Work with Journals display is shown. To display the name of the currently attached journal receiver, type a 5 (Display journal status) in the *Opt* field for each journal on which you want to apply changes. Write down all the names of the journals and their currently attached journal receivers.

   Notes:

   a. You only need to perform the following steps for those journals you plan to use for recovering journaled files by performing the APYJRNCHG command. If no database files have been journaled to a journal, the system cannot apply any journaled changes using the journal.
   b. If you are using OfficeVision/400 or PC Support/400, you must apply journaled changes to the files journaled to the system-supplied journal QUSRSYS/QAOSDIAJRN.

4. You cannot restore journal receivers from the SAVLIB, SAVOBJ, or SAVCHGOBJ media if they have the same names as the journal receivers that are attached. To later apply all journaled changes that have occurred since the

last complete save operation, you must restore the receivers to the system from the save media.

To avoid a failed restore operation of saved journal receivers because of name conflicts, do the following for each journal identified in the previous step.

a. Create a journal receiver that will be used as a temporary receiver. Give it a name that will identify it as a temporary receiver, for example, TEMPnn. You can enter a description in the text (TEXT parameter) that identifies it as a temporary receiver for disaster recovery.

```
CRTJRNRCV JRNRCV(library-name/TEMPnn)
      TEXT('temporary journal receiver for journal xxx')
```

Repeat this step for each journal found in step 3.

b. To detach the current receiver and attach the new TEMPnn receiver, type the following and press the Enter key.

```
CHGJRN JRN(library-name/journal-name) JRNRCV(library-name/TEMPnn)
```

Repeat this step for each journal found in step 3.

c. Delete the detached journal receiver (identified in step 3 where you wrote down the name of the journal and journal receiver) using the Delete Journal Receiver (DLTJRNRCV) command.

```
DLTJRNRCV JRNRCV(library-name/journal-receiver)
```

Repeat this step for each journal found in step 3.

If you receive message CPA7025 *Receiver never fully saved*, enter an I to ignore and press Enter to continue the delete.

This allows the journal receivers on the save media to be restored successfully.

Restoring Changed Objects

1. Load the SAVCHGOBJ tape.

   Note: Several commands found in library QUSRTOOL can help you during save and restore operations. If you create the RSTALLCHG command in library QUSRTOOL, you can use the RSTALLCHG command to restore the libraries with changed objects from the SAVCHGOBJ or SAVALLCHG media without the need to know the names of the saved libraries. You need to run only one RSTALLCHG command to restore all the libraries. For more information about these commands, see "Restore All Changes (RSTALLCHG) Command" on page D-9.

2. If you do not use the RSTALLCHG in library QUSRTOOL and you specified SAVCHGOBJ LIB(*ALLUSR), type the following to determine the libraries that were saved:

```
DSPTAP DEV(device-name) OUTPUT(*PRINT)
```

3. To restore changed objects, type the following and press the Enter key:

```
RSTOBJ OBJ(*ALL) DEV(tape-device) SAVLIB(library-name)
          OBJTYPE(*ALL) ENDOPT(*LEAVE) MBROPT(*ALL)
```

You must repeat this step for every library saved using the SAVCHGOBJ command.

4. Do one of the following:

- If you are using journaling, perform the steps in "Applying Journal Changes" for each journal.
- If you need to restore changed documents and folders, with the steps in "Restoring Changed Documents and Folders."
- If you do not have no other restore steps to perform, continue with the following step.

5. Restore users' authority by entering:

   ```
   RSTAUT
   ```

   The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.

6. This completes the restore operation.
7. Perform a normal IPL and return the system to normal operations:
   a. Turn the keylock switch to the Normal position.
   b. Type the following on a command line and press the Enter key.

      ```
      PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
      ```

8. When the IPL is complete, sign on the system.
9. Start any other subsystems that need to be started, such as QTCP or QSNADS.

   ```
   STRSBS SBSD(subsystem-name)
   ```

Task 8. Apply Journaled Changes

Ensure that all the journal receivers required for the apply journaled changes operation are available on the system. In general, you will need all journal receivers that were attached to the journal for the length of time for which journaled changes are now to be applied to the restored files. Restore all necessary journal receivers, including ones that might have not been restored earlier because of name conflicts with the receivers attached to the restored journals. Use the Display Journal Receiver Attributes (DSPJRNRCVA) command to determine when a journal receiver was attached to and detached from a journal.

1. Determine the name of the last journal receiver (the last receiver restored) by entering the following:

   ```
   WRKJRNA JRN(library-name/journal-name)
   ```

2. Press the Enter key.
3. Press F15 (Work with receiver directory) from the Work with Journal Attributes display to show the last journal receiver with a status of SAVED or PARTIAL. Write down the name of the receiver.
4. Determine the chain of receivers to be used in the APYJRNCHG command from the Work with Receiver Directory display. Write down the first and last receiver that you restored (last receiver is prior to the TEMPnn receiver). Notice that the first and last receiver are the same if only one journal receiver was restored.

   Note: While looking at the receiver directory, you should also look for any receiver chain breaks. You can determine a chain break by looking at the first two digits in the *Number* column on the Work with Receiver

Directory display. You cannot apply journaled changes across receiver chain breaks. Therefore, you must write down the beginning and ending receiver names for each receiver chain. Then you need to run a series of apply journaled changes operations, one for each chain using these receivers. The *Advanced Backup and Recovery Guide* has more information about receiver chain breaks.

5. When applying journal changes, if the ending receiver has a status of PARTIAL (saved while attached), the TOENT parameter requires a sequence number to be specified on the APYJRNCHG command. Determine the last entry to be applied for the last receiver (identified in previous step).

   To determine the last receiver in the receiver range, type an 8 (Display attributes) in the *Opt* field next to the receiver name on the Work with Receiver Directory display.

   Write down the value for the *Last Sequence Number* field.

6. To ensure that the files are currently being journaled, do the following from the Work with Journal Attributes display:

   a. Press F13 (Display journaled files) from the Work with Journal Attributes display to show the list of files currently being journaled. To start journaling for a physical file that should be in the list, run the STRJRNPF command for each physical file not in the list.

   b. Press F14 (Display Journaled Access Paths) from the Work with Journal Attributes main display to display the list of currently journaled access paths. To start journaling access paths for a physical or logical file that should be in the list, run the STRJRNAP command for the physical or logical file that is not in the list.

   Notice that before journaling an access path, all physical files over which the access path is built must first be journaled to this journal. When you have ensured all files are correctly journaled, continue with the next step.

7. To continue the naming convention for your journal receivers, create a receiver that follows the same naming convention as the last receiver but assign it a number of one greater.

   ```
   CRTJRNRCV JRNRCV(library-name/journal-receiver-nameNN)
   ```

   By doing this, you are doing what the CHGJRN command would normally do if the last receiver saved was the current receiver being detached with a new receiver name being created.

8. Use the CHGJRN command to detach the temporary receiver and attach the new receiver you just created.

   ```
   CHGJRN JRN(library-name/journal-name)
          JRNRCV(library-name/journal-receiver-nameNN)
   ```

9. Enter the following command to apply the journaled changes using the first and last journal receivers identified on the Work with Receiver Directory display.

   ```
   APYJRNCHG JRN(library-name/journal-name)
             FILE((library-name/*ALL))
             RCVRNG(lib-name/first-receiver lib-name/last-receiver)
             FROMENT(*LASTSAVE) TOENT(last-entry)
   ```

   Note: If you determined in step 4 of this procedure that this journal had receiver chain breaks, then you must run an APYJRNCHG command

for each chain instead of one command as shown. For the RCVRNG parameter, specify the first and last receiver for each chain. For the FROMENT and TOENT parameters, specify:

a. FROMENT(*LASTSAVE) and TOENT(*LAST) for the first receiver chain.

b. FROMENT(*FIRST) and TOENT(*LAST) for the middle receiver chains.

c. FROMENT(*FIRST) and TOENT(last-entry) for the last receiver chain.

Attention

You must specify individual files on the FILE parameter instead of *ALL for the QAOSDIAJRN journal in library QUSRSYS. Do not apply journal changes to the document and folder search index database files (QAOSSS10 through QAOSSS15, QAOSSS17, and QAOSSS18) for journal QAOSDIAJRN in library QUSRSYS.

```
APYJRNCHG JRN(QUSRSYS/QAOSDIAJRN)
     FILE((QUSRSYS/QAOKPLCA) (QUSRSYS/QAOSAY05)
          (QUSRSYS/QAOKPX4A) (QUSRSYS/QAOSAY07)
          (QUSRSYS/QAOKP01A) (QUSRSYS/QAOKP02A)
          (QUSRSYS/QAOKP03A) (QUSRSYS/QAOKP04A)
          (QUSRSYS/QAOKP05A) (QUSRSYS/QAOKP06A)
          (QUSRSYS/QAOKP08A) (QUSRSYS/QAOKP09A))
      RCVRNG(lib-name/first-receiver lib-name/last-receiver)
      FROMENT(*LASTSAVE) TOENT(last-entry)
```

If you need to restore changed documents and folders, with the steps in "Restoring Changed Documents and Folders." Otherwise, continue with the next step.

10. Restore users' authority by entering:

    ```
    RSTAUT
    ```

    The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.

11. This completes the restore operation.

12. Perform a normal IPL and return the system to normal operations:

    a. Turn the keylock switch to the Normal position.

    b. Type the following on a command line and press the Enter key.

    ```
    PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
    ```

13. When the IPL is complete, sign on the system.

14. Start any other subsystems that need to be started, such as QTCP or QSNADS.

    ```
    STRSBS SBSD(subsystem-name)
    ```

Task 9. Restore Changed Documents and Folders

If you performed daily save operations for documents and folders, do the following steps. Otherwise, continue with the RSTAUT command.

1. Load the last daily SAVDLO tape.
2. If you performed daily save (SAVDLO DLO(*CHG)) operations to back up all new folders, new and changed documents, and mail since the last complete SAVDLO DLO(*ALL) FLR(*ANY) operation, type the following and press the Enter key.

   ```
   RSTDLO DLO(*ALL) DEV(TAP01) SAVFLR(*ANY)
   ```

   Note: If an unrecoverable error occurs when running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command, see "Media or Device Error When Running the RSTDLO Command" on page 9-11.
3. Restore users' authority by entering:

   ```
   RSTAUT
   ```

   The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.
4. This completes the restore operation.
5. Perform a normal IPL and return the system to normal operations:
   a. Turn the keylock switch to the Normal position.
   b. Type the following on a command line and press the Enter key.

      ```
      PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
      ```
6. When the IPL is complete, sign on the system.
7. Start any other subsystems that need to be started, such as QTCP or QSNADS.

   ```
   STRSBS SBSD(subsystem-name)
   ```

Recovering Devices that Will Not Vary On

If you have a problem with your devices, such as not being able to vary on a device, it may be because the system resource management (SRM) database that was restored does not match the device descriptions on the system.

Tape Controller - Tape Unit Types 3422, 3430, 3480, and 3490: To correct the problem for or tape controller, do the following:

1. Type the following and press the Enter key to display the Work with Storage Resources display.

   ```
   WRKHDWRSC TYPE(*STG)
   ```
2. Find the correct storage controller for the device that would not vary on.
3. Type a 9 (Work with resource) in the *Opt* column next to the resource name. The Work with Storage Controller Resources display is shown.
4. Find the valid resource name for the device type and model you tried to vary on.
5. Press F12 (Cancel) until you return to a display with a command line.

6. Type the following and press the Enter key to display the device description for the device that would not vary on.

   ```
   WRKCTLD CTLD(controller-name)
   ```

   The Work with Device Descriptions display is shown.

7. Type a 2 (Change) in the *Opt* column next to the device description you want to change and press the Enter key. The Change Device Description display is shown.
8. Change the name in the *Resource name* prompt to the correct name for the resource and press the Enter key. You will return to the Work with Device Descriptions display.
9. Type an 8 (Work with status) in the *Opt* column next to the device description you changed and press the Enter key. The Work with Configuration Status display is shown.
10. Type a 1 (Vary on) in the *Opt* column next to the device description name and press the Enter key to vary on the device.

Tape Units Other Than Types 3422, 3430, 3480, and 3490: To correct the problem for a tape unit, do the following:

1. Type the following and press the Enter key to display the Work with Storage Resources display.

   ```
   WRKHDWRSC TYPE(*STG)
   ```

2. Find the correct storage controller for the device that would not vary on.
3. Type a 9 (Work with resource) in the *Opt* column next to the resource name. The Work with Storage Controller Resources display is shown.
4. Find the valid resource name for the device type and model you tried to vary on.
5. Press F12 (Cancel) until you return to a display with a command line.
6. Type the following and press the Enter key to display the device description for the device that would not vary on.

   ```
   WRKDEVD DEVD(device-name)
   ```

   The Work with Device Descriptions display is shown.

7. Type a 2 (Change) in the *Opt* column next to the device description you want to change and press the Enter key. The Change Device Description display is shown.
8. Change the name in the *Resource name* prompt to the correct name for the resource and press the Enter key. You will return to the Work with Device Descriptions display.
9. Type an 8 (Work with status) in the *Opt* column next to the device description you changed and press the Enter key. The Work with Configuration Status display is shown.
10. Type a 1 (Vary on) in the *Opt* column next to the device description name and press the Enter key to vary on the device.

Local Work Station Controller: To correct the problem for a work station, do the following:

1. Type the following and press the Enter key to display the Work with Local Workstation Resources display.

   ```
   WRKHDWRSC TYPE(*LWS)
   ```

2. Find the correct controller description for the device that would not vary on.
3. Type a 5 (Work with configuration description) in the *Opt* column next to the controller description name and press the Enter key. The Work with Configuration Description display is shown.
4. Type a 5 (Display) in the *Opt* column to display the valid resource name for the work station controller.
5. Press F12 (Cancel) until you return to a display with a command line.
6. Type the following and press the Enter key to display the device description for the device that would not vary on.

   ```
   WRKCTLD CTLD(controller-name)
   ```

   The Work with Controller Descriptions display is shown.
7. Type a 2 (Change) in the *Opt* column next to the controller description you want to change and press the Enter key. The Change Controller Description display is shown.
8. Change the name in the *Resource name* prompt to the correct name for the resource and press the Enter key. You will return to the Work with Controller Descriptions display.
9. Type an 8 (Work with status) in the *Opt* column next to the controller description you changed and press the Enter key. The Work with Configuration Status display is shown.
10. Type a 1 (Vary on) in the *Opt* column next to the controller description name and press the Enter key to vary on the device.

    Note: It is possible that another device description is varied on for this resource. Vary off the device first and then vary on the changed device description. This situation can happen to the console device.

Recovering the System/36 Environment Configuration

If you are experiencing a problem with the System/36 environment after restoring the system, it may be caused by the locking rules used during the installation process. The QS36ENV configuration object in library #LIBRARY may have been locked by the System/36 environment.

This object contains the System/36 environment names for the work station, printer, tape and diskette units on the system and default System/36 environment values used for all users. This object may have been modified by the Change S/36 Environment Configuration (CHGS36) command to customize the System/36 environment.

When the first subsystem is started on the system after the installation process is complete, a new #LIBRARY and a new QS36ENV object in #LIBRARY is created with the AS/400 system defaults. In addition to the creating the new objects, each subsystem holds a lock on the QS36ENV configuration object to ensure that it is

not deleted. This lock will not allow the saved QS36ENV configuration object to be restored.

If the QS36ENV configuration object did not restore, start with step 1. If the configuration object did restore but you are experiencing problems with the System/36 environment configuration, go to step 5.

1. Rename the newly created #LIBRARY to something else (for example, #LIBNEW).
   - The locks held on QS36ENV object remain with the renamed library. This allows the saved System/36 environment configuration object to be restored.
2. Restore the saved copy of library #LIBRARY. This library was saved using SAVLIB LIB(*NONSYS) or SAVLIB LIB(*ALLUSR).
3. Perform an IPL of the system.
   - The QS36ENV object in the restored copy of #LIBRARY is the System/36 environment configuration again.
4. Delete the earlier renamed version of #LIBRARY (for example, #LIBNEW).
5. Use the Change S/36 Environment Configuration (CHGS36) command to refresh the configuration object.
   a. Select each of the device types you want to change.
      - Work station devices
      - Printer devices
      - Tape devices
      - Diskette devices
   b. Do the following for each device type you want to change:
      1) Press the F5 key to ensure the configuration object matches the device descriptions on the system.
      2) Do one of the following if any System/36 names are not specified:
         - Press the F10 key to use the AS/400 defaults for the System/36 names for those devices.
         - Update the System/36 names manually.
   c. Save the changes to the configuration object.

   See the topic on configuring the System/36 environment in the *Concepts and Programmer's Guide for the System/36 Environment* for more information about configuring the System/36 environment.

Recovering the System ASP with User ASPs Configured

This example describes how you recover from a disk failure in the system ASP when checksum or mirrored protection is not in effect and user ASPs are configured. It assumes that you have saved your system by using the SAVSYS, SAVLIB LIB(*NONSYS), and SAVDLO commands, and that you have a complete backup copy of the system ASP. This information is required to restore the system after a failure.

If a unit in the system ASP fails, as described above, you and your service representative determine whether it should be treated as a disk unit media failure. If this is the case, the service representative will replace the failed disk and, as a result, the system will clear all units allocated to the system ASP (all objects in the system ASP are destroyed and all overflowed user ASPs are cleared). All other user ASPs remain as they were before the failure occurred.

Task Overview

You will perform the following tasks during this procedure:

1. Start the restore of the Operating System.
2. Select install options.
3. Select IPL options.
4. Recovery from SRC A900 2000, if necessary.
5. Reclaim storage.
6. Restore the remaining parts of the system.
7. Restore changed objects and apply journaled changes.

Note: This procedure assumes the service representative has installed or restored the Licensed Internal Code. If you have not read the disk recovery summary information, go to "Summary of Disk Recovery Actions" on page 13-2 before you perform the following procedure.

Task 1. Start Restoring the Operating System

During this task, the system may have to perform some lengthy disk recovery processing prior to actually starting the install process. For more information on this disk recovery processing, see the *Advanced Backup and Recovery Guide*, SC41-8079.

You use two displays to select the install options. The IPL or Install the System display allows you to restore the operating system or work with the service tools. The Install the Operating System display allows you to set the options to be used for restoring the system, and for the system date and time.

1. At the IPL or Install the System menu:

```
                        IPL or Install the System

Select one of the following:

          1. Perform an IPL
          2. Install the operating system
          3. Use Dedicated Service Tools (DST)
          4. Perform automatic installation of the operating system
```

2. Type a 2 (Install the operating system).

   Note: **Do not** use option 4 (Perform automatic installation of the operating system) to restore the operating system.

3. Press the Enter key.

   The Confirm Install of the Operating System display is shown.

```
                    Confirm Install of Operating System

Press Enter to confirm your choice to install the operating system.
Press F12 to return and cancel your choice to install the
  operating system.
```

4. Press the Enter key.

5. The following display **may** be shown if your system is set up to prevent unauthorized installation of the operating system:

```
                    Dedicated Service Tools (DST) Sign On

Type choice, press Enter.

  DST password . . . . . .  _____
```

6. If the Dedicated Service Tools (DST) Sign On display is shown, enter the DST password and press the Enter key. For more information about preventing unauthorized installation of the operating system, see the *Basic Security Guide*.

7. The Select a Language Group display is shown. This display shows the primary language currently on the system or on the save tapes.

   The value specified on the display must be the same as the national language that is on the distribution media, or on your most recent SAVSYS tape.

```
                          Select a Language Group

Note:  The language feature shown is the language feature
installed on the system.

Type choice, press Enter.

  Language feature . . . . . .  2924
```

8. Press the Enter key.

   After the language feature is entered, the Confirm Language Feature Selection display is shown. If you need to change your system's primary language, see

the *Licensed Programs and New Release Installation Guide* for more information.

```
                    Confirm Language Feature Selection

Language feature  . . . . . . . . . . . . . . . . . :   2924

Press Enter to confirm your choice for language feature.
  Installing the system will continue.
Press F12 to return to change your choice for
  language feature.
```

9. Press the Enter key to confirm the information.
10. The following display is shown only if disk units are in nonconfigured status.

    Note: If function code 24 was used and the recover configuration was not run, all disk units except unit 1 are in nonconfigured status.

```
                    Add All Disk Units to the System

Select one of the following:

          1. Add all disk units to the system auxiliary storage pool
          2. Keep the current disk configuration
          3. Perform disk configuration using DST
```

    Note: You may receive a message at the top of the display indicating that the disk unit configuration information may have been damaged. There is currently only one disk unit configured on the system.

11. Select the correct option using the following information:

    Option 1 (Add all disk units to the system auxiliary storage pool)

    Select this option if you want to add all of the nonconfigured units to the system auxiliary storage pool.

    Attention!

    If you used Function Code 24 to install the Licensed Internal Code, and the service representative did not use Recover Configuration in DST, you must select this option. If you are restoring to the same system and have mirrored protection, checksum protection, or user ASPs configured, the service representative must use the Recover Configuration option in Dedicated Service Tools (DST) to recover the configuration.

    Before adding the units to the system, all data stored on the non-configured units is deleted.

Note: Adding units can change the checksum set configuration of the system ASP. You can use option 3 (Perform disk configuration using DST) to calculate the effect of adding units to the system ASP.

Option 2 (Keep the current disk configuration)

This option continues the IPL without adding units to the system configuration. The disk units that are in nonconfigured status will remain so.

Select this option if:

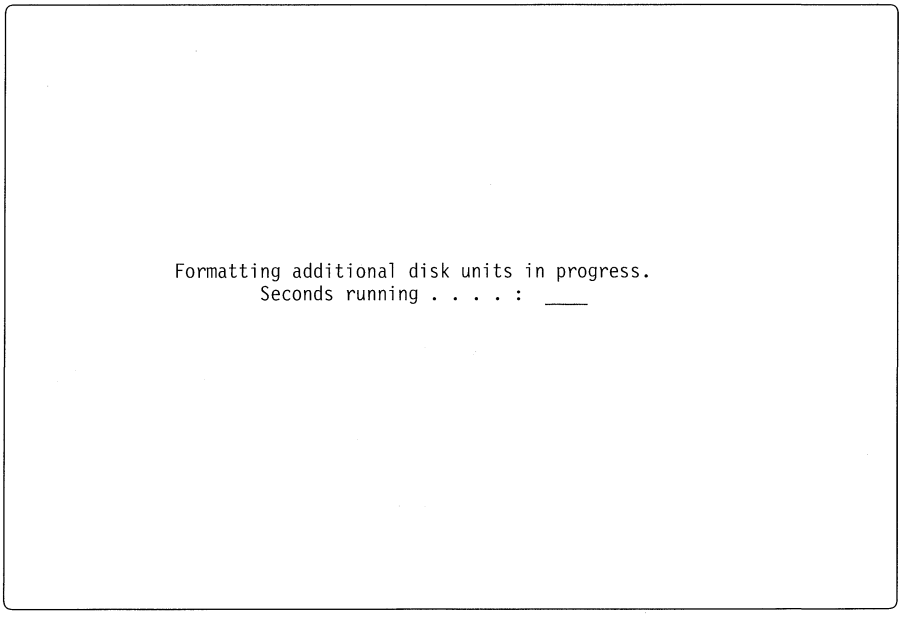
- You are recovering from a disk unit failure in the system ASP and you had user ASPs configured.
- You plan to add the nonconfigured units to user ASPs.
- You plan to use them as spare units.

Option 3 (Perform disk configuration using DST)

This option starts the Dedicated Service Tools (DST). On the DST main menu, select option 4 (Work with Disk Units).

12. Press the Enter key.

    As the disk units are configured, the following display is shown:



    Adding disk units takes several minutes. The time it takes depends on the size of each unit and the ability of the system to do multiple adds at the same time.

13. Status messages are displayed.

    The following is an example of a status display shown before the Install the Operating System display is shown. The status messages shown do not require any action by the user.

```
                          IPL Step in Progress

IPL step . . . . : Storage Management Recovery
```

After the IPL steps complete, the Install the Operating System menu appears.

```
                        Install the Operating System

Type options, press Enter.

     Install
       option . . . .  __              1=Take defaults (No other
                                         options are displayed)
                                       2=Change install options

     Date:
       Year . . . . .  __              00-99
       Month  . . . .  __              01-12
       Day  . . . . .  __              01-31

     Time:
       Hour . . . . .  __              00-23
       Minute . . . .  __              00-59
       Second . . . .  __              00-59
```

14. When the Install the Operating System display is shown, continue with the task to select Install options.

Task 2. Select the Install Options

Do the following.

1. Select option 1 (Take defaults) to restore objects such as the system values, system reply lists, and the edit descriptions. This option is selected when you are performing a total system restore operation. When you select option 1 (Take defaults), the operating system is installed again and no more install options displays are shown. Do the following:

   a. Fill in the date and time.

      Date

      The system inserts the date based on the internal clock. If the date is incorrect, you can type over the date to change it.

      Time

      The system inserts the time based on the internal clock. If the time is incorrect, you can type over the time to change it.

b. Press the Enter key.

c. Messages are shown to indicate how many programs and language objects are restored. These messages are for your information only.

d. Continue loading tapes in sequence when messages are shown that ask you to load the next tape. The system searches through the tapes and loads the necessary programs and language information. After processing all the system save tapes, the following message may be displayed at the bottom of a blank display:

```
Operating system has been installed.  IPL in progress.
```

When the IPL is complete, the IPL Sign On display is shown and the system in ready to complete the IPL. Continue with the next task "Select IPL Options."

Task 3. Select IPL Options

1. Type QSECOFR in the *User* prompt and the password required for that user ID in the *Password* prompt (if password security is active) on the Sign On display.

   Note: If function code 23 was used to restore the Licensed Internal Code, before restoring the operating system, the password is the special one you assigned to QSECOFR user profile after the system was installed.

   If function code 24 was used to install the Licensed Internal Code, no password is required at this time. The system security level will be restored after the operating system is installed and the IPL completes.

2. Press the Enter key. Informational messages are displayed.

3. If the Select Product to Work with PTFs display appears, press F3 (Exit) to continue.

```
                Select Product to Work with PTFs
                                                                RCHASTTX
Position to . . . . . .___________ Product


Type options, press Enter.  Press F21 to select all.
   1=Select


              Product
Opt  Product  Option  Release
 _   5738999  *BASE   V2R3M0
 _   5738SS1  *BASE   V2R3M0
```

4. When the IPL Options display is shown, respond to the prompts using the following information.

```
                                IPL Options

Type choices, press Enter.

  System date  . . . . . . . . . . . . . .  07 / 26 / 88   MM / DD / YY
  System time  . . . . . . . . . . . . . .  12 : 00 : 00   HH : MM : SS
  Clear job queues . . . . . . . . . . . .  N              Y=Yes,  N=No
  Clear output queues  . . . . . . . . . .  N              Y=Yes,  N=No
  Clear incomplete job logs  . . . . . . .  N              Y=Yes,  N=No
  Start print writers  . . . . . . . . . .  N              Y=Yes,  N=No
  Start this device only . . . . . . . . .  Y              Y=Yes,  N=No


  Set major system options . . . . . . . .  Y              Y=Yes,  N=No
  Define or change system at IPL . . . . .  N              Y=Yes,  N=No
```

Figure 13-2. IPL Options Display

5. Enter the value for the system date.

   The date is displayed. The system date format shown can be YY/MM/DD, DD/MM/YY, or MM/DD/YY where MM means month, DD means day, and YY means year. For English, the default is MM/DD/YY; the default value differs according to the primary language.

   If the date is not correct, you can type over the date to change it. The system date must have a year value in the range of 87 to 99, or 00 to 22.

6. Enter the value for system time.

   The current time is displayed. The time format is HH : MM : SS; HH means hour, MM means minutes, and SS means seconds. If you want to change the time, type it in accordance with the 24-hour clock. For example, for an IPL at 4:30 p.m., type 163000 for the time.

7. Enter the value for start print writers.

   If you are going to continue restoring user profiles, device configuration objects, user libraries, and authorities, type an N to not start the print writers. Otherwise, type a Y to start print writers.

8. Enter the value for start this device only.

   If you are going to continue restoring user profiles, device configuration objects, user libraries, and authorities, type a Y to start this device only. Otherwise, type an N to start all devices.

9. Enter the value for set major system options.

   The default is different, depending on the type of restore operation. If you restored the Licensed Internal Code using function code 23 (Restore), the default value is set to N. If you installed the Licensed Internal Code using function code 24 (Install), the default value is set to Y.

   Type a Y to set the major system options.

10. Enter the value for the define or change system at IPL.

    If the System/36 environment is your main operating system environment or you are restoring from the distribution tapes, then type a Y to define or change the system at IPL.

    If you are doing a partial recovery, you must ensure that all the libraries in the library list (QSYSLIBL and QUSRLIBL system values) are restored or remove

the libraries not being restored from the library list. To change the QSYSLIBL and QUSRLIBL system values, type a Y to define or change the system at IPL.

11. Press the Enter key.

    The Set Major System Options display is shown.

    Ensure enable automatic configuration is set to Yes, unless you are using the System/36 environment as your main operating environment. If you are using the System/36 environment as your main operating environment, ensure enable automatic configuration is set to No.

    If enable automatic configuration is set to No, you will receive SRC A900 2000 on the control panel later in the restore operation. The instructions to recover from SRC A900 2000 are provided, if necessary.

12. Press the Enter key.

    The Define or Change System at IPL is shown if you specified a *Y* for define or change system at IPL on the IPL options display. If you specified an *N* on the IPL options display, go to step 13.

    Note: The following sets of instructions (prior to step 13) deal with three distinct topics:

    - Enabling the automatic configuration setting
    - Restoring from the distribution tapes
    - Changing the QSYSLIBL and QUSRLIBL system values

    The restoration process may require you to proceed through any, all, or none of the topics. If you do not need to proceed through any of them, you may go on to step 13.

    Was enable automatic configuration set to No?

    If it is set to No, do the following:

    a. Select option 3 (System value commands) and press the Enter key.

    b. Select option 3 (Work with system values) and press the Enter key.

    c. Type a 2 in the *Option* column next to the system value QIPLTYPE and press the Enter key.

    d. Change the value to 2 and press the Enter key. Press F12 until you return to the Define of Change the System at IPL menu.

    e. If you are not restoring from the distribution tapes and you do not need to change the QSYSLIBL or QUSRLIBL system values, press F3 (Exit) to continue the IPL.

    Are you restoring from the distribution tapes?

    If you are restoring the operating system from the distribution tapes, the system has reset some values back to the IBM-supplied defaults. These values must be changed back to the values that were in effect at the time of save operation. You should have lists of these values that were created at the time you performed a complete save operation.

    The following may need to be changed:

    - System values
    - Network attributes
    - Configuration lists
    - Edit descriptions

- Reply list entries
- IBM-supplied subsystem descriptions

Note: Configuration lists, edit descriptions, reply list entries, and IBM-supplied subsystem descriptions can be changed after the operating system is restored.

To change the system values, do the following:

a. Select option 3 (System value commands) and press the Enter key.

b. Select option 3 (Work with system values) and press the Enter key.

c. Type a 2 in the *Option* column next to the system value values you want to change and press the Enter key.

d. Change the values to the correct values and press the Enter key. Press F12 to return to the Define or Change the System at IPL menu.

If you had changed the network attributes from the IBM-supplied defaults, do the following:

a. Select option 4 (Network attributes commands) and press the Enter key.

b. Select option 2 (Change network attributes) and press the Enter key to display a list of network attributes.

c. Change the values to the correct network attributes and press the Enter key.

d. Press F12 (Cancel) to return to the Define or Change the System at IPL menu.

e. If the enable automatic configuration was set to *Yes*, and you do not need to change the QSYSLIBL or QUSRLIBL system values, press F3 (Exit) to continue the IPL.

Are you changing the QSYSLIBL or QUSRLIBL system values?

If you are changing the QSYSLIBL or QUSRLIBL system values, do the following:

a. Select option 3 (System value commands) and press the Enter key.

b. Select option 3 (Work with system values) and press the Enter key.

c. Type a 2 in the *Option* column next to the system value values you want to change and press the Enter key.

d. Change the values to the correct values and press the Enter key.

e. Press F12 to return to the Define or Change the System at IPL menu.

f. Press F3 to continue the IPL.

13. The following display is shown during the IPL process (attended mode) when system access paths are marked for rebuild:

```
                    Edit Rebuild of Access Paths                RCHAS331
                                                        05/12/90  13:49:34

IPL threshold . . . . . . . . . . . . . 50   0-99

Type sequence, press Enter.
Sequence:  1-99, *OPN, *HLD

                    -----------Access Paths----------  Unique  Rebuild
Seq   Status        File        Library     Member      Keyed   Time
25__  IPL           QAPZSYM2    QSYS        QAPZSYM2    NO      00:00:01
25__  IPL           QAPZREQ2    QSYS        QAPZREQ2    NO      00:00:01
25__  IPL           QAPZPTF3    QSYS        QAPZPTF3    NO      00:00:01
25__  IPL           QAPZPTF2    QSYS        QAPZPTF2    NO      00:00:01
25__  IPL           QAPZOBJ2    QSYS        QAPZOBJ2    NO      00:00:01
*OPN  OPEN          QTWALL      QSYS        QTWALL      NO      00:00:06
*OPN  OPEN          QASULTEL    QSYS        QASULTEL    NO      00:00:01
*OPN  OPEN          QASULE05    QSYS        QASULE05    NO      00:00:01
*OPN  OPEN          QASULE03    QSYS        QASULE03    NO      00:00:01
*OPN  OPEN          QASULE01    QSYS        QASULE01    NO      00:00:01
                                                              More...
F5=Refresh   F11=Display member text   F13=Change multiple  F15=Sort by
F16=Repeat position to   F17=Position to
```

This display does not support the F3 and F12 keys.

- A status message is sent to notify the user that the system is performing access path recovery.
- The *IPL threshold* is a value from 1 through 99 that can be set by the user (default is 50), which indicates that access paths with a sequence less than or equal to the number specified will be rebuilt at IPL time. If the IPL threshold changes, all access paths with a status of IPL and AFTIPL will be changed to reflect the new status of the IPL threshold.
- Sequence
  - *IPL threshold*-1 represents the sequence of the access paths that are to be rebuilt prior to completion of the IPL. A rebuild sequence of 25 is initially set by the system to set the sequence of access paths for the files that have MAINT(*IMMED) and RECOV(*IPL) specified. The access paths with the same sequence are built first according to rebuild time (the access paths that take the longest to rebuild are rebuilt first if the priorities are the same). The access paths are displayed in the same order.
  - *IPL threshold*-99 represents the sequence in which the access paths are rebuilt after the IPL. A rebuild sequence of 75 is initially set by the system to set the sequence of the access paths for the files that have MAINT(*IMMED) and RECOV(*AFTIPL) specified.
  - *OPN indicates the access path is to be rebuilt when the file is opened. The *OPN must be changed to 1 through 99 before the system job will initiate the rebuild. The system initially sets the sequence to *OPN for the files that have MAINT(*IMMED) and RECOV(*NO) specified.
  - *HLD indicates the access path is not to be rebuilt until the user changes the sequence from *HLD to a *OPN, or 1 through 99. *HLD will also cancel the rebuilding of any access path.
- Status

- RUN indicates that the access path is being rebuilt.
- IPL indicates that the access path is to be rebuilt before the system completes the IPL process.
- AFTIPL indicates that the access path is to be rebuilt after the system completes the IPL process.
- HELD indicates that the access path is not to be rebuilt until the user changes the sequence from *HLD to a *OPN, or 1 through 99.
- OPEN indicates that the access path is to rebuilt when the file is opened.

- Rebuild Time
  - The time the access path will take to be rebuilt when the system is running without any other jobs on the system. For example, at IPL time. This is an estimate of rebuild time based on the file size and key length. No time for journaled access paths is displayed.

14. Do one of the following:
    - Make changes and press the Enter key. After changing the fields on the display and pressing the Enter key, the change is made, if possible. For example, if the user attempts to change the sequence from 9 to 50, but the sequence cannot be changed because the access path has already been rebuilt, the user is sent an error message for each improper input.
    - Press the Enter key. If you press the Enter key without making any changes to the display, the Display Access Path Status display is shown (only if access paths remain to be rebuilt). If no access paths need to be rebuilt, the status display is not shown and the IPL continues.

    The following display is shown during the IPL process when the user finishes with the Edit Rebuild of Access Paths display.

```
                    Display Access Path Status

IPL Threshold . . . . . : 50

          ----------Access Paths----------   Rebuild     Current
Status    File       Library    Member       Build Time  Run Time
RUN       QAPZSYM2   QSYS       QAPZSYM2     00:00:01    00:00:01
JRN       QAPZREQ2   QSYS       QAPZREQ2     00:00:01
JRN       QAPZPTF3   QSYS       QAPZPTF3     00:00:01
JRN       QAPZPTF2   QSYS       QAPZPTF2     00:00:01
JRN       QAPZOBJ2   QSYS       QAPZOBJ2     00:00:07
JRN       QTWALL     QSYS       QTWALL       00:00:01
JRN       QASULTEL   QSYS       QASULTEL     00:00:01
SYS       QASULE05   QSYS       QASULE05     00:00:01
SYS       QASULE03   QSYS       QASULE03     00:00:01
IPL       QASULE01   QSYS       QASULE01     00:00:01
                                                        More...




F3=Exit and continue IPL   F12=Cancel
```

Every 5 seconds the display is updated with the current run time.

After all the access paths have been rebuilt (access paths with a sequence less than or equal to the *IPL threshold*), the IPL process continues and this display is removed.

F12 (Cancel) calls the Edit Rebuild of Access Paths display. If the user returns to the Edit Rebuild of Access Paths display using F12 (Cancel), the user must exit the Edit Rebuild of Access Paths again. Even if all the access paths are rebuilt, the user remains at the Edit Rebuild of Access Paths display until the user exits the display.

If F12 (Cancel) is pressed and there are only SYS/JRN access paths to be recovered, the edit display is shown without any access paths to be edited.

Status

- RUN–indicates that the access path is being rebuilt.
- SYS–indicates the access path is a system access path and is waiting to be rebuilt.
- JRN–indicates that the access path is being recovered from its associated journal.
- IPL–indicates that the access path will be rebuilt before the system completes the IPL and is waiting to be rebuilt.

15. Press F3 (Exit and continue the IPL) to continue.
16. Press the Enter key to continue.

Did You Receive SRC A900 2000?

If you receive A900 2000 on the control panel and message CPF0975: `Console did not vary on`, on the console display, automatic configuration is turned off. However, the system has created device description QCONSOLE to allow you to continue the restore operation. **Do not** create a user-defined device description for the console display. This will cause unpredictable results. Recovery for SRC A900 2000 is provided in the next task.

If you did not receive SRC A900 2000, continue with the task to restore the remaining parts of the system.

After the recovery process completes, you can proceed with the next step.

1. If the units that failed included unit 1, a message may appear during IPL processing, stating that some hardware configuration information has been lost and prompting you to enter that information again. To do this, use the Work with Hardware Products (WRKHDWPRD) command.
2. If the units that failed included unit 1, a message (CPI0916) may appear during IPL processing, stating that network attribute information has been lost and prompting you to set the correct values for these attributes on your system. Follow the instructions provided in that message to set the correct network attributes at this point.
3. If the units that failed included unit 1 and if you use the AS/400 Cryptographic Support (5728-CR1) licensed program on your system, you must reenter the master cryptographic key. To do this you use the Set Master Key (SETMSTK) command.

Task 4. Recover from SRC A900 2000, If Necessary

If function code 24 (Install) was used to restore the Licensed Internal Code and automatic configuration was turned off during the restore operation of the operating system (SRC A900 2000 is displayed on the console), you must create a tape description and possibly a controller description to finish the restore operation. **Do not** create a user-defined device description for the console display.

Do the following:

1. If your tape unit is a 3422, 3430, 3480, or a 3490, do the following:
   a. Use the Work with Hardware Resource (WRKHDWRSC) command to determine the location of the tape controller.

      ```
      WRKHDWRSC TYPE(*STG)
      ```

   b. Locate the resource name for the tape controller on the Work with Storage Resources display. 2604, 2622, or 2644 will be displayed in the *Type* column.
   c. Type a 9 (Work with) in the *OPT* column next to name and press the Enter key. The Work with Storage Controller Resources display is shown.
   d. Locate the resource for the tape controller (for example, TAPCTL01).
   e. Type a 7 (Create description) in the *Opt* column next to the name and press the Enter key. The Create Controller Description display is shown.
   f. Enter a tape controller name (such as TAPCTL01) in the *New device description* prompt and press the Enter key.
   g. On the Create CTL Desc (Tape) (CRTDEVCTL) display, enter a controller description name and controller type and model.
   h. Use the Create Device Description command to create a device description for each tape unit attached to the controller. For example:

      ```
      CRTDEVTAP DEVD(TAPxx) TYPE(34xx) MODEL(model-number)
           CTLD(tape-controller-description) TEXT('text description')
      ```

      where DEVD is the name of the description, TYPE is tape unit type, MODEL is the model (or *ANY), and CTLD is the name of the controller description created above.
   i. Use the Work with Configuration Status command to vary on the controller and tape unit.

      ```
      WRKCFGSTS *CTL *TAP
      ```

   j. Find the controller description and type a 1 in the *Opt* column next to the name. Press the Enter key. This will vary on the controller and any tape units attached to the controller.
2. If you are not using a 34xx tape unit, do the following:
   a. Use the Work with Hardware Resource (WRKHDWRSC) command to determine tape controller name.

      ```
      WRKHDWRSC TYPE(*STG)
      ```

   b. Locate the tape controller.
   c. Type a 9 (Work with) next to tape controller name and press the Enter key.
   d. Locate the resource name for the tape unit (for example, TAP01).

e. Enter a 7 (Add configuration) in the *Opt* column next to the tape resource name and press the Enter key.

f. Enter a tape device description name (for example, TAP01) in the *New device description* prompt and press the Enter key.

g. Use the Work with Configuration Status command to vary on the tape unit.

```
WRKCFGSTS *DEV *TAP
```

h. Find the tape device description and type a 1 in the *Opt* column next to the name. Press the Enter key. This will vary on the tape unit attached to the controller.

SRC A900 2000 remains displayed on the control panel throughout the remaining restore operations. When the final IPL of the system is complete, SRC A900 2000 disappears. The user-defined device description for the console display will be restored when the Restore Configuration (RSTCFG) command is run later in the recovery.

Task 5. Restore the Remaining Parts of the System

1. End all subsystems:

   ```
   ENDSBS SBS(*ALL) OPTION(*IMMED)
   ```

2. Type the following to reclaim storage:

   ```
   RCLSTG
   ```

   If you had journals, journal receivers, or save files stored in user ASPs and their libraries were in the system ASP, this command places the objects in library QRCL and transfers ownership of the objects to QDFTOWN user profile.

   If you had libraries and associated objects stored in a user ASP, this command will restore their addressability and transfers ownership of the objects to QDFTOWN user profile.

   If objects are not usable in the ASP because the library is not known, this command places the objects in library QRCL and transfers ownership of the objects to QDFTOWN user profile. This happens whether you have isolated objects or an entire library in an ASP.

   If an authorization list is found damaged, all objects secured the authorization list are be transferred to the system authorization list QRCLAUTL. To recover from a damaged authorization list, see the *Security Reference*.

3. Restore user profiles from the correct save tape file (label QFILEUPR).

   Note: Use the tapes from the most recent complete save operation (SAVSYS). If a SAVSECDTA command has been run since the last complete save operation, use the SAVSECDTA tapes.

   If the SAVSYS tape is used, type the following:

   ```
   RSTUSRPRF DEV(TAP01) USRPRF(*ALL) ENDOPT(*LEAVE)
   ```

   If the save security data tape (SAVSECDTA) is used, type the following:

   ```
   RSTUSRPRF DEV(TAP01) USRPRF(*ALL) ENDOPT(*UNLOAD)
   ```

   The time that this takes can vary significantly.

4. Restore the device configuration objects from your most recent SAVSYS or SAVCFG tapes.

If the SAVSYS media is used, type the following:

```
RSTCFG OBJ(*ALL) DEV(TAP01) OBJTYPE(*ALL) ENDOPT(*LEAVE)
```

If the SAVCFG media is used, type the following:

```
RSTCFG OBJ(*ALL) DEV(TAP01) OBJTYPE(*ALL) ENDOPT(*UNLOAD)
```

The time that this takes can vary significantly.

5. Save library QRCL and its contents to create a backup copy of the objects in the user ASPs in case another failure should occur.

   Load a scratch tape, type the following and press the Enter Key.

   ```
   SAVLIB LIB(QRCL) DEV(TAP01) ENDOPT(*UNLOAD)
   ```

6. Depending on the type of user ASP, restore the objects to the system in **one or more** of the following ways:

Option 1. Recovery When No Objects in User ASPs Exist or the Old Type User ASPs Exist

If you had no objects stored in user ASPs or journals, journal receivers, or save files exist in user ASPs (where the library for the objects exists in the system ASP) at the start of this procedure, or if you want to simplify the restore process at the expense of going through restoring objects that are still intact in the user ASPs on your system, perform the following steps:

1. Use the DSPLIB command to display the objects that were placed in library QRCL by the reclaim storage operation.
2. Move all journals and journal receivers to their original libraries. To do this, use the CRTLIB command to create the libraries for the journals and journal receivers. Use the MOVOBJ command to move the journals and journal receivers from library QRCL to their original libraries. This is necessary because journals and journal receivers saved in library QRCL cannot be restored to their original libraries.
3. Delete library QRCL by typing the following and pressing the Enter key.

   ```
   DLTLIB LIB(QRCL)
   ```

4. Restore the IBM and user libraries in one of the following ways.

   Attention

   To ensure the journaling environment is restored correctly, the libraries containing the journals must be restored before the library containing the journaled files. If the journaled files are restored before the journals, journaling is not started again for the files.

   If you saved the libraries using SAVLIB LIB(*NONSYS), enter the following and press the Enter key.

   ```
   RSTLIB SAVLIB(*NONSYS) DEV(TAP01) ENDOPT(*UNLOAD)
   ```

   Or if you saved the IBM libraries using SAVLIB LIB(*IBM) and SAVLIB LIB(*ALLUSR), load the correct tape and then use the following two commands. The first command must complete before entering the second command.

   ```
   RSTLIB SAVLIB(*IBM) DEV(TAP01)
   ```

   And:

```
RSTLIB SAVLIB(*ALLUSR) DEV(TAP01)
```

If a media error occurs....

If an unrecoverable media error occurs during the RSTLIB procedure, you can restart the procedure using the STRLIB parameter on the RSTLIB command. The STRLIB parameter is valid only when *NONSYS, *ALLUSR, or *IBM is specified for the restore operation,

The basic recovery steps for a restore operation are:

1. Check the job log to determine the library where the previous RSTLIB SAVLIB(*NONSYS, *IBM, or *ALLUSR) failed. Find the last library restored which is indicated by a successful restore completion message.
2. Load the first tape of the SAVLIB LIB(*NONSYS, *ALLUSR, or *IBM) media.
3. Type the following and press the Enter key:

   ```
   RSTLIB SAVLIB(*NONSYS, *IBM or *ALLUSR) DEV(tape-name)
       ENDOPT(*LEAVE) STRLIB(library-name) OMITLIB(library-name)
   ```

   where the *library-name* for the STRLIB and the OMITLIB parameters is the library where the RSTLIB failed. This starts the restore operation on the library after the library where the RSTLIB failed.
4. You will be asked to load the volume containing the starting library.
5. After the restore operation is complete, restore the library that failed using the media from a previous save operation.

   Note: Consider eliminating the tape with the media error from the next save rotation cycle to avoid a tape error again.

5. Restore the save files, if any from tape that were saved from library QRCL back to their original ASP libraries.

   ```
   RSTOBJ OBJ(object-name) DEV(TAP01) SAVLIB(QRCL) RSTLIB(library-name)
          ALWOBJDIF(*ALL)
   ```

6. The RCLSTG command changed ownership of objects in user ASPs to QDFTOWN user profile. Transfer ownership of the objects owned by user profile QDFTOWN to the correct user profile.

   a. Type the following and press the Enter key.

      ```
      WRKOBJOWN USRPRF(QDFTOWN)
      ```

      The Work with Objects by Owner display is shown.

   b. On the Work with Objects by Owner display, type a 9 in the *Opt* column for each object in the ASP library that you want to change ownership for.

   c. If all the objects will have the same owner, type the following on the command line of the Work with Objects by Owner display and press the Enter key. Otherwise, continue with the next step.

      ```
      NEWOWN(owner-name)
      ```

      Note: If you enter NEWOWN(owner-name) on the command line of the Work with Object by Owner display, you will not have to enter an owner name in the *New owner* prompt on the Change Object Owner display.

d. Press the Enter key.

e. On the Change Object Owner (CHGOBJOWN) display, type the name of the new owner in the *New owner* prompt and press the Enter key. Repeat this step for all the objects that need the ownership changed.

7. If you have document library objects to restore, load the SAVDLO tape, and then type the following:

   ```
   RSTDLO DLO(*ALL) SAVFLR(*ANY) DEV(TAP01) ENDOPT(*UNLOAD)
   ```

   Note: If you have changed objects to restore or were journaling, do not run the RSTAUT command. Continue with the task "Restore Changed Objects."

8. Grant all private object authorities that existed when the system was saved by typing the following and pressing the Enter key. No media is required.

   ```
   RSTAUT
   ```

9. The RCLSTG command changed ownership of objects existing in user ASPs to QDFTOWN user profile. Transfer ownership of the objects in the user ASP library from QDFTOWN user profile to the correct user profile.

   a. Type the following and press the Enter key:

      ```
      WRKOBJOWN USRPRF(QDFTOWN)
      ```

      The Work with Objects by Owner display is shown.

   b. On the Work with Objects by Owner display, type a 9 in the *Opt* column for each object in the ASP library that you want to change ownership for.

   c. If all the objects will have the same owner, type the following on the command line of the Work with Objects by Owner display. Otherwise, continue with the next step.

      ```
      NEWOWN(owner-name)
      ```

      Note: If you enter NEWOWN(owner-name) on the command line of the Work with Object by Owner display, you will not have to enter an owner name in the *New owner* prompt on the Change Object Owner display for each object.

   d. Press the Enter key.

   e. On the Change Object Owner (CHGOBJOWN) display, type the name of the new owner in the *New owner* prompt and press the Enter key. Repeat this step for all the objects that need the ownership changed.

10. Load the SAVDLO tape, and then type the following to restore document library objects:

    ```
    RSTDLO DLO(*ALL) SAVFLR(*ANY) DEV(TAP01) ENDOPT(*UNLOAD)
    ```

    Note: If you have changed objects to restore or were journaling, do not run the RSTAUT command. Continue with the task "Restoring Changed Objects."

11. Type the following to grant all private object authorities that existed when the system was saved:

    ```
    RSTAUT
    ```

Option 2. Recovery of Objects and Libraries Existing in User ASPs

After the RCLSTG command is run, the addressability of libraries and objects in the user ASP is restored.

1. If the user ASP contained a library with journal receivers, save the library in the user ASP if step 4b on page 13-63 applies:
   a. Load a tape in the tape unit.
   b. Save the library by typing the following and pressing the enter key.

      ```
      SAVOBJ OBJ(*ALL) LIB(user-ASP-library-name) DEV(TAP01)
           OBJTYPE(*JRNRCV) VOL(*MOUNTED) ENDOPT(*UNLOAD)
      ```

      Or

      ```
      SAVLIB LIB(user-ASP-library-name) DEV(tape-device-name)
            VOL(*MOUNTED) ENDOPT(*UNLOAD)
      ```

2. If objects are found in QRCL, then the objects are not associated with a library. Do the following:
   a. Delete the objects in the user ASP. If the object is a physical file, you must delete the associated logical files first, and then delete the physical file. Do the following:
      1) Display the library in the user ASP:

         ```
         WRKLIB LIB(library-name)
         ```

      2) Type a 12 (Work with objects) in the *Opt* column and press the Enter key.
      3) Find the objects to be deleted in the *Object* column.
      4) Type a 4 (Delete) in the *Opt* column for each object you want to delete.
      5) Press the Enter key.
   b. After the objects in the ASP are deleted, create the original libraries for the journals and journal receivers. Specify the ASP number on the ASP parameter of the CRTLIB command.

      ```
      CRTLIB LIB(library-name) ASP(ASP-number)
      ```

3. Restore the individual libraries to the system ASP from your save tapes.

   Do not restore libraries from the SAVLIB tapes that are in user ASPs (those found by reclaim processing). Specify the OMITLIB parameter to exclude up to 300 libraries that exist in the user ASPs.

   Attention

   To ensure the journaling environment is restored correctly, the libraries containing the journals must be restored before the library containing the journaled files. If the journaled files are restored before the journals, journaling is not started again for the files.

   ```
   RSTLIB SAVLIB(*NONSYS) DEV(TAP01) OMITLIB(user-ASP-library-name)
   ```

   Or if you saved the IBM libraries using SAVLIB LIB(*IBM) and SAVLIB LIB(*ALLUSR), load the correct tape and then use the following two commands. The first command must complete before entering the second command.

```
RSTLIB SAVLIB(*IBM) DEV(TAP01)
```

And:

```
RSTLIB SAVLIB(*ALLUSR) DEV(TAP01) OMITLIB(user-ASP-library-name)
```

If a media error occurs....

If an unrecoverable media error occurs during the RSTLIB procedure, you can restart the procedure using the STRLIB parameter on the RSTLIB command. The STRLIB parameter is valid only when *NONSYS, *ALLUSR, or *IBM is specified for the restore operation,

The basic recovery steps for a restore operation are:

1. Check the job log to determine the library where the previous RSTLIB SAVLIB(*NONSYS, *IBM, or *ALLUSR) command failed. Find the last library restored which is indicated by a successful restore completion message.
2. Load the first tape of the SAVLIB LIB(*NONSYS, *ALLUSR, or *IBM) media.
3. Type the following and press the Enter key:

   ```
   RSTLIB SAVLIB(*NONSYS, *IBM or *ALLUSR) DEV(tape-name)
       ENDOPT(*LEAVE) STRLIB(library-name) OMITLIB(library-name)
   ```

   where the *library-name* for the STRLIB and the OMITLIB parameters is the library where the RSTLIB failed. This starts the restore operation on the library after the library where the RSTLIB failed.
4. You will be asked to load the volume containing the starting library.
5. After the restore operation is complete, restore the library that failed using the media from a previous save operation.

   Note: Consider eliminating the tape with the media error from the next save rotation cycle to avoid a tape error again.

4. If journal receivers are in a user ASP and the journals and journaled files are in a different ASP, you must re-associate the receivers with their journals.

   Use one of the following methods to re-associate the journal receivers:

   a. Use the Work with Journals command:

      1) Type WRKJRN on a command line and press the Enter key.
      2) Type a 9 (Associate receivers with journal) in the *Opt* column next to the journal you want to work with.
      3) Press the Enter key.

         The receivers are re-associated with the journal.

   b. Restore the journal receivers from the save media created in step 1, by typing the following and press the Enter key.

      ```
      RSTOBJ OBJ(*ALL) SAVLIB(user-ASP-library-name) DEV(TAP01)
             VOL(*MOUNTED) ENDOPT(*UNLOAD)
      ```

      Or

      ```
      RSTLIB SAVLIB(user-ASP-library-name) DEV(TAP01) VOL(*MOUNTED)
        ENDOPT(*UNLOAD)
      ```

The receivers are re-associated with the journal.

5. The RCLSTG command changed ownership of objects existing in user ASPs to QDFTOWN user profile. Transfer ownership of the objects in the user ASP library from QDFTOWN user profile to the correct user profile.

   a. Type the following and press the Enter key:

      ```
      WRKOBJOWN USRPRF(QDFTOWN)
      ```

      The Work with Objects by Owner display is shown.

   b. On the Work with Objects by Owner display, type a 9 in the *Opt* column for each object in the ASP library that you want to change ownership for.

   c. If all the objects will have the same owner, type the following on the command line of the Work with Objects by Owner display. Otherwise, continue with the next step.

      ```
      NEWOWN(owner-name)
      ```

      Note: If you enter NEWOWN(owner-name) on the command line of the Work with Object by Owner display, you will not have to enter an owner name in the *New owner* prompt on the Change Object Owner display for each object.

   d. Press the Enter key.

   e. On the Change Object Owner (CHGOBJOWN) display, type the name of the new owner in the *New owner* prompt and press the Enter key. Repeat this step for all the objects that need the ownership changed.

6. Load the SAVDLO tape, and then type the following to restore document library objects:

   ```
   RSTDLO DLO(*ALL) SAVFLR(*ANY) DEV(TAP01) ENDOPT(*UNLOAD)
   ```

   Note: If you have changed objects to restore or were journaling, do not run the RSTAUT command. Continue with the task "Restoring Changed Objects."

7. Type the following to grant all private object authorities that existed when the system was saved:

   ```
   RSTAUT
   ```

Task 6. Restore Changed Objects

Attention!

If you are using journaling and need to apply journaled changes, continue with the following steps. Use these recommended steps to avoid a failed restore operation caused by restoring journal receivers with names that conflict with the journal receivers currently attached to the restored journals. Otherwise, ignore these steps and continue with "Restoring Changed Objects."

Note: If you are using OfficeVision/400 or PC Support/400 and are performing daily save operations using SAVDLO and SAVCHGOBJ LIB(QUSRSYS) OBJJRN(*NO) commands, you must perform the steps in "Working with Journals" for the system supplied journal QUSRSYS/QAOSDIAJRN. If you specified OBJJRN(*YES) on the SAVCHGOBJ command, you do not need to apply journal changes.

Working with Journals

1. Type the following and press the Enter key:

   ```
   WRKJRN
   ```

2. The Specify Journal Name display is shown. Specify *ALL for the *Library name* prompt and press the Enter key.

3. The Work with Journals display is shown. To display the name of the currently attached journal receiver, type a 5 (Display journal status) in the *Opt* field for each journal on which you want to apply changes. Write down all the names of the journals and their currently attached journal receivers.

   Notes:

   a. You only need to perform the following steps for those journals you plan to use for recovering journaled files by performing the APYJRNCHG command. If no database files have been journaled to a journal, the system cannot apply any journaled changes using the journal.

   b. If you are using OfficeVision/400 or PC Support/400, you must apply journaled changes to the files journaled to the system-supplied journal QUSRSYS/QAOSDIAJRN.

4. You cannot restore journal receivers from the SAVLIB, SAVOBJ, or SAVCHGOBJ media if they have the same names as the journal receivers that are attached. To later apply all journaled changes that have occurred since the last complete save operation, you must restore the receivers to the system from the save media.

   To avoid a failed restore operation of saved journal receivers because of name conflicts, do the following for each journal identified in the previous step.

   a. Create a journal receiver that will be used as a temporary receiver. Give it a name that will identify it as a temporary receiver, for example, TEMPnn. You can enter a description in the text (TEXT parameter) that identifies it as a temporary receiver for disaster recovery.

      ```
      CRTJRNRCV JRNRCV(library-name/TEMPnn)
            TEXT('temporary journal receiver for journal xxx')
      ```

      Repeat this step for each journal found in step 3.

   b. To detach the current receiver and attach the new TEMPnn receiver, type the following and press the Enter key.

      ```
      CHGJRN JRN(library-name/journal-name) JRNRCV(library-name/TEMPnn)
      ```

      Repeat this step for each journal found in step 3.

   c. Delete the detached journal receiver (identified in step 3 where you wrote down the name of the journal and journal receiver) using the Delete Journal Receiver (DLTJRNRCV) command.

      ```
      DLTJRNRCV JRNRCV(library-name/journal-receiver)
      ```

      Repeat this step for each journal found in step 3.

      If you receive message CPA7025 *Receiver never fully saved*, enter an I to ignore and press Enter to continue the delete.

      This allows the journal receivers on the save media to be restored successfully.

Restoring Changed Objects

1. Load the SAVCHGOBJ tape.

   Note: Several commands found in library QUSRTOOL can help you during save and restore operations. If you create the RSTALLCHG command in library QUSRTOOL, you can use the RSTALLCHG command to restore the libraries with changed objects from the SAVCHGOBJ or SAVALLCHG media without the need to know the names of the saved libraries. You need to run only one RSTALLCHG command to restore all the libraries. For more information about these commands, see "Restore All Changes (RSTALLCHG) Command" on page D-9.

2. If you do not use the RSTALLCHG in library QUSRTOOL and you specified SAVCHGOBJ LIB(*ALLUSR), type the following to determine the libraries that were saved:

   ```
   DSPTAP DEV(device-name) OUTPUT(*PRINT)
   ```

3. To restore changed objects, type the following and press the Enter key:

   ```
   RSTOBJ OBJ(*ALL) DEV(tape-device) SAVLIB(library-name)
              OBJTYPE(*ALL) ENDOPT(*LEAVE) MBROPT(*ALL)
   ```

   You must repeat this step for every library saved using the SAVCHGOBJ command.

4. Do one of the following:

   - If you are using journaling, perform the steps in "Applying Journal Changes" for each journal.
   - If you need to restore changed documents and folders, with the steps in "Restoring Changed Documents and Folders."
   - If you do not have no other restore steps to perform, continue with the following step.

5. Restore users' authority by entering:

   ```
   RSTAUT
   ```

   The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.

6. This completes the restore operation.

7. Perform a normal IPL and return the system to normal operations:

   a. Turn the keylock switch to the Normal position.

   b. Type the following on a command line and press the Enter key.

      ```
      PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
      ```

8. When the IPL is complete, sign on the system.

9. Start any other subsystems that need to be started, such as QTCP or QSNADS.

   ```
   STRSBS SBSD(subsystem-name)
   ```

Task 7. Apply Journaled Changes

Ensure that all the journal receivers required for the apply journaled changes operation are available on the system. In general, you will need all journal receivers that were attached to the journal for the length of time for which journaled changes are now to be applied to the restored files. Restore all necessary journal receivers, including ones that might have not been restored earlier because of name conflicts with the receivers attached to the restored journals. Use the Display Journal Receiver Attributes (DSPJRNRCVA) command to determine when a journal receiver was attached to and detached from a journal.

1. Determine the name of the last journal receiver (the last receiver restored) by entering the following:

   ```
   WRKJRNA JRN(library-name/journal-name)
   ```

2. Press the Enter key.
3. Press F15 (Work with receiver directory) from the Work with Journal Attributes display to show the last journal receiver with a status of SAVED or PARTIAL. Write down the name of the receiver.
4. Determine the chain of receivers to be used in the APYJRNCHG command from the Work with Receiver Directory display. Write down the first and last receiver that you restored (last receiver is prior to the TEMPnn receiver). Notice that the first and last receiver are the same if only one journal receiver was restored.

   Note: While looking at the receiver directory, you should also look for any receiver chain breaks. You can determine a chain break by looking at the first two digits in the *Number* column on the Work with Receiver Directory display. You cannot apply journaled changes across receiver chain breaks. Therefore, you must write down the beginning and ending receiver names for each receiver chain. Then you need to run a series of apply journaled changes operations, one for each chain using these receivers. The *Advanced Backup and Recovery Guide* has more information about receiver chain breaks.

5. When applying journal changes, if the ending receiver has a status of PARTIAL (saved while attached), the TOENT parameter requires a sequence number to be specified on the APYJRNCHG command. Determine the last entry to be applied for the last receiver (identified in previous step).

   To determine the last receiver in the receiver range, type an 8 (Display attributes) in the *Opt* field next to the receiver name on the Work with Receiver Directory display.

   Write down the value for the *Last Sequence Number* field.

6. To ensure that the files are currently being journaled, do the following from the Work with Journal Attributes display:

   a. Press F13 (Display journaled files) from the Work with Journal Attributes display to show the list of files currently being journaled. To start journaling for a physical file that should be in the list, run the STRJRNPF command for each physical file not in the list.

   b. Press F14 (Display Journaled Access Paths) from the Work with Journal Attributes main display to display the list of currently journaled access paths. To start journaling access paths for a physical or logical file that

should be in the list, run the STRJRNAP command for the physical or logical file that is not in the list.

Notice that before journaling an access path, all physical files over which the access path is built must first be journaled to this journal. When you have ensured all files are correctly journaled, continue with the next step.

7. To continue the naming convention for your journal receivers, create a receiver that follows the same naming convention as the last receiver but assign it a number of one greater.

   ```
   CRTJRNRCV JRNRCV(library-name/journal-receiver-nameNN)
   ```

   By doing this, you are doing what the CHGJRN command would normally do if the last receiver saved was the current receiver being detached with a new receiver name being created.

8. Use the CHGJRN command to detach the temporary receiver and attach the new receiver you just created.

   ```
   CHGJRN JRN(library-name/journal-name)
          JRNRCV(library-name/journal-receiver-nameNN)
   ```

9. Enter the following command to apply the journaled changes using the first and last journal receivers identified on the Work with Receiver Directory display.

   ```
   APYJRNCHG JRN(library-name/journal-name)
             FILE((library-name/*ALL))
             RCVRNG(lib-name/first-receiver lib-name/last-receiver)
             FROMENT(*LASTSAVE) TOENT(last-entry)
   ```

   Note: If you determined in step 4 of this procedure that this journal had receiver chain breaks, then you must run an APYJRNCHG command for each chain instead of one command as shown. For the RCVRNG parameter, specify the first and last receiver for each chain. For the FROMENT and TOENT parameters, specify:

   a. FROMENT(*LASTSAVE) and TOENT(*LAST) for the first receiver chain.

   b. FROMENT(*FIRST) and TOENT(*LAST) for the middle receiver chains.

   c. FROMENT(*FIRST) and TOENT(last-entry) for the last receiver chain.

Attention

You must specify individual files on the FILE parameter instead of *ALL for the QAOSDIAJRN journal in library QUSRSYS. Do not apply journal changes to the document and folder search index database files (QAOSSS10 through QAOSSS15, QAOSSS17, and QAOSSS18) for journal QAOSDIAJRN in library QUSRSYS.

```
APYJRNCHG JRN(QUSRSYS/QAOSDIAJRN)
     FILE((QUSRSYS/QAOKPLCA) (QUSRSYS/QAOSAY05)
          (QUSRSYS/QAOKPX4A) (QUSRSYS/QAOSAY07)
          (QUSRSYS/QAOKP01A) (QUSRSYS/QAOKP02A)
          (QUSRSYS/QAOKP03A) (QUSRSYS/QAOKP04A)
          (QUSRSYS/QAOKP05A) (QUSRSYS/QAOKP06A)
          (QUSRSYS/QAOKP08A) (QUSRSYS/QAOKP09A))
      RCVRNG(lib-name/first-receiver lib-name/last-receiver)
      FROMENT(*LASTSAVE) TOENT(last-entry)
```

If you need to restore changed documents and folders, with the steps in "Restoring Changed Documents and Folders." Otherwise, continue with the next step.

10. Restore users' authority by entering:

    ```
    RSTAUT
    ```

    The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.

11. This completes the restore operation.

12. Perform a normal IPL and return the system to normal operations:

    a. Turn the keylock switch to the Normal position.

    b. Type the following on a command line and press the Enter key.

    ```
    PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
    ```

13. When the IPL is complete, sign on the system.

14. Start any other subsystems that need to be started, such as QTCP or QSNADS.

    ```
    STRSBS SBSD(subsystem-name)
    ```

Task 8. Restore Changed Documents and Folders

If you performed daily save operations for documents and folders, do the following steps. Otherwise, continue with the RSTAUT command.

1. Load the last daily SAVDLO tape.

2. If you performed daily save (SAVDLO DLO(*CHG)) operations to back up all new folders, new and changed documents, and mail since the last complete SAVDLO DLO(*ALL) FLR(*ANY) operation, type the following and press the Enter key.

   ```
   RSTDLO DLO(*ALL) DEV(TAP01) SAVFLR(*ANY)
   ```

   Note: If an unrecoverable error occurs when running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command, see "Media or Device Error When Running the RSTDLO Command" on page 9-11.

3. Restore users' authority by entering:

   ```
   RSTAUT
   ```

   The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.

4. This completes the restore operation.
5. Perform a normal IPL and return the system to normal operations:
   a. Turn the keylock switch to the Normal position.
   b. Type the following on a command line and press the Enter key.

      ```
      PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
      ```

6. When the IPL is complete, sign on the system.
7. Start any other subsystems that need to be started, such as QTCP or QSNADS.

   ```
   STRSBS SBSD(subsystem-name)
   ```

This completes the steps to recover from a disk unit media failure in the system ASP with user ASPs configured.

Recovering from a Disk Media Failure in a User ASP

This example describes two methods to recover from a media failure in a user ASP:

1. Method 1 is used to recover a user ASP if it was not in overflowed status at the time of the failure.
2. Method 2 is used to recover a user ASP if it was in overflowed status at the time of the failure.

These procedures assume that you have a backup tape or diskette containing saved objects and libraries.

If a disk unit failure occurs in a user ASP, as described above, you and your service representative will determine whether it should be treated as a disk unit media failure. If this is the case, the service representative will replace the failed disk unit and as a result, the system will clear all units in the user ASP where the unit failure occurred (all objects in the failed user ASP are destroyed). All unaffected user ASPs, as well as the system ASP, remain as they were before the media failure occurred.

After the service representative replaces the failed disk unit, do **one** the following:

Method 1. Recovering a User ASP that Was Not in Overflowed Status

```
                    Use Dedicated Service Tools (DST)

Select one of the following:

          1. Perform an IPL
          2. Install the operating system
          3. Work with licensed internal code
          4. Work with disk units
          5. Work with DST environment
          6. Select DST console mode
          7. Start a service tool
          8. Perform automatic installation of the operating system
          9. Work with save storage and restore storage




Selection
     —

F3=Exit           F12=Cancel
```

1. Select option 1 (Perform an IPL) on the Use Dedicated Service Tools menu.
2. Select option 1 (Perform an IPL) on the IPL or Install the System menu

   After IPL processing is complete, the command entry display will appear and you can proceed to the next step.
3. Sign on the system as QSECOFR.
4. Load the SAVSECDTA tape or the correct volume of the SAVSYS media.
5. Restore the user profiles.

   ```
   RSTUSRPRF DEV(TAP01) USRPRF(*ALL) ENDOPT(*UNLOAD)
   ```
6. Load the correct volume of the RSTLIB or RSTOBJ tapes.
7. Use the appropriate restore command to restore the desired objects to the ASP:

   ```
   RSTLIB SAVLIB(library-name) DEV(TAP01)
   ```

   Or:

   ```
   RSTOBJ OBJ(*ALL) SAVLIB(library-name) DEV(TAP01) OBJTYPE(*ALL)
          ENDOPT(*REWIND) MBROPT(*ALL)
   ```

   Notes:

   a. If the user ASP contained journal receivers associated with journals in another ASP, create a new journal receiver in the user ASP for each of these journals and run the CHGJRN command to attach the new receiver to the journal.

   b. If the user ASP contained journals and the journaled files were in the system ASP (ASP1), do the following to restore your journaling environment:

1) Create the journal receivers (CRTJRNRCV command) and the journal (CRTJRN). You may have restored the journal in step 5. If you have restored the journal, skip this step.
2) Use the STRJRNPF command to resume journaling for the physical files that were journaled to this journal.
3) Use the STRJRNAP command to resume journaling for the access paths that were journaled to this journal.
4) If the restored files need journaled changes applied, see "Restoring Changed Objects" on page 10-51.
5) Save all the journaled objects. Saving these objects now will allow you to use the journal for recovery in the future.

As an alternative for steps 7b2 and 7b3, if the files were saved after journaling was started, the restore operation automatically resumes journaling for the files.

1) Delete all files and access paths that were previously journaled to this journal.
2) Restore all the journaled files and access paths.

8. Restore the private authorities:

   ```
   RSTAUT
   ```

   Note: If users have many private authorities to objects, the RSTAUT command may take a long time to run.

9. If any objects were restored into a different library than the one from which they were saved, manually grant private authority for the restored objects with the EDTOBJAUT command.
10. This completes the steps to recover from a disk unit media failure in a user ASP that was not in overflowed status.
11. Saving of the libraries in the ASP is recommended.

Method 2. Recovering a User ASP that Was in Overflowed Status

1. Select option 1 (Perform an IPL) on the IPL or Install the System menu

   After IPL processing is complete, the command entry display will appear and you can proceed to the next step.

2. End all subsystem using the following command:

   ```
   ENDSBS *ALL *IMMED
   ```

   Note: Before running the RCLSTG command after an IPL, you may need to wait several minutes for the IPL to complete. Use the Work with Active Jobs (WRKACTOBJ) command to verify no jobs are running.

3. Type the following to reclaim storage:

   ```
   RCLSTG
   ```

   If objects were found in library QRCL, the objects are still known to the system. Although the initial disk extents for these objects may have been allocated in the system ASP, portions of the objects may still have been lost. Therefore, the integrity of the object cannot be predicted.

4. To identify the objects in library QRCL, type the following and press the Enter key.

   ```
   DSPLIB QRCL
   ```

   Write down the names of the objects found in library QRCL.

5. Delete the objects.

   If the object is a physical file, you must delete the associated logical files first, and then delete the physical file. Do the following:

   a. Display the library in the user ASP:

      ```
      WRKLIB LIB(library-name)
      ```

   b. Type a 12 (Work with objects) in the *Opt* column and press the Enter key.

   c. Find the objects to be deleted in the *Object* column.

   d. Type a 4 (Delete) in the *Opt* column for each object you want to delete.

   e. Press the Enter key.

6. Load the SAVSECDTA tape or the correct volume of the SAVSYS media.

7. Restore the user profiles.

   ```
   RSTUSRPRF DEV(TAP01) USRPRF(*ALL)
   ```

8. Load the correct volume of the RSTLIB or RSTOBJ tapes.

9. Use the appropriate restore command to restore the desired objects to the ASP. If you are restoring physical and logical files, the physical files must be restored before the logical files.

   ```
   RSTLIB SAVLIB(library-name) DEV(TAP01)
   ```

   Or:

   ```
   RSTOBJ OBJ(*ALL) SAVLIB(library-name) DEV(TAP01)
       OBJTYPE(*ALL) ENDOPT(*REWIND) MBROPT(*ALL)
   ```

10. Restore the private authorities:

    ```
    RSTAUT
    ```

    Note: If users have many private authorities to objects, the RSTAUT command may take a long time to run.

11. If any objects were restored into a different library than the one from which they were saved, manually grant private authority for the restored objects with the EDTOBJAUT command.

    a. If the user ASP contained journal receivers associated with journals in another ASP, create a new journal receiver for each of these journals and run the CHGJRN command to attach the new receiver to the journal.

    b. If the user ASP contained journals and the journaled files were in the system ASP (ASP1), do the following to restore your journaling environment:

       1) Create the journal receivers (CRTJRNRCV command) and the journal (CRTJRN). You may have restored the journal in step 5. If you have restored the journal, skip this step.

       2) Use the STRJRNPF command to resume journaling for the physical files that were journaled to this journal.

3) Use the STRJRNAP command to resume journaling for the access paths that were journaled to this journal.

4) Save all the journaled objects. Saving these objects now will allow you to use the journal for recovery in the future.

As an alternative for steps 11b2 on page 13-73 and 11b3, do the following:

1) Restore all the journaled files and access paths. If the files were saved after journaling was started, the restore operation automatically resumes journaling for the files.

2) If the restored files need journaled changes applied, see "Restoring Changed Objects" on page 10-51.

12. This completes the steps to recover from a disk unit media failure in a user ASP.

Recovering from Unreadable Sectors during a Disk Unit Failure

During the replacement of a failed disk unit, some sectors on the failing disk unit might not be readable. On a system that does not have checksum protection, the data from these sectors is lost. The objects that the data belongs to are damaged. If the unreadable sectors are in the system ASP, it may be necessary to install the operating system again.

During the IPL of the operating system, storage management recovery attempts to locate the damaged objects and enter them in the Object recovery list. Message CPI8197 is sent to QSYSOPR message queue if any of the objects are in the object recovery list. Each damaged object is identified by message CPI81xx in the history log QHST. Use the Display Log (DSPLOG) command to view these messages. Look at each message and do the recovery actions listed.

If there are a large number of damaged objects in the object recovery list, or if the system continues to encounter damaged objects during normal operations, it may be necessary to clear the Auxiliary Storage Pool (ASP), and reload all data in that ASP. Selecting the option to delete the ASP data causes all data in the ASP to be erased. All data and programs in the ASP must then be restored.

Part 4. Appendixes

Appendix A. Licensed Internal Code SRCs That Require User Input (A6xx xxxx)

The following topics describe Licensed Internal Code SRCs that require user input (A6xx xxxx).

Function 11, Data Code A6xx 6001

This topic describes the user input required by the Licensed Internal Code SRC A6xx 6001.

Description: Select the utility (Licensed Internal Code Install or Licensed Internal Code Restore you want to run.

Reply: Using the Select key on the control panel, select the function code for the utility you want to run, then press the Enter key:

Function Code	*Utility Selected*
23	Stand-Alone Licensed Internal Code Restore The stand-alone Licensed Internal Code restore utility copies all system Licensed Internal Code from the tape and writes over the Licensed Internal Code found on the disk. Select this utility to exchange or update an existing system's Licensed Internal Code without losing customer data already on the system.
24	Stand-Alone Licensed Internal Code Install The stand-alone Licensed Internal Code install utility deletes all information found on unit 1 (including customer data) and copies all system Licensed Internal Code from tape to disk. The data on all the remainder of the disk units will not be erased but may not be accessible (because of the way data is spread over multiple units on the system). Select this utility when initially starting up a new system (which contains no customer data and no Licensed Internal Code) or in cases where the primary disk was exchanged.
29	Load Model-Unique Licensed Internal Code The load model-unique Licensed Internal Code utility copies only the Licensed Internal Code from tape, and writes over any existing Licensed Internal Code on disk. Select this utility when a hardware model upgrade is performed.
32	Download disk Licensed Internal Code The download disk Licensed Internal Code utility downloads the Licensed Internal Code from tape to disk. Use this function when the disk Licensed Internal Code should be changed.
(None)	Cancel this request. If you do not want to select any of these options, turn the system control panel off.

Function 11, Data Code A6xx 6002

This topic describes the user input required by the Licensed Internal Code SRC A6xx 6002.

Description: **Warning:** Do you want to destroy all data on all disk units?

The stand-alone Licensed Internal Code install was requested; however, the disk unit that contains storage unit 1 already contains data. Continuing with Licensed Internal Code install will delete all data on the disk unit that contains unit 1. The data on all the remainder of the disk units will not be deleted, but may not be accessible (because of the way data is spread over multiple units on the system).

Function codes may be used to display to which disk the system is attempting to install.

The function codes are different for systems with Version 2 hardware. The Version 2 hardware function codes are identified with a **-2** and are enclosed in parentheses (such as 15-2).

Function Code	*Function*
14 (15-2)	Display type and model of the disk unit that contains unit 1. The first 4 characters displayed in the lights will show the type. The next 4 characters show the model. An example of what would be shown after you select this option follows. (This shows what you would see if the disk was a 9332 Model 400.)

14 (15-2)	9332 0400

15 (16-2)	Display address of the disk unit that contains unit 1. Eight characters will be shown on the display lights. The meaning of these characters is shown below.

Character Position	***Description***
1–2	Bus number (should be zero)
3	IOP card number
4	IOP board number
5–6	Facility address (DFCI)
7–8	Secondary address

The following is an example of what would be shown after you select this option:

15 (16-2)	0010 0700

16 (17-2)	Display the serial numbers of the disk unit that contains unit 1. The following is an example of what should be shown after you select this option:

16 (17-2)	0012 3456

Reply: Using the Function Select key on the control panel, type one of the following codes and press the Enter key:

Function Code	*Function*
23	Restore the Licensed Internal Code without destroying customer data. Select function code 23 if you want to restore the Licensed Internal Code to the disk unit that contains storage unit 1 without deleting any other data from the system. Selecting this option will copy all system Licensed Internal Code from tape and will exchange the Licensed Internal Code found on unit 1. Select this option if you want to exchange or update an existing system's Licensed Internal Code without losing customer data.
24	Destroy all system data and restore the Licensed Internal Code. Select function code 24 if you want to restore the licensed internal code to the selected disk unit, and you want to *destroy all data* on the system. Selecting this option will first delete all information found on the disk unit that contains storage unit 1 (including customer data) and then will copy all system licensed internal code from tape to disk. The data on all the remainder of the disk units will not be deleted but may not be accessible (because of the way data is spread over multiple units on the system). Select this option if you are installing a new system (which contains no customer data and no Licensed Internal Code), or if you have exchanged the disk unit that contains storage unit 1.
(None)	Cancel this request. If you do not want to continue with the Licensed Internal Code install, turn the control panel off.

Function 11, Data Code A6xx 6003

This topic describes the user input required by the Licensed Internal Code SRC A6xx 6003.

Description: **Warning:** Do you want to destroy all data on all disk units?

The stand-alone Licensed Internal Code install was requested. The system found a disk unit attached at the correct location for being the disk unit that contains storage unit 1. However, the disk unit found already contains data, and the data is not in the correct format to be unit 1. The wrong disk unit may be attached at the location where the disk unit that contains storage unit 1 should be, or the correct disk unit that contains storage unit 1 may not be turned on (in which case the system detected the wrong disk unit as unit 1).

Continuing with Licensed Internal Code install will delete all data on the disk unit that contains storage unit 1. The data on all the remainder of the disk devices will not be deleted, but may not be accessible (because of the way data is spread over multiple units on the system). This information can be used with the rack configuration list printouts to ensure the system will install or restore to the correct disk.

Function codes may be used to identify which disk the system is attempting to install the Licensed Internal Code. The function codes are different for systems

with Version 2 hardware. The Version 2 hardware function codes are identified with a **-2** and are enclosed in parentheses (such as 15-2).

Function Code	*Function*
14 (15-2)	Display type and model of the disk unit that contains storage unit 1. The first 4 characters displayed in the lights will show the type. The next 4 characters show the model. The following is an example of what would be shown after you select this option. (This shows what you would see if the disk was a 9332 Model 400.) 14 (15-2) | 9332 0400
15 (16-2)	Display address of the disk unit that contains storage unit 1. Eight characters will be shown on the display lights. The meaning of these characters is as follows: ***Character Position*** — ***Description*** 1–2 — Bus number (should be zero) 3 — IOP card number 4 — IOP board number 5–6 — Facility address (DFCI) 7–8 — Secondary address The following is an example of what would be shown after you select this option: 15 (16-2) | 0010 0700
16 (17)	Display the serial numbers of the disk unit that contain storage unit 1. The following is an example of what should be shown after you select this option. 16 (17-2) | 0012 34561

Reply: Using the Function Select key on the control panel, type one of the following codes and press the Enter key:

Function Code	*Function*
24	Destroy all system data and restore the Licensed Internal Code. Select function code 24 if you want to do the following: • Restore the Licensed Internal Code to the selected disk unit. • Destroy all data on the system. Selecting this option will first delete all information found on the disk unit that contains storage unit 1 (including customer data) and then will copy all system licensed internal code from tape to disk. The data on all the

remainder of the disk units will not be deleted but may not be accessible (because of the way data is spread over multiple units on the system).

Select this option if you are installing a new system (which contains no customer data and no Licensed Internal Code), or if you have exchanged unit 1.

(None) Cancel this request.

If you do not want to continue with the Licensed Internal Code install operation, turn the control panel off.

Function 11, Data Code A6xx 6004

This topic describes the user input required by the Licensed Internal Code SRC A6xx 6004.

Description: **Warning:** The disk unit that contains storage unit 1 does not contain Licensed Internal Code.

The stand-alone Licensed Internal Code restore was requested. The system found a disk unit attached at the correct location for being the disk unit that contains storage unit 1. However, the disk unit found already contains data and the data is not in the correct format to be unit 1. The wrong disk unit may be attached at the location where unit 1 should be, or the correct disk unit that contains storage unit 1 may not be turned on (in which case the system detected the wrong disk unit as unit 1).

To restore Licensed Internal Code to this disk unit, the system must first destroy all data on the disk unit that contains storage unit 1 (to correctly format it to be a disk unit that contains storage unit 1). The data on all the remainder of the disk units will not be deleted, but may not be accessible (because of the way data is spread over multiple units on the system).

Function codes may be used to display which disk the system is attempting to restore. This information can be used with the rack configuration list printouts to ensure the system will restore to the correct disk.

The function codes are different for systems with Version 2 hardware. The Version 2 hardware function codes are identified with a **-2** and are enclosed in parentheses (such as 15-2).

Function Code *Function*

14 (15-2) Display type and model of the disk unit that contains storage unit 1. The first 4 characters displayed in the lights will show the type. The next 4 characters show the model.

The following is an example of what would be shown after you select this option. (This shows what you would see if the disk was a 9332 Model 400.)

14 (15-2)	9332 0400

15 (16-2) Display address of the disk unit that contains storage unit 1. Eight characters will be shown on the display lights. The meaning of these characters are as follows:

Character Position	*Description*
1–2	Bus number (should be zero)
3	IOP card number
4	IOP board number
5–6	Facility address (DFCI)
7–8	Secondary address

The following is an example of what would be shown after you select this option:

15 (16-2)	0010 0700

16 (17-2) Display the serial numbers of the disk unit that contains storage unit 1.

The following is an example of what should be shown after you select this option:

16 (17-2)	0012 3456

Reply:

Function Code	*Function*
24	Destroy all system data and restore the Licensed Internal Code.

Select function code 24 if you want to do the following:

- Destroy all data on the system.
- Restore the Licensed Internal Code to the selected disk unit.

Selecting this option will first delete all information found on the disk unit that contains storage unit 1 (including customer data) and then will copy all system Licensed Internal Code from tape to disk. The data on all the remainder of the disk units will not be deleted but may not be accessible (because of the way data is spread over multiple units on the system).

Select this option if you are installing a new system (which contains no customer data and no Licensed Internal Code), or if you have exchanged the disk unit that contains unit 1.

(None) Cancel this request.

If you do not want to continue with the Licensed Internal Code restore operation, turn off the control panel.

Function 11, Data Code A6xx 6005

This topic describes the user input required for the Licensed Internal Code SRC A6xx 6005.

Description: Disk unit that contains storage unit 1 not found.

The disk unit that contains unit 1 cannot be located. Try the following:

- For 9335 devices, ensure that the Enable/Disable switch is in the Enable position.

- Ensure that all disk units are turned on. If the devices are already turned on, turn them off, wait a minute, then turn them back on.

If the disk unit that contains storage unit 1 still cannot be located, call for service support.

Function 11, Data Code A6xx 6006

This topic describes the user input required for the Licensed Internal Code SRC A6xx 6006.

Description: Tape Licensed Internal Code file is incompatible for restoring.

The *load Licensed Internal Code* level found on tape is not compatible with the *Licensed Internal Code* found on disk. Continuing to restore this code will result in system failure.

Reply: Using the Select key on the control panel, select one of the following codes, and press the Enter key:

Function Code	*Function*
24	Destroy all system data and install the Licensed Internal Code. Select this option if you are installing a new system (which contains no customer data) or if you have exchanged the disk unit that contains storage unit 1.
(None)	Cancel this request. If you do not want to continue with the Licensed Internal Code restore operation, turn off the system control panel.

Function 11, Data Code A6xx 6007

This topic describes the user input required for the Licensed Internal Code SRC A6xx 6007.

Description: **Warning:** Disk unit that contains storage unit 1 does not contain Licensed Internal Code.

The stand-alone download disk Licensed Internal Code, function code 32, was requested. The system found the disk unit attached at the correct location for being a disk unit that contains storage unit 1. However, the disk unit found is not in the correct format to be a unit 1. The wrong disk unit may be attached at the location where unit 1 should be, or the correct disk unit that contains storage unit 1 may not be turned on (in which case the system detected the wrong disk unit as the disk unit that contains storage unit 1).

Function codes may be used to display which disk the system is attempting to restore. This information can be used with the rack configuration list printouts to ensure the system will restore to the correct disk.

The function codes are different for systems with Version 2 hardware. The Version 2 hardware function codes are identified with a **-2** and are enclosed in parentheses (such as 15-2).

Function Code	*Function*
14 (15-2)	Display type and model of the disk unit that contains storage unit 1. The first 4 characters displayed in the lights will show the type. The next 4 characters show the model. The following is an example of what would be shown after you select this option. (This shows what you would see if the disk was a 9332 Model 400.)

14 (15-2)	9332 0400

15 (16-2)	Display address of the disk unit that contains storage unit 1. Eight characters will be shown on the display lights. The meaning of these characters is as follows:

Character Position	***Description***
1–2	Bus number (should be zero)
3	IOP card number
4	IOP board number
5–6	Facility address (DFCI)
7–8	Secondary address

The following is an example of what would be shown after you select this option:

15 (16-2)	0010 0000

16 (17)	Display the serial numbers of the disk unit that contains storage unit 1. The following is an example of what should be shown after you select this option:

16 (17-2)	0012 3456

Reply:

Function Code	*Function*
24	Destroy all system data and restore the Licensed Internal Code. Select function code 24 if you want to do the following: • Restore the Licensed Internal Code to the selected disk unit. • Destroy all data on the system. Selecting this option will first delete all information found on the disk unit that contains storage unit 1 (including customer data) and then will copy all system Licensed Internal Code from tape to disk. The data on all the remainder of the disk units will not be deleted but may not be accessible (because of the way data is spread over multiple units on the system).

Select this option if you are installing a new system (which contains no customer data and no Licensed Internal Code), or if you have exchanged the disk unit that contains storage unit 1.

32 Forced download of disk Licensed Internal Code.

Select function code 32 to force down load of the disk Licensed Internal Code to the disk unit selected.

(None) Cancel this request.

If you do not want to continue with the Licensed Internal Code restore operation, turn off the control panel.

Function 11, Data Code A6xx 6008

This topic describes the user input required for the Licensed Internal Code SRC A6xx 6008.

Description: **Warning:** Load-source disk unit not found.

The vital product data (VPD) within the system indicates that unit 1 will be found at the address specified in the following function codes. Either the disk unit at this address did not report or the device at that address is not a disk unit.

This condition can occur because of one of the following:

1. Either the disk unit at that address is not powered on, or did not report in, or is missing. Verify the following and make any necessary corrections. The install automatically continues when the device is ready and reports in.
   - Ensure that all 9335 and 9336 disk units (if there are any) have their switches set to the Enable position.
   - Ensure that the disk unit at that address is powered on and the Ready light is on. If the disk unit is already powered on and its indicator shows a ready status, you might try powering the disk unit off, waiting a few minutes, and powering the disk unit back on. The install automatically continues when the disk unit becomes ready and reports in.
   - Ensure that any separate disk unit controller attached to the requested disk unit is powered on and ready. Do not power off the controller.
2. The AS/400 service processor has been replaced.

   The service processor card contains some of the VPD information being used. If the card has been replaced, then the VPD information will be incorrect.

   Function 27 can be used to override the VPD information and locate the default load-source disk unit.

   Warning: Read the instructions for function 27 below before taking this option.
3. The disk units on this system has been removed or cabled again, or their address switches have been changed. Ensure that the system is cabled correctly and that the disk units have the correct addresses. Notice that some disk units also contain VPD information about the system. If the units are not in the same positions, the VPD information will be incorrect.

   To locate storage unit 1, power down the system and move and cable the disk units again so that storage unit 1 and its mirrored unit have the correct address. Then run the stand-alone utility again.

Function 27 can be used to override the VPD information and locate the default unit 1.

Warning: Read the instructions for function 27 below before taking this option.

The function codes are different for systems with Version 2 hardware. The Version 2 hardware function codes are identified with a **-2** and are in parentheses (such as 15-2).

Function Code *Function*

14 (15-2) Displays the disk unit address of the candidate for storage unit 1.

The location of the candidate for storage unit 1 is displayed.

Character Position	***Description***
1–2	Bus number (should be zero)
3	IOP card number
4	IOP board number
5–6	Facility address (DFCI)
7–8	Secondary address

The following is an example of what would be shown after you select this option:

14 (15-2)	0010 0000

15 (16-2) Display the serial numbers of the disk unit that contains storage unit 1. If the serial number of the disk unit is available, it is displayed. If it is not available, zeros are displayed.

The following is an example of what should be shown after you select this option:

15 (16-2)	0012 3456

If the system has mirrored protection, 16 (17-2) and 17 (18-2) will contain the information for the other unit in the mirrored pair, if the information is available.

Reply: Press the Function Select key on the control panel until the following code appears and press the Enter key:

Function Code *Function*

27 Ignore the VPD information. Select the default disk unit.

Using this option may result in the licensed internal code being loaded to the wrong disk unit.

Note: Before selecting this option, you should unload the tape, and IPL the system from disk (either A or B side) with the keylock switch in the Manual position. This action should correct the VPD information or displays are shown to indicate the problem and recommend actions. If the IPL of the system cannot be started from disk, then select this function.

Select function 27 if you are unable to bring the requested disk unit online. This causes the SAU to select the default disk unit to be unit 1. On high-end systems, this is the disk unit whose address is 0010000 or 00200000. On low-end system, this is the disk unit at address 00100100.

Note: * On low-end stage 1 systems, the disk unit must be in the bottom slot of the first tower. On low-end Version 2 systems, this restriction does not apply.

In some situations, the VPD information found on the default disk unit may be used to locate the correct unit 1.

(None) Cancel this request.

If you do not want to continue installing the licensed internal code, unload the tape and either power off the system or perform an IPL of the system from disk (either A or B side)

Function 11, Data Code A6xx 6009

This topic describes the user input required for the licensed internal code SRC A6xx 6009.

Description: **Warning:** Mirrored load-source disk unit not found.

The vital product data (VPD) within the system indicates unit 1 will be found at the address specified in the following function codes. Either the disk unit at this address did not report or the device at that address is not a disk unit.

This condition can occur because of one of the following:

1. Either the disk unit at that address is not powered on, or did not report in, or is missing. Verify the following and make any necessary corrections. The install automatically continue when the device is ready and reports in.
   - Ensure all 9335 and 9336 disk units (if there are any) have their switches set to the Enable position.
   - Ensure that the disk unit at that address is powered on and the Ready light is on. If the disk unit is already powered on and its indicator shows a ready status, you might try powering the disk unit off, waiting a few minutes, and powering the disk unit back on. The install automatically continues when the disk unit becomes ready and reports in.
   - Ensure that any separate disk unit controller attached to the requested disk unit is powered on and ready. Do not power off the controller.
2. The AS/400 service processor has been replaced.

   The service processor card contains some of the VPD information being used. If the card has been replaced, then the VPD information will be incorrect.

   Function 27 can be used to override the VPD information and locate the default unit 1. **Caution: Read the instructions for function 27 below before taking this option.**
3. The disk units on this system has been removed or cabled again, or their address switches have been changed. Ensure that the system is cabled correctly and that the disk units have the correct addresses. Notice that some

disk units also contain VPD information about the system. If the units are not in the same positions, this VPD information will be incorrect.

To locate unit 1, power down the system and move and cable the disk units again so that the load-source disk unit and its mirrored unit have the correct address. The run the stand-alone utility again.

Function 27 can be used to override the VPD information and locate the default storage unit 1. **Caution: Read the instructions for function 27 below before taking this option.**

The function codes are different for systems with Version 2 hardware. The Version 2 hardware function codes are identified with a **-2** and are in parentheses (such as 15-2).

Function Code	*Function*
14 (15-2)	Displays the disk unit address of the mirrored storage unit 1. The location of the mirrored disk unit 1 is displayed. ***Character Position*** — ***Description*** 1–2 — Bus number (should be zero) 3 — IOP card number 4 — IOP board number 5–6 — Facility address (DFCI) 7–8 — Secondary address The following is an example of what would be shown after you select this option: 14 (15-2) | 0010 0000
15 (16-2)	Display the serial number of the disk unit that contains mirrored unit for storage unit 1. If the serial number of the disk unit is available, it is displayed. If it is not available, zeros are displayed. The following is an example of what should be shown after you select this option: 15 (16-2) | 0012 3456

If the system has mirrored protection, 16 (17-2) and 17 (18-2) will contain the information for the other unit in the mirrored pair, if the information is available.

Reply: Press the Function Select key on the control panel until the following code appears and press the Enter key:

Function Code	*Function*
27	Ignore the VPD information. Select the default disk unit. **Warning:** Using this option may result in the licensed internal code being loaded to the wrong disk unit.

Note: Before selecting this option, you should unload the tape, and IPL the system from disk (either A or B side) with the keylock switch in the manual position. This action should correct the VPD information or displays are shown to indicate the problem and recommend actions. If the IPL of the system cannot be started from disk, then select this function.

Select function 27 if you are unable to bring the requested disk unit online. This causes the install to continue without the mirrored unit for storage unit 1.

(None) Cancel this request.

If you do not want to continue installing the licensed internal code, unload the tape and either power off the system or perform an IPL of the system from disk (either A or B side).

Function 11, Data Code A6xx 6010

This topic discusses the user input for licensed internal code SRC A6xx 6010.

Description: **Warning:** Load-source disk unit not found.

The disk unit for storage unit 1, specified in the following function codes, indicates that it is a part of a mirrored pair. Because of the available information, the stand alone utility is unable to verify that the disk unit selected is in the correct mirrored state.

Warning: Continuing this procedure may cause the Licensed Internal Code to be loaded to a suspended or resuming mirrored pair.

Either the vital product data (VPD) within the system indicates that the disk unit specified in the following function codes is unit 1 or a request was made to override the VPD by previously entering function 27 in response to SRCs A6xx 6008 or A6xx 6009.

This condition can occur because of one of the following:

1. The AS/400 service processor has been replaced.

   The service processor card contains some of the VPD information being used. If the card has been replaced, then the VPD information will be incorrect.

2. The disk units on this system has been removed or cabled again, or their address switches have been changed. Ensure that the system is cabled correctly and that the disk units have the correct addresses. Notice that some disk units also contain VPD information about the system. If the units are not in the same positions, this VPD information will be incorrect.

3. A request to override the VPD information was previously done and the default disk unit location was selected.

The function codes are different for systems with Version 2 hardware. The Version 2 hardware function codes are identified with a **-2** and are in parentheses (such as 15-2).

Function Code	*Function*
14 (15-2)	Displays the disk unit address of the candidate for storage unit 1. The location of the candidate for storage unit 1 is displayed. ***Character Position*** — ***Description*** 1–2 Bus number (should be zero) 3 IOP card number 4 IOP board number 5–6 Facility address (DFCI) 7–8 Secondary address The following is an example of what would be shown after you select this option: 14 (15-2) | 0010 0000
15 (16-2)	Display the serial number of the disk unit that contains storage unit 1. If the serial number of the disk unit is available, it is displayed. If it is not available, zeros are displayed. The following is an example of what should be shown after you select this option: 15 (16-2) | 0012 3456

If the system has mirrored protection, 16 (17-2) and 17 (18-2) will contain the information for the other unit in the mirrored pair, if the information is available.

Reply: Press the Function Select key on the control panel until the following code appears and press the Enter key:

Note: Before selecting this option, you should unload the tape, and perform an IPL of the system from disk (either A or B side) with the keylock switch in the manual position. This action should correct the VPD information or displays are shown to indicate the problem and recommend actions. If the system cannot perform an IPL from disk, then select this function.

Function Code	*Function*
27	Ignore this warning and continue the install. To continue installing the Licensed Internal Code, press the Function Select key until 27 appears. Use the function codes to display the disk unit where the Licensed Internal Code will be installed.
(None)	Cancel this request. If you do not want to continue installing the Licensed Internal Code, power off the control panel.

Function 11, Data Code A6xx 6011

This topic discusses the user input for Licensed Internal Code SRC A6xx 6011.

Description: Verify selection to load model-unique Licensed Internal Code.

The Load Model-Unique Licensed Internal Code Utility was selected. Continuing this procedure will copy the model-unique Licensed Internal Code from tape to disk. Any existing model-unique Licensed Internal Code existing on disk will be exchanged.

Using the Function Selection switch on the control panel, select one of the following codes and press the Enter button on the control panel.

Function Code	*Function*
23	Load the model unique Licensed Internal Code. Press the Function Select key until 23 appears to continue exchanging the model-unique Licensed Internal Code disk with the model-unique Licensed Internal Code on tape.
29	Cancel this request. Select option 29 if you do not want to load the model-unique Licensed Internal Code. After selecting this option, SRC A6xx 6001 occurs again.

Function 11, Data Code A6xx 6030

This topic describes the user input required for the Licensed Internal Code SRC A6xx 6030.

Description: Primary disk unit is not ready or not operational.

Reply: Prepare the disk unit. See the *System Operator's Guide*, SC41-8082, if you need more information on how to prepare the disk.

Function 11, Data Code A6xx 6041

This topic describes the user input required for the Licensed Internal Code SRC A6xx 6041.

Description: Tape device is not operational.

Reply: See the *System Operator's Guide*, SC41-8082, for the specific type of tape unit and for an explanation of how to make the tape device operational.

Function 11, Data Code A6xx 6042

This topic describes the user input required for the Licensed Internal Code SRC A6xx 6042.

Description: Tape device is not ready.

The 3rd and 4th characters in the SRC give further information on why the tape unit is not ready.

Code	*Definition*
33	Load assistance
37	Cartridge length check

3B Volume removed early
43 Tape not placed in tape unit
FE Tape unit turned off
FF Tape unit turned off

Reply: Prepare the tape device.

See the *System Operator's Guide*, SC41-8082, for the specific type of tape device and for an explanation of how to prepare the tape device.

Function 11, Data Code A6xx 6043

This topic describes the user input required for the Licensed Internal Code SRC A6xx 6043.

Description: Tape device load failure occurred.

The 3rd and 4th characters in the SRC give further information on why a load failure occurred.

Code Definition

11 Door open
12 Reel missing
13 Reel inverted
14 No BOT marker
16 Load failure
1B Address switch changed
1C Address switch failure

Reply: Prepare the tape device.

For an explanation of how to make the tape device ready, see the device operator's guide that came with your tape unit.

Function 11, Data Code A6xx 6048

This topic describes the user input required for the Licensed Internal Code SRC A6xx 6048.

Description: New tape volume needs to be installed.

Reply: Insert tape volume, and then prepare the tape device. After the tape is loaded and ready, the system will start reading this tape and continue with the install (or restore) process.

The 3rd and 4th characters in the SRC tell which volume should be loaded.

Code Definition

01 Volume 1
02 Volume 2
03 Volume 3
.
.
.
nn Volume nn

For an explanation of how to insert a tape, see the device operator's guide that came with your tape unit.

Function 11, Data Code A6xx 6049

This topic describes the user input required for the Licensed Internal Code SRC A6xx 6049.

Description: Insert correct tape volume.

Reply: You already inserted a new tape volume, but it was not the correct volume.

Code	*Definition*
01	Volume 1
02	Volume 2
03	Volume 3
.	
.	
.	
nn	Volume nn

For an explanation of how to install a tape, see the device operator's guide that came with your tape unit.

Function 11, Data Code A6xx 6051

This topic describes the user input required for the model-unique Licensed Internal Code SRC A6xx 6051.

Description: Load tape volume containing model-unique Licensed Internal Code located in the system service kit.

Reply: Insert the tape volume containing the model-unique Licensed Internal Code into the alternative IPL tape device, and make the tape device ready. After the tape is loaded and the device is ready, the system will start reading this tape and load the model-unique Licensed Internal Code.

Function 11, Data Code A6xx 6052

This topic describes the user input required for the model-unique Licensed Internal Code SRC A6xx 6052.

Description: The inserted tape did not contain the model-unique Licensed Internal Code.

Reply: Place the model-unique Licensed Internal Code tape into the tape device used for the IPL, and prepare the tape device.

Appendix B. Example Disaster Recovery Plan

Section 1. Disaster Recovery Introduction and Overview

NOTICE

This plan will be reviewed for update every _____ months by _____ .

A copy of this plan will remain at the business site. The original of the plan is stored off site at _____.

The continued growth in dependence on computers and on the information from them has increased the importance of the plans to prevent the loss of their availability. It is becoming very difficult, costly, and confusing to revert back to manual systems for any length of time. A disaster recovery plan is necessary to minimize the damage that might be caused by unexpected and undesirable occurrences affecting information services or other parts of an organization's information systems.

The objectives of a disaster recovery plan for information services are to make sufficient preparations, and to establish a sufficient set of agreed upon procedures, for responding to a disaster or emergency in the Information Services of responsibility, in order to minimize the effect upon the operation of the business.

Need for a Disaster Recovery Plan

Three areas need to be reviewed: legal responsibility, financial loss, and business service interruptions.

Legal Responsibility: Management has a legal responsibility to protect its corporate resources and vital documents.

Financial Loss: Because of the efficiency, accuracy, speed and control of information services methods, organizations are more dependent on their information services in normal business operations. If the information systems services break down, a great financial loss to the company could develop, or even destroy the business if proper disaster planning has not been done.

Business Service Interruption: This can be very damaging to future relationships with customers. It can also affect the public image of the organization. The costs of not taking precautions could be much more damaging and costly than modest preparation for disaster recovery.

Levels of Security and Disaster Recovery Measures

This disaster plan is developed to minimize the costs resulting from losses or damages to the resources or the capabilities of information services and related services. The resources include people, programs, data, hardware, communication equipment and systems, electric power, physical facility and associated supplies such as forms, printer paper, and so forth.

There are three levels of security and disaster recovery measures that should be considered in balancing cost to need. These are: mandatory, necessary, desirable.

Mandatory Measures: Are those related to fire control, alarm systems, evacuation procedures, and other emergency precautions necessary to protect the lives and well-being of people in the area. They also include those measures necessary to protect the assets of the company.

Necessary Measures: Include all reasonable precautions taken to prevent serious disruptions of the operation of the business.

Desirable Measures: Include reasonable precautions taken to prevent real inconvenience or disruptions to any area of business and to keep the business under smooth control.

Types of Disasters to Consider

Natural Disasters: Storms, earthquakes, hurricanes, and tornadoes.

Man-Made Disasters: Fire, accident, theft, sabotage, burst pipes, building collapse, explosion, civil disturbance, and war.

In any case, the maintenance of vital information and data must be kept in a secure place. Realistically, we must concentrate on the most probable types of disaster.

Information services is generally vulnerable to five types of disasters:

1. Damage to separate workstation areas - localized situation in a terminal area might require some readjustment of communication and establishment of new workstation areas.
2. Localized damage to information services offices - might affect schedules, development work, etc.
3. Damage to information services - substantial damage done as a result of fire, water leak, or airplane crash.
4. Substantial damage to business offices or manufacturing.
5. Regional damage in a broad area - storms, hurricane, or industrial accident. There could be widespread damage, loss of power, communication lines, and so forth.

Management Direction

Management should provide the following direction for the disaster recovery plan.

- Direct the establishment of disaster contingency plans.
- Direct support of the planning process by all functional areas serviced by the information services facility. In particular, identify those functions which are critically dependent upon the information services facility.
- Direct initial and subsequent tests of the workability of the plan and of costs associated with it.
- Direct periodic revision of the plan as required.

Major Goals of the Plan

The major goals of this plan are:

1. To minimize interruptions to the normal operations.
2. To limit the extent of disruption and damage.
3. To provide smooth degradation.
4. To minimize the economic impact of the interruption.
5. To establish alternative means of operation in advance.
6. To train personnel with emergency procedures.
7. To provide for smooth and rapid restoration of service.

Section 2. Personnel

Data Processing Personnel

Table B-1. Data Processing Personnel

Name	Position	Address	Telephone

User Personnel

Table B-2. User Personnel

Name	Position	Address	Telephone

Other Important Telephone Numbers

Table B-3. Other Important Personnel

Name	Position	Address	Telephone

Organization Chart

Attach the organization chart here.

Section 3. Application Profile

Use the Display Software Resources (DSPSFWRSC) command to fill in this table.

Table B-4. Applications Profile

Name	Critical Yes / No	Fixed Asset Yes / No	Manufacturer	Comments

Comment Legend:

1. Runs daily

2. Runs weekly on _____.

3. Runs monthly on _____.

Section 4. Inventory Profile

Use the Work with Hardware Products (WRKHDWPRD) command to fill in this table.

Table B-5. Inventory Profile

Manufacturer	Description	Model	Serial Number	Own or Leased	Cost

Notes:

1. This list should be audited every _____ months.

2. This list should include:

Processing units	System printer
Disk units	Tape and diskette units
Models	Controllers
Workstation controllers	I/O processors
Personal computers	General data communication
Spare workstations	Spare displays
Telephones	Racks
Air conditioner/heater	Humidifier/dehumidifier

Table B-6. Miscellaneous

Description	Quantity	Comments

Note:

This list should include:

Tapes	Diskettes
PC software (such as DOS)	Emulation packages
File cabinet contents/Documentation	Language software (such as COBOL and PASCAL)
Tape vault contents	Printer supplies (such as paper and forms)

Section 5. Disaster Recovery

For any disaster recovery plan, the following three elements should be addressed.

- Emergency Response Procedures - to document the appropriate emergency response to a fire, natural disaster, or any other activity in order to protect lives and limit damage.
- Backup Operations Procedures - to ensure that essential data processing operational tasks can be conducted after the disruption.
- Recovery Actions Procedures - to facilitate the rapid restoration of a data processing system following a disaster.

Disaster Action Checklist

1. Plan Initiation
   a. Notify senior management
   b. Contact and setup disaster recovery team
   c. Determine degree of disaster
   d. Implement proper application recovery plan dependent on extent of disaster (see "Section 6. Recovery Plan Mobile Site")
   e. Monitor progress
   f. Contact backup site and establish schedules
   g. Contact all other necessary personnel—both user and data processing
   h. Contact vendors—both hardware and software
   i. Notify users of disruption of service
2. Checklist (Follow-up)
   a. List teams and tasks of each
   b. Obtain emergency cash and set-up transportation to and from backup site, if necessary
   c. Set up living quarters, if necessary
   d. Set up eating establishments, as required
   e. List all personnel and their telephone numbers
   f. Establish user participation plan
   g. Set-up delivery and receipt of mail
   h. Establish emergency office supplies
   i. Rent or purchase equipment, as needed
   j. Determine application(s) to be run and in what sequence
   k. Identify number of workstations needed
   l. Check out any off-line equipment needs per application
   m. Check on forms needed per application
   n. Check all data being taken to backup site before leaving and leave inventory profile at home location
   o. Set up primary vendors for assistance with problems incurred during emergency
   p. Plan for transportation of any additional items needed at backup site
   q. Take directions (map) to backup site
   r. Check for additional magnetic tapes, if required
   s. Take system and operational documentation and procedural manuals (copies)
   t. Ensure that all personnel involved know their tasks
   u. Notify insurance companies

Recovery Start-Up Procedures for Use After Actual Disaster

1. Notify _____ Disaster Recovery Services of the need to utilize service and of recovery plan selection.

   Note: Guaranteed delivery time countdown begins at the time _____ is notified of recovery plan selection.

   a. Disaster Notification Numbers

      _____

      or _____

      The above telephone numbers are in service from _____ am until _____ pm Monday through Friday.

   b. Disaster Notification Number

      _____

      The above telephone number is in service for disaster notification after business hours, on weekends, and during holidays. Please use the above number only for the notification of the actual disaster.

2. Provide _____ with an equipment delivery site address (when applicable), a contact, and an alternate contact for coordinating service and telephone numbers at which contacts can be reached 24 hours a day.
3. Contact power and telephone service suppliers and schedule any necessary service connections.
4. Notify _____ immediately if any related plans should change.

Section 6. Recovery Plan Mobile Site

1. Notify _____ of the nature of the disaster and of its desire to select the mobile site plan.
2. Confirm in writing the substance of the telephone notification to _____ within 48 hours of the telephone notification. (See sample letter attached).
3. Confirm all needed backup media are available to load backup machine.
4. Cut purchase order to cover use of backup equipment.
5. Notify _____ of impending trailer and its placement (on _____ side of _____). (See "Mobile Site Setup Plan" on page B-14.)
6. Depending on communication needs, notify telephone company (_____) of possible emergency line changes.
7. Begin set-up of power and communication at _____.
   a. Power and communication would be prearranged to hook into when trailer arrives.
      1) At the point where telephone lines come into the building (_____), break the current linkage to the administration controllers (_____). These lines would be rerouted to lines going to the mobile data center. They would be linked to modems at the mobile unit.

         The lines currently going from _____ to _____ would then be linked to the mobile unit via lads modems.
   b. This could conceivably require _____ to redirect lines at _____ complex to a more secure area in case of disaster.
8. When the trailer arrives, plug into power and do necessary checks.
9. Plug into the communication lines and do necessary checks.
10. Begin loading system from backups (see "Section 7. Restoring the Entire System").
11. Begin normal operations as soon as possible:
    a. Daily jobs
    b. Daily saves
    c. Weekly saves
12. Plan schedule to backup the system in order to restore on home base computer when site is available. (Utilize regular system backup procedures).
13. Secure mobile site and distribute keys as required.
14. Keep a maintenance log on mobile equipment.

Mobile Site Setup Plan

Attach the mobile site setup plan here.

Telecommunications Disaster Plan

Attach the telecommunications disaster plan here.

Communication Disaster Plan

Attach the communication disaster plan, including the wiring diagrams.

Electrical Service

Attach the electrical service diagram here.

Recovery Plan Hot Site

The disaster recovery service provides an alternate hot site. The site has a backup system for temporary use while the home site is being reestablished.

1. Notify _____ of nature of the disaster and of its desire for a hot site and request air shipment of modems to _____ for communications. (See _____ for communications for the HOT SITE.)
2. Confirm in writing the substance of the telephone notification to _____ within 48 hours of the telephone notification.
3. Begin making necessary travel arrangements to site for the operations team.
4. Confirm that all needed tapes are available and packed for shipment to restore on the backup system.
5. Cut purchase order to cover use of the backup system.
6. Review checklist for all necessary materials before departure to the hot site.
7. Make sure the disaster recovery team at the disaster site has necessary information to begin restoring site. (See "Section 11. Disaster Site Rebuild").
8. Provide for travel expenses (cash advance).
9. After arrival at hot site, contact home base to establish communication procedures.
10. Review materials brought to the hot site for completeness.
11. Begin loading the system from the save tapes.
12. Begin normal operations as possible:
    a. daily jobs
    b. daily saves
    c. weekly saves
13. Plan schedule to backup the hot site system in order to restore on the home base computer.

Hot Site System Configuration

Attach the hot site system configuration here.

Section 7. Restoring the Entire System

The following procedure outlines the steps that need to be taken to get the system back to the way it was before the disaster. You may be restoring to the same system or to a different system (different serial number).

Note: This example assumes you are using a complete save strategy (SAVSYS, SAVLIB *NONSYS, SAVDLO), not save storage (SAVSTG).

First, the following tapes and equipment need to be retrieved from the on-site tape vault or the off-site storage location:

1. The Model-Unique Licensed Internal Code tape, if you are restoring to the same system
2. All tapes from the most recent complete save operation
3. The most recent save security data tapes
4. The most recent configuration tapes, if necessary
5. All tapes containing journals and journal receivers saved since the most recent daily save operation
6. All tapes from the most recent daily save operation
7. PTF list (stored with the most recent complete save tapes, weekly save tapes, or both)
8. Tape list from most recent complete save operation
9. Tape list from most recent weekly save operation
10. Tape list from daily saves
11. History log from the most recent complete save operation
12. History log from the most recent weekly save operation
13. History log from the daily save operations
14. The *Licensed Programs and New Release Installation Guide*, SC41-9878
15. The *System Operator's Guide*, SC41-8082
16. The *Basic Backup and Recovery Guide*, SC41-0036
17. Telephone directory
18. Modem manual
19. Tool kit

Once these tapes and manuals are available, the restore operation can begin.

Total System Restore

This procedure is used to restore the entire system after a disaster has occurred. It assumes the system is unusable.

Task Overview

The following tasks must be completed for a total system restore. It is assumed that you have your current SAVSYS tapes.

1. Install the Licensed Internal Code
2. Install the Model-Unique Licensed Internal Code
3. Restore the operating system
4. Restore:
   a. User profiles (RSTUSRPRF)
   b. Device configurations (RSTCFG)
   c. User libraries (RSTLIB)
   d. Document library objects (RSTDLO)
   e. Restore changed objects (RSTOBJ) from the daily SAVCHGOBJ tape
   f. Document library objects (RSTDLO) from the daily SAVDLO DLO(*CHG) tapes
   g. Apply journal changes (APYJRNCHG)
   h. Restore authority (RSTAUT)
5. Restore program temporary fixes (PTFs) tapes

Step 1. Installing the Licensed Internal Code

Before You Begin

Installing the Licensed Internal Code during this procedure is done using function code **24** (Install), which is run completely from the control panel. Because it is run completely from the control panel, this function is referred to as a *stand-alone* function.

When you perform this option, the system will continuously display system reference codes (SRCs) in the control panel display lights. The yellow System Attention light will be on whenever user input is needed. SRCs that start with A6 indicate that the system is waiting for you to do something, such as answer a question or prepare a tape device. When xx is shown in the SRC (such as A6xx 6001), a variety of characters may be shown in the place where the xx appears. Appendix A, "Licensed Internal Code SRCs That Require User Input (A6xx xxxx)," has a description of the SRCs. If an SRC is shown that is not discussed in Appendix A, "Licensed Internal Code SRCs That Require User Input (A6xx xxxx)" on page A-1, contact your service representative.

The documentation for this function makes reference to a **Licensed Internal Code tape**. This is the **first** volume of the customer's most recent set of complete save tapes that were used to save the system (SAVSYS, SAVLIB *NONSYS, and SAVDLO), or the distribution tapes supplied by IBM if no SAVSYS tapes exist.

The **Model-Unique Licensed Internal Code tape** is the tape found in a pouch on the side of the 9402 and 9404 system units or behind the back panel of the 9406 processing unit. Every system has a Model-Unique Licensed Internal Code tape

except the 9402 system unit models C02, D02, and E02. These models of the 9402 system unit do not require this tape.

1. Ensure the key is in the keylock switch on the control panel.
2. Turn the key in the keylock switch until it points to the Manual position.
3. Press the Function Select switch to display `02` in the Function display on the control panel.
4. Press the Enter button on the control panel.
5. Select IPL type D (this specifies that the IPL source comes from tape) by pressing the Function Select switch on the control panel until **D** is shown on the Data display.
6. Press the Enter button on the control panel.
7. For the 9406 system unit, ensure that the power switches for the tape unit used for the IPL and all disk units are in the On position.
8. Find the Licensed Internal Code tape, which is the first volume of the most current set of SAVSYS tapes or the first volume of the distribution tapes.

   Warning!

   Use the distribution tapes only if no SAVSYS tape exists. If you use the distribution tapes, some system information will be lost. This includes, but is not limited to, PTFs and PTF packages. All cumulative PTF packages and individual PTFs applied after the initial installation of your system must be installed again.

9. Place the tape in the tape unit used for the IPL. For more information on loading the tape, see the setup manual for the device.

   Note: If your tape unit cannot be loaded when the power is off, continue with the next step. You will be prompted later by an SRC code for the tape.

10. Turn on the power to the system by pushing the Power switch on the control panel up. The switch returns to center after you push it. The 9402 system unit has a green button labeled Power On on the control panel.
11. If you could not load your tape in a previous step, load the first tape volume into the tape unit used for the IPL. Make the device ready and then continue with the next step.

    Note: If your system was not powered down after ending the subsystems, do the following:

    a. Press the Function Select switch to display `03` (continue the IPL) in the Function display on the control panel.

    b. Press the Enter button on the control panel.

12. If the system attention light is on and one of the SRC codes shown in the following table is displayed in the Data display, complete the instructions for that SRC code. Otherwise, continue with the next step.

Table B-7. SRC codes

Symptom	Action
A100 1933 **A12x 1933** ('x' is any character)	This SRC is shown if the tape device for the alternate IPL is not ready. Make sure the correct tape is loaded and make the tape device ready. Wait for the System Attention light to go off. Then, continue with the next step. If the System Attention light stays on for more than 5 minutes, check to see if you have the correct tape loaded in the tape device for the alternate IPL and make the tape device ready. Then continue with the next step.
B1xx 1803 **B1xx 1806** **B1xx 1938**	These SRCs are shown if the tape device for the alternate IPL was not found or was not ready. Make sure the tape device is powered on, the correct tape is loaded, and ready. Then continue with the next step.
B1xx 1934	This SRC is shown if the wrong tape is loaded. Load the correct tape and make the tape device ready. Then continue with the next step. This SRC is also shown if the high speed feature is enabled on the 2440 tape unit. The high speed feature must be disabled before installing or restoring the Licensed Internal Code.
2507 0001 **2642 0001** **2643 0001**	These SRCs are shown if a tape is not loaded in the tape device for the alternate IPL. Make sure the correct tape is loaded in the correct drive and then continue with the next step.

Note:

If any SRC listed in the table does not disappear from the control panel, do the following:

1. Press the Function Select switch to display `03` (continue the IPL) in the Function display on the control panel.
2. Press the Enter button on the control panel.

13. Ensure that the tape is online or ready. No action is required for tape units that perform this step automatically (such as the tape cartridge unit).
14. Ensure that the console display is turned on.
15. Wait for the yellow System Attention light on the control panel to light up.

    There is a delay while the system loads information from the tape. SRCs showing status are continuously updated on the control panel while processing occurs. This can take from 5 to 20 minutes; the time varies depending on the speed of the tape unit and the processor speed for the specific system model.

    When SRC A6xx 6001 is displayed, the system is prepared to start installing or restoring the Licensed Internal Code on the disk unit containing unit 1. Continue with the next step.
16. Select function code 24 by pressing the Function Select switch on the control panel until 24 is shown in the function display on the control panel.
17. Press the Enter button on the control panel.

Warning!

Function Code 24 (Install) is used only to install the licensed internal code from the SAVSTG media, recover from the loss of unit 1 in the system ASP, or to recovery from a disaster. Function code 24 (Install) deletes all information on the disk unit containing unit 1, including customer data. All system configuration information is also deleted. All disk units except unit 1 become nonconfigured units during the IPL. If you are restoring to the same system and have mirrored protection, checksum protection, or user ASPs configured, the service representative must use the Recover Configuration option in Dedicated Service Tools (DST) to recover the configuration.

The System Attention light may appear in one or two minutes and SRC A6xx 6002 is displayed. If you are sure you want to install the licensed internal code, select function code 24 again and press the Enter button. When SRC A6xx 6002 is displayed, option 23 can also be selected. If option 23 is selected, a restore of the licensed internal code is performed (not an install). Data on the disk units will not be lost.

Note: If another SRC is displayed after A6xx 6001 that is not in the A6xx xxxx format, then the system needs additional attention. Call your service representative.

If the following SRCs are displayed after SRC A6xx 6001 is displayed, see Appendix A, "Licensed Internal Code SRCs That Require User Input (A6xx xxxx)" for an explanation of these SRCs and the steps to follow.

A6xx 6002 Disk unit may contain a valid system
A6xx 6003 Disk unit not currently a load source
A6xx 6004 Disk unit not currently a load source
A6xx 6005 Disk unit not found

18. After pressing the Enter button on the control panel, the system starts displaying status SRCs again, which will be continuously updated to show the status of the install or restore operation. An example of a status SRC is D6xx 6201 (stand-alone install operation is running).

19. If the yellow system attention light is on again, and SRC A6xx 6048 (New tape volume needs to be loaded) is displayed, the system needs the next tape. The *xx* tells which volume needs to be loaded. Load the correct tape and make the device ready. The install or restore operation automatically continues.

    If SRC A6xx 6051 appears, the stand-alone function is requesting the Model-Unique Licensed Internal Code tape found inside the back cover of the system unit or on the side of the 9402 Model C04, D02, and E02 system units. Unload the current tape from the tape device and load the Model-Unique Licensed Internal Code tape.

    - A6xx 6051 Model-Unique Licensed Internal Code tape needs to be loaded.
    - A6xx 6052 Tape loaded was not the Model-Unique Licensed Internal Code.

    If another SRC A6xx xxxx is displayed, look up the displayed SRC in Appendix A, "Licensed Internal Code SRCs That Require User Input (A6xx xxxx)" on page A-1 and follow the instructions. For all other SRCs call your service representative.

Step 2. Restoring the Operating System

The following procedure is used to restore only the OS/400 licensed program (operating system) from tape. The procedure for restoring the operating system assumes that the Licensed Internal Code is already installed or restored on the system.

Task 1. Start Restoring the Operating System

You use two displays to select the install options. The IPL or Install the System display allows you to restore the operating system or work with the service tools. The Install the Operating System display allows you to set the options to be used for restoring the system, and for the system date and time.

1. At the IPL or Install the System menu:

```
                        IPL or Install the System

Select one of the following:

          1. Perform an IPL
          2. Install the operating system
          3. Use Dedicated Service Tools (DST)
          4. Perform automatic installation of the operating system
```

2. Type a 2 (Install the operating system).

   Note: **Do not** use option 4 (Perform automatic installation of the operating system) to restore the operating system.

3. Press the Enter key.

   The Confirm Install of the Operating System display is shown.

```
                  Confirm Install of Operating System

Press Enter to confirm your choice to install the operating system.
Press F12 to return and cancel your choice to install the
  operating system.
```

4. Press the Enter key.

5. The following display **may** be shown if your system is set up to prevent unauthorized installation of the operating system:

```
                    Dedicated Service Tools (DST) Sign On

Type choice, press Enter.

  DST password . . . . . .  _____
```

6. If the Dedicated Service Tools (DST) Sign On display is shown, enter the DST password and press the Enter key. For more information about preventing unauthorized installation of the operating system, see the *Basic Security Guide*.
7. The Select a Language Group display is shown. This display shows the primary language currently on the system or on the save tapes.

   The value specified on the display must be the same as the national language that is on the distribution media, or on your most recent SAVSYS tape.

```
                          Select a Language Group

Note:  The language feature shown is the language feature
installed on the system.

Type choice, press Enter.

  Language feature . . . . . .  2924
```

8. Press the Enter key.

   After the language feature is entered, the Confirm Language Feature Selection display is shown. If you need to change your system's primary language, see the *Licensed Programs and New Release Installation Guide* for more information.

```
                    Confirm Language Feature Selection

 Language feature  . . . . . :   2924

 Press Enter to confirm your choice for language feature.
   Installing the system will continue.
 Press F12 to return to change your choice for
   language feature.
```

9. Press the Enter key to confirm the information.
10. The following display is shown only if disk units are in nonconfigured status.

    Note: If function code 24 was used and the recover configuration was not run, all disk units except unit 1 are in nonconfigured status.

```
                    Add All Disk Units to the System

Select one of the following:

          1. Add all disk units to the system auxiliary storage pool
          2. Keep the current disk configuration
          3. Perform disk configuration using DST
```

Note: You may receive a message at the top of the display indicating that the disk unit configuration information may have been damaged. There is currently only one disk unit configured on the system.

11. Select the correct option using the following information:

    Option 1 (Add all disk units to the system auxiliary storage pool)

    Select this option if you want to add all of the nonconfigured units to the system auxiliary storage pool.

    Attention!

    If you used Function Code 24 to install the Licensed Internal Code, and the service representative did not use Recover Configuration in DST, you must select this option. If you are restoring to the same system and have mirrored protection, checksum protection, or user ASPs configured, the service representative must use the Recover Configuration option in Dedicated Service Tools (DST) to recover the configuration.

    Before adding the units to the system, all data stored on the non-configured units is deleted.

    Note: Adding units can change the checksum set configuration of the system ASP. You can use option 3 (Perform disk configuration using DST) to calculate the effect of adding units to the system ASP.

    Option 2 (Keep the current disk configuration)

    This option continues the IPL without adding units to the system configuration. The disk units that are in nonconfigured status will remain so.

    Select this option if:

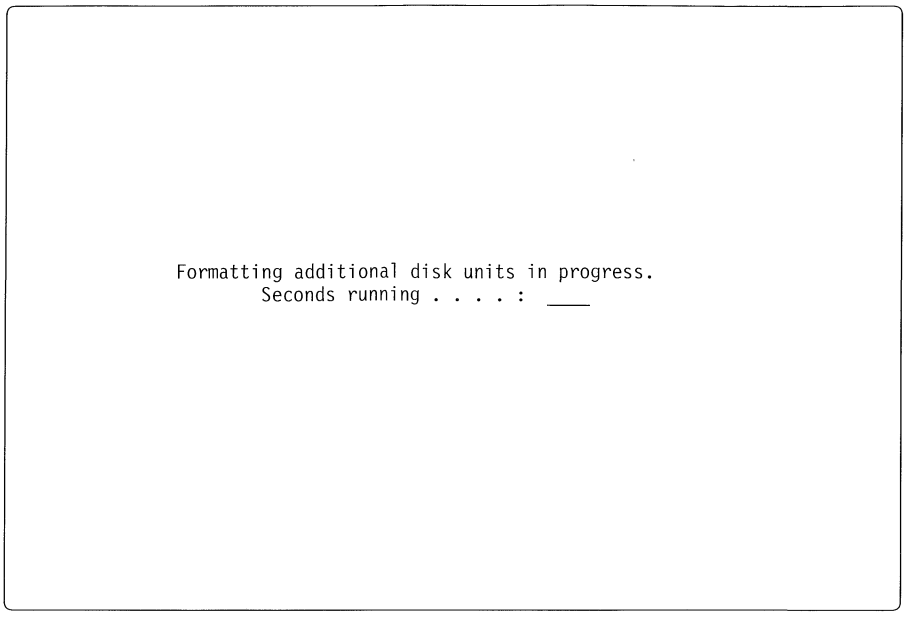
    - You are recovering from a disk unit failure in the system ASP and you had user ASPs configured.
    - You plan to add the nonconfigured units to user ASPs.
    - You plan to use them as spare units.

    Option 3 (Perform disk configuration using DST)

    This option starts the Dedicated Service Tools (DST). On the DST main menu, select option 4 (Work with Disk Units).

12. Press the Enter key.

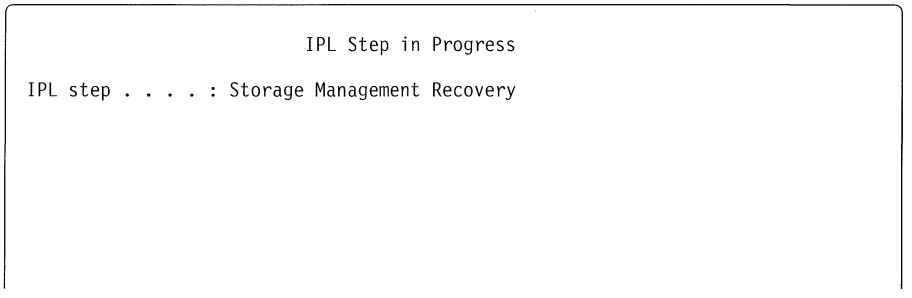
    As the disk units are configured, the following display is shown:



Adding disk units takes several minutes. The time it takes depends on the size of each unit and the ability of the system to do multiple adds at the same time.

13. Status messages are displayed.

    The following is an example of a status display shown before the Install the Operating System display is shown. The status messages shown do not require any action by the user.



After the IPL steps complete, the Install the Operating System menu appears.

```
                        Install the Operating System

Type options, press Enter.

     Install
       option . . . .  __              1=Take defaults (No other
                                         options are displayed)
                                       2=Change install options

     Date:
       Year . . . . .  __              00-99
       Month  . . . .  __              01-12
       Day  . . . . .  __              01-31

     Time:
       Hour . . . . .  __              00-23
       Minute . . . .  __              00-59
       Second . . . .  __              00-59
```

14. When the Install the Operating System display is shown, continue with the task to select Install options.

Task 2. Select the Install Options

On the Install the Operating System display, do the following.

1. Select option 1 (Take defaults) to restore objects such as the system values, system reply lists, and the edit descriptions. This option is selected when you are performing a total system restore operation. When you select option 1 (Take defaults), the operating system is installed again and no more install options displays are shown. Do the following:

   a. Fill in the date and time.

      Date

      The system inserts the date based on the internal clock. If the date is incorrect, you can type over the date to change it.

      Time

      The system inserts the time based on the internal clock. If the time is incorrect, you can type over the time to change it.

   b. Press the Enter key.

   c. Messages are shown to indicate how many programs and language objects are restored. These messages are for your information only.

   d. Continue loading tapes in sequence when messages are shown that ask you to load the next tape. The system searches through the tapes and loads the necessary programs and language information. After processing all the system save tapes, the following message may be displayed at the bottom of a blank display:

      ```
      Operating system has been installed.  IPL in progress.
      ```

When the IPL is complete, the IPL Sign On display is shown and the system in ready to complete the IPL. Continue with the next task "Select IPL Options."

Task 3. Select IPL Options

1. Type QSECOFR in the *User* prompt and the password required for that user ID in the *Password* prompt (if password security is active) on the Sign On display.

   Note: If function code 23 was used to restore the Licensed Internal Code, before restoring the operating system, the password is the special one you assigned to QSECOFR user profile after the system was installed.

   If function code 24 was used to install the Licensed Internal Code, no password is required at this time. The system security level will be restored after the operating system is installed and the IPL completes.

2. Press the Enter key. Informational messages are displayed.

3. If the Select Product to Work with PTFs display appears, press F3 (Exit) to continue.

```
                Select Product to Work with PTFs
                                                              RCHASTTX
Position to . . . . . .___________ Product


Type options, press Enter.  Press F21 to select all.
   1=Select


             Product
Opt  Product Option  Release
 _   5738999 *BASE   V2R3M0
 _   5738SS1 *BASE   V2R3M0
```

4. When the IPL Options display is shown, respond to the prompts using the following information.

```
                              IPL Options

Type choices, press Enter.

  System date  . . . . . .  07 / 26 / 88   MM / DD / YY
  System time  . . . . . .  12 : 00 : 00   HH : MM : SS
  Clear job queues . . . . . .  N          Y=Yes,  N=No
  Clear output queues  . . . . .  N        Y=Yes,  N=No
  Clear incomplete job logs  . . . . . .  N  Y=Yes,  N=No
  Start print writers  . . . . . .  N      Y=Yes,  N=No
  Start this device only . . . . . .  Y    Y=Yes,  N=No


  Set major system options . . . . . .  Y  Y=Yes,  N=No
  Define or change system at IPL . . . . .  N  Y=Yes,  N=No
```

Figure B-1. IPL Options Display

5. Enter the value for the system date.

   The date is displayed. The system date format shown can be YY/MM/DD, DD/MM/YY, or MM/DD/YY where MM means month, DD means day, and YY means year. For English, the default is MM/DD/YY; the default value differs according to the primary language.

If the date is not correct, you can type over the date to change it. The system date must have a year value in the range of 87 to 99, or 00 to 22.

6. Enter the value for system time.

   The current time is displayed. The time format is HH : MM : SS; HH means hour, MM means minutes, and SS means seconds. If you want to change the time, type it in accordance with the 24-hour clock. For example, for an IPL at 4:30 p.m., type 163000 for the time.

7. Enter the value for start print writers.

   If you are going to continue restoring user profiles, device configuration objects, user libraries, and authorities, type an N to not start the print writers. Otherwise, type a Y to start print writers.

8. Enter the value for start this device only.

   If you are going to continue restoring user profiles, device configuration objects, user libraries, and authorities, type a Y to start this device only. Otherwise, type an N to start all devices.

9. Enter the value for set major system options.

   The default is different, depending on the type of restore operation. If you restored the Licensed Internal Code using function code 23 (Restore), the default value is set to N. If you installed the Licensed Internal Code using function code 24 (Install), the default value is set to Y.

   Type a Y to set the major system options.

10. Enter the value for the define or change system at IPL.

    If the System/36 environment is your main operating system environment or you are restoring from the distribution tapes, then type a Y to define or change the system at IPL.

    If you are doing a partial recovery, you must ensure that all the libraries in the library list (QSYSLIBL and QUSRLIBL system values) are restored or remove the libraries not being restored from the library list. To change the QSYSLIBL and QUSRLIBL system values, type a Y to define or change the system at IPL.

11. Press the Enter key.

    The Set Major System Options display is shown.

    Ensure enable automatic configuration is set to Yes, unless you are using the System/36 environment as your main operating environment. If you are using the System/36 environment as your main operating environment, ensure enable automatic configuration is set to No.

    If enable automatic configuration is set to No, you will receive SRC A900 2000 on the control panel later in the restore operation. The instructions to recover from SRC A900 2000 are provided, if necessary.

12. Press the Enter key.

    The Define or Change System at IPL is shown if you specified a *Y* for define or change system at IPL on the IPL options display. If you specified an *N* on the IPL options display, go to step 13.

    Note: The following sets of instructions (prior to step 13) deal with three distinct topics:

    - Enabling the automatic configuration setting

- Restoring from the distribution tapes
- Changing the QSYSLIBL and QUSRLIBL system values

The restoration process may require you to proceed through any, all, or none of the topics. If you do not need to proceed through any of them, you may go on to step 13.

Was enable automatic configuration set to No?

If it is set to No, do the following:

a. Select option 3 (System value commands) and press the Enter key.

b. Select option 3 (Work with system values) and press the Enter key.

c. Type a 2 in the *Option* column next to the system value QIPLTYPE and press the Enter key.

d. Change the value to 2 and press the Enter key. Press F12 until you return to the Define of Change the System at IPL menu.

e. If you are not restoring from the distribution tapes and you do not need to change the QSYSLIBL or QUSRLIBL system values, press F3 (Exit) to continue the IPL.

Are you restoring from the distribution tapes?

If you are restoring the operating system from the distribution tapes, the system has reset some values back to the IBM-supplied defaults. These values must be changed back to the values that were in effect at the time of save operation. You should have lists of these values that were created at the time you performed a complete save operation.

The following may need to be changed:

- System values
- Network attributes
- Configuration lists
- Edit descriptions
- Reply list entries
- IBM-supplied subsystem descriptions

Note: Configuration lists, edit descriptions, reply list entries, and IBM-supplied subsystem descriptions can be changed after the operating system is restored.

To change the system values, do the following:

a. Select option 3 (System value commands) and press the Enter key.

b. Select option 3 (Work with system values) and press the Enter key.

c. Type a 2 in the *Option* column next to the system value values you want to change and press the Enter key.

d. Change the values to the correct values and press the Enter key. Press F12 to return to the Define or Change the System at IPL menu.

If you had changed the network attributes from the IBM-supplied defaults, do the following:

a. Select option 4 (Network attributes commands) and press the Enter key.

b. Select option 2 (Change network attributes) and press the Enter key to display a list of network attributes.

c. Change the values to the correct network attributes and press the Enter key.

d. Press F12 (Cancel) to return to the Define or Change the System at IPL menu.

e. If the enable automatic configuration was set to *Yes*, and you do not need to change the QSYSLIBL or QUSRLIBL system values, press F3 (Exit) to continue the IPL.

Are you changing the QSYSLIBL or QUSRLIBL system values?

If you are changing the QSYSLIBL or QUSRLIBL system values, do the following:

a. Select option 3 (System value commands) and press the Enter key.

b. Select option 3 (Work with system values) and press the Enter key.

c. Type a 2 in the *Option* column next to the system value values you want to change and press the Enter key.

d. Change the values to the correct values and press the Enter key.

e. Press F12 to return to the Define or Change the System at IPL menu.

f. Press F3 to continue the IPL.

13. The following display is shown during the IPL process (attended mode) when system access paths are marked for rebuild:

```
                  Edit Rebuild of Access Paths                 RCHAS331
                                                     05/12/90  13:49:34

IPL threshold . . . . . . . . . . . . . 50   0-99

Type sequence, press Enter.
Sequence:  1-99, *OPN, *HLD

                  ------------Access Paths----------  Unique  Rebuild
Seq   Status      File        Library     Member      Keyed   Time
25__  IPL         QAPZSYM2    QSYS        QAPZSYM2    NO      00:00:01
25__  IPL         QAPZREQ2    QSYS        QAPZREQ2    NO      00:00:01
25__  IPL         QAPZPTF3    QSYS        QAPZPTF3    NO      00:00:01
25__  IPL         QAPZPTF2    QSYS        QAPZPTF2    NO      00:00:01
25__  IPL         QAPZOBJ2    QSYS        QAPZOBJ2    NO      00:00:01
*OPN  OPEN        QTWALL      QSYS        QTWALL      NO      00:00:06
*OPN  OPEN        QASULTEL    QSYS        QASULTEL    NO      00:00:01
*OPN  OPEN        QASULE05    QSYS        QASULE05    NO      00:00:01
*OPN  OPEN        QASULE03    QSYS        QASULE03    NO      00:00:01
*OPN  OPEN        QASULE01    QSYS        QASULE01    NO      00:00:01
                                                          More...
F5=Refresh   F11=Display member text   F13=Change multiple  F15=Sort by
F16=Repeat position to   F17=Position to
```

This display does not support the F3 and F12 keys.

- A status message is sent to notify the user that the system is performing access path recovery.
- The *IPL threshold* is a value from 1 through 99 that can be set by the user (default is 50), which indicates that access paths with a sequence less than or equal to the number specified will be rebuilt at IPL time. If the IPL threshold changes, all access paths with a status of IPL and AFTIPL will be changed to reflect the new status of the IPL threshold.

- Sequence
  - *IPL threshold*-1 represents the sequence of the access paths that are to be rebuilt prior to completion of the IPL. A rebuild sequence of 25 is initially set by the system to set the sequence of access paths for the files that have MAINT(*IMMED) and RECOV(*IPL) specified. The access paths with the same sequence are built first according to rebuild time (the access paths that take the longest to rebuild are rebuilt first if the priorities are the same). The access paths are displayed in the same order.
  - *IPL threshold*-99 represents the sequence in which the access paths are rebuilt after the IPL. A rebuild sequence of 75 is initially set by the system to set the sequence of the access paths for the files that have MAINT(*IMMED) and RECOV(*AFTIPL) specified.
  - *OPN indicates the access path is to be rebuilt when the file is opened. The *OPN must be changed to 1 through 99 before the system job will initiate the rebuild. The system initially sets the sequence to *OPN for the files that have MAINT(*IMMED) and RECOV(*NO) specified.
  - *HLD indicates the access path is not to be rebuilt until the user changes the sequence from *HLD to a *OPN, or 1 through 99. *HLD will also cancel the rebuilding of any access path.
- Status
  - RUN indicates that the access path is being rebuilt.
  - IPL indicates that the access path is to be rebuilt before the system completes the IPL process.
  - AFTIPL indicates that the access path is to be rebuilt after the system completes the IPL process.
  - HELD indicates that the access path is not to be rebuilt until the user changes the sequence from *HLD to a *OPN, or 1 through 99.
  - OPEN indicates that the access path is to rebuilt when the file is opened.
- Rebuild Time
  - The time the access path will take to be rebuilt when the system is running without any other jobs on the system. For example, at IPL time. This is an estimate of rebuild time based on the file size and key length. No time for journaled access paths is displayed.

14. Do one of the following:
    - Make changes and press the Enter key. After changing the fields on the display and pressing the Enter key, the change is made, if possible. For example, if the user attempts to change the sequence from 9 to 50, but the sequence cannot be changed because the access path has already been rebuilt, the user is sent an error message for each improper input.
    - Press the Enter key. If you press the Enter key without making any changes to the display, the Display Access Path Status display is shown (only if access paths remain to be rebuilt). If no access paths need to be rebuilt, the status display is not shown and the IPL continues.

The following display is shown during the IPL process when the user finishes with the Edit Rebuild of Access Paths display.

```
                    Display Access Path Status

IPL Threshold . . . . . . : 50

          ----------Access Paths----------   Rebuild     Current
Status    File        Library    Member      Build Time  Run Time
RUN       QAPZSYM2    QSYS       QAPZSYM2    00:00:01    00:00:01
JRN       QAPZREQ2    QSYS       QAPZREQ2    00:00:01
JRN       QAPZPTF3    QSYS       QAPZPTF3    00:00:01
JRN       QAPZPTF2    QSYS       QAPZPTF2    00:00:01
JRN       QAPZOBJ2    QSYS       QAPZOBJ2    00:00:07
JRN       QTWALL      QSYS       QTWALL      00:00:01
JRN       QASULTEL    QSYS       QASULTEL    00:00:01
SYS       QASULE05    QSYS       QASULE05    00:00:01
SYS       QASULE03    QSYS       QASULE03    00:00:01
IPL       QASULE01    QSYS       QASULE01    00:00:01
                                                        More...



F3=Exit and continue IPL   F12=Cancel
```

Every 5 seconds the display is updated with the current run time.

After all the access paths have been rebuilt (access paths with a sequence less than or equal to the *IPL threshold*), the IPL process continues and this display is removed.

F12 (Cancel) calls the Edit Rebuild of Access Paths display. If the user returns to the Edit Rebuild of Access Paths display using F12 (Cancel), the user must exit the Edit Rebuild of Access Paths again. Even if all the access paths are rebuilt, the user remains at the Edit Rebuild of Access Paths display until the user exits the display.

If F12 (Cancel) is pressed and there are only SYS/JRN access paths to be recovered, the edit display is shown without any access paths to be edited.

Status

- RUN–indicates that the access path is being rebuilt.
- SYS–indicates the access path is a system access path and is waiting to be rebuilt.
- JRN–indicates that the access path is being recovered from its associated journal.
- IPL–indicates that the access path will be rebuilt before the system completes the IPL and is waiting to be rebuilt.

15. Press F3 (Exit and continue the IPL) to continue.
16. Press the Enter key to continue.

Did You Receive SRC A900 2000?

If you receive A900 2000 on the control panel and message CPF0975: `Console did not vary on`, on the console display, automatic configuration is turned off. However, the system has created device description QCONSOLE to allow you to continue the restore operation. **Do not** create a user-defined device description for the console display. This will cause unpredictable results. Recovery for SRC A900 2000 is provided in the next task.

If you did not receive SRC A900 2000, continue with the task to restore the remaining parts of the system.

Task 4. Recover from SRC A900 2000, If Necessary

If function code 24 (Install) was used to restore the Licensed Internal Code and automatic configuration was turned off during the restore operation of the operating system (SRC A900 2000 is displayed on the console), you must create a tape description and possibly a controller description to finish the restore operation. **Do not** create a user-defined device description for the console display.

Do the following:

1. If your tape unit is a 3422, 3430, 3480, or a 3490, do the following:
   a. Use the Work with Hardware Resource (WRKHDWRSC) command to determine the location of the tape controller.

      ```
      WRKHDWRSC TYPE(*STG)
      ```

   b. Locate the resource name for the tape controller on the Work with Storage Resources display. 2604, 2622, or 2644 will be displayed in the *Type* column.
   c. Type a `9` (Work with) in the *OPT* column next to name and press the Enter key. The Work with Storage Controller Resources display is shown.
   d. Locate the resource for the tape controller (for example, TAPCTL01).
   e. Type a `7` (Create description) in the *Opt* column next to the name and press the Enter key. The Create Controller Description display is shown.
   f. Enter a tape controller name (such as TAPCTL01) in the *New device description* prompt and press the Enter key.
   g. On the Create CTL Desc (Tape) (CRTDEVCTL) display, enter a controller description name and controller type and model.
   h. Use the Create Device Description command to create a device description for each tape unit attached to the controller. For example:

      ```
      CRTDEVTAP DEVD(TAPxx) TYPE(34xx) MODEL(model-number)
           CTLD(tape-controller-description) TEXT('text description')
      ```

      where DEVD is the name of the description, TYPE is tape unit type, MODEL is the model (or *ANY), and CTLD is the name of the controller description created above.
   i. Use the Work with Configuration Status command to vary on the controller and tape unit.

      ```
      WRKCFGSTS *CTL *TAP
      ```

j. Find the controller description and type a 1 in the *Opt* column next to the name. Press the Enter key. This will vary on the controller and any tape units attached to the controller.

2. If you are not using a 34xx tape unit, do the following:

   a. Use the Work with Hardware Resource (WRKHDWRSC) command to determine tape controller name.

      ```
      WRKHDWRSC TYPE(*STG)
      ```

   b. Locate the tape controller.

   c. Type a 9 (Work with) next to tape controller name and press the Enter key.

   d. Locate the resource name for the tape unit (for example, TAP01).

   e. Enter a 7 (Add configuration) in the *Opt* column next to the tape resource name and press the Enter key.

   f. Enter a tape device description name (for example, TAP01) in the *New device description* prompt and press the Enter key.

   g. Use the Work with Configuration Status command to vary on the tape unit.

      ```
      WRKCFGSTS *DEV *TAP
      ```

   h. Find the tape device description and type a 1 in the *Opt* column next to the name. Press the Enter key. This will vary on the tape unit attached to the controller.

SRC A900 2000 remains displayed on the control panel throughout the remaining restore operations. When the final IPL of the system is complete, SRC A900 2000 disappears. The user-defined device description for the console display will be restored when the Restore Configuration (RSTCFG) command is run later in the recovery.

Step 3. Restoring the Remaining Parts of the System

Before You Begin. . .

_ Clean the read and write head of the tape unit.

_ Find the tape volume that contains the user profiles.

Note: Depending on the circumstances and how much of the system you have restored, the DSPTAP command may or may not work. If not enough of the operating system has been restored, refer to the list of libraries you created when you saved the system.

- If you do not know where the user profiles are stored on tape, determine where they are by using the DSPTAP command with DATA(*LABELS) specified. (This is not necessary if you are restoring user profiles from the SAVSECDTA media.)

  Examine each tape until you find the file labeled QFILEUPR containing object type *USRPRF.

- Find the file on tape containing the device configuration objects using the DSPTAP command with DATA(*LABELS) specified. Examine each tape until you find the file labeled QFILEIOC containing object types *DEVD, *CTLD, *LIND, *COSD, *CFGL, *CNNL, *NWID, *SRMSPC and *MODD. (This is not necessary if you are restoring configuration and system resource management information from the SAVCFG media.)

- Ensure any device configuration objects not used in the restore operation are varied off. Ensure that any tape devices, tape controllers, or work-station device that you are using for the restore operation are varied on. These configuration objects will be excluded from the restore operation (message CPF379C in the job log).

Considerations: There are two options you can use to restore the user profiles, device configuration objects, user libraries, document library objects, and authority:

1. If you are restoring the user profiles from a SAVSYS tape and the following considerations do not apply, go to "Option 1. Using Option 21 on the Restore Menu" in this procedure.
2. If any of the following considerations apply, go to "Option 2. Using the Restore Commands" (not option 21 on the Restore menu) in this procedure.

Use the restore commands (not option 21 on the Restore menu) if:

- You prefer to enter the commands manually.
- You saved changed objects or have journal changes to apply.

  Attention

  To ensure the journaling environment is restored correctly, the libraries containing the journals must be restored before the libraries containing the journaled files. If the journaled files are restored before the journals, journaling is not started again for the files.

- You performed individual save operations instead of using the SAVLIB LIB(*NONSYS) command. You must use a RSTLIB command for each saved

library. If you saved individual objects using the SAVOBJ or SAVCHGOBJ command, you must use a RSTOBJ command for each group of saved objects.

- You performed a SAVLIB LIB(*IBM) and a SAVLIB LIB(*ALLUSR). You need to do a RSTLIB SAVLIB(*IBM) and RSTLIB SAVLIB(*ALLUSR).
- You saved the security information with the Save Security Data (SAVSECDTA) command. You must restore the information using the restore commands.
- You saved logical file access paths using either the SAVOBJ or SAVCHGOBJ command. You must restore the logical files the same way you restored the physical files using the RSTOBJ command.

Restoring to a Different System?

Consider the following when restoring to a different system (different serial number):

1. You must specify ALWOBJDIF(*ALL) on the RSTUSRPRF, RSTCFG, RSTLIB, and RSTDLO commands to automatically link the objects to their associated authorization lists.
2. You must specify SRM(*NONE) on the RSTCFG command to prevent the restore of the SRM database. If the SRM database is restored the configuration objects may become unusable.
3. If you saved the system at security level 30 or higher, *ALLOBJ special authority is removed from the user profiles when they are restored. Manually give *ALLOBJ special authority to the user profiles using the CHGUSRPRF command after the restore operation is complete.

Method 1. Using Option 21 (System) on the Restore Menu

Note: Do not use this option if you are restoring to a different system. Go to "Method 2. Using the Restore Commands" on page B-45.

To restore user profiles, configuration objects, system resource management information, user libraries, document library objects, and authority, use the following steps:

1. Sign on the system as the security officer; type QSECOFR in the user prompt and the password for QSECOFR in the *Password* prompt.

   Note: If you restored the Licensed Internal Code (function code 23), it is the user-assigned password. If you installed the Licensed Internal Code (function code 24), it is the default password QSECOFR.

2. Press the Enter key.
3. Ensure that the correct volume of your last set of save tapes is loaded and make the tape device ready. The tape should contain the file labeled QFILEUPR. Run the DSPTAP command and specify DATA(*LABELS) to find the file labeled QFILEUPR.
4. Ensure that any device configuration objects not used in the restore operation are varied off.
5. Ensure that the devices you are using for the restore operation (workstations, tape devices, and tape controllers) are varied on. These configuration objects are excluded from the restore operation (message CPF379C in the job log).

6. Go to the Restore menu:

   GO RESTORE

   The Restore menu is shown.

```
RESTORE                              Restore
                                                        System:   RCHASLLZ
Select one of the following:

  Restore Data
     1. Files
     2. Libraries
     3. Documents and folders
     4. Programs
     5. Other objects
     6. Licensed programs
     7. Configuration
     8. User profiles

  Restore System Data
    20. All libraries other than system library
    21. The system
```

Doing an Unattended Restore

To prevent an interrupted restore caused by incomplete restore messages, run the following commands before selecting option 21 from the Restore menu.

1. To display the reply list sequence numbers currently being used, type the following and press the Enter key.

   ```
   WRKRPYLE
   ```

2. To add message CPA3709 to the reply list, type the following (where xxxx is an unused sequence number 1-9999) and press the Enter key.

   ```
   ADDRPYLE SEQNBR(xxxx) MSGID(CPA3709) RPY('G')
   ```

3. To change the job, type the following and press the Enter key.

   ```
   CHGJOB INQMSGRPY(*SYSRPYL)
   ```

   Note: Communications messages with a severity of 99 that require a reply can stop an unattended restore operation. If you have communication messages that can stop an unattended restore operation, you can specify *NOTIFY for the *Message queue delivery* prompt on the Specify Command Defaults display. This sends the communication messages to the QSYSOPR message queue without interrupting the restore operation.

   After running these commands, the following messages will be displayed:

   a. `CPF0994  ENDSBS(*ALL) command being processed`

   b. Press the Enter key.

   c. `CPF0968  System ended to restricted condition`

   d. Press the Enter key.

After performing step d, the first message, `ENDSBS(*ALL) command being processed`, will return to the screen. Repeat steps b through d before moving on to select option 21.

7. Select option 21 (The system) on the Restore menu and press the Enter key. The following display is shown.

```
                        Specify Command Defaults

Type choices, press Enter.

  Tape devices . . . . . .  TAP01       Names
                            _____
                            _____
                            _____

  Prompt for commands  . . . . .   N          Y=Yes, N=No

  Message queue delivery . . . .   *BREAK     *BREAK, *NOTIFY
```

Tape devices

You can specify up to four tape device names. If you specify more than one device, the system automatically switches to the next tape device after the current tape is read.

Prompt for commands

You can specify whether or not you want to be prompted for the commands. If you specify Y=Yes, the prompt display is shown and you can change the defaults on the commands. If you specify N=No, the system runs the commands without prompting and uses the default values.

Message queue delivery

You can specify whether or not you want messages sent in *BREAK or *NOTIFY mode to the QSYSOPR message queue. If *BREAK is specified, any message of severity 99 that requires a reply interrupts the restore operation. If *NOTIFY is specified, severity 99 messages that are not are associated with restore operation, do not interrupt the restore process. For example, messages that request a new volume to be loaded interrupt the restore operation because they are associated with the job. You cannot continue until the you reply to these messages.

Note: If you are doing an unattended restore operation and communications is active, change the message queue delivery to *NOTIFY mode.

Option 21 will guide you through the following if you selected `Y` for the *Prompt for commands* prompt on the Specify Command Defaults display.

a. ENDSBS SBS(*ALL) OPTION(*IMMED)

b. RSTUSRPRF USRPRF(*ALL)

c. RSTCFG OBJ(*ALL)

d. RSTLIB SAVLIB(*NONSYS)

e. RSTDLO DLO(*ALL) SAVFLR(*ANY)

Notes:

1) If you specify that the RSTDLO DLO(*ALL) SAVFLR(*ANY) command is to be run, the RSTAUT command will run immediately afterwards. There is no prompt for the RSTAUT command, however.

2) If an unrecoverable error occurs when running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command, see "Media or Device Error When Running the RSTDLO Command" on page 9-11.

8. Press the Enter Key.

9. Continue loading the save tapes in sequence when the system sends a message to load the next volume.

If a media error occurs....

If an unrecoverable media error occurs during the RSTLIB procedure, you can restart the procedure using the STRLIB parameter on the RSTLIB command. The STRLIB parameter is valid only when *NONSYS, *ALLUSR, or *IBM is specified for the restore operation,

The basic recovery steps for a restore operation are:

1. Check the job log to determine the library where the previous RSTLIB SAVLIB(*NONSYS, *IBM, or *ALLUSR) command failed. Find the library that follows the last successfully restored library. It is indicated by a successful restore completion message in the job log. If the library is not identified in the job log, look at the output from the save operation or display the tape file QFILE to determine which library is next.
2. Load the first tape of the SAVLIB LIB(*NONSYS, *ALLUSR, or *IBM) media.
3. Type the following and press the Enter key:

   ```
   RSTLIB SAVLIB(*NONSYS, *IBM or *ALLUSR) DEV(tape-name)
       ENDOPT(*LEAVE) STRLIB(library-name) OMITLIB(library-name)
   ```

   where the *library-name* for the STRLIB and the OMITLIB parameters is the library where the RSTLIB failed. This starts the restore operation on the library after the library where the RSTLIB failed.
4. You will be asked to load the volume containing the starting library.
5. After the restore operation is complete, restore the library that failed using the media from a previous save operation.

   Note: Consider eliminating the tape with the media error from the next save rotation cycle to avoid a tape error again.

10. If you used the distribution tapes to restore the operating system, some information was not restored. You must create or change this information again. You should have lists of this information that were created at the time you performed your save operation.

    The following may need to be created or changed:

    - Configuration lists
    - Edit descriptions
    - Reply list entries
    - IBM-supplied subsystem descriptions

    a. For the configuration lists, do the following:

       Use the Work With Configuration Lists (WRKCFGL CFGL(*ALL)) command to create the configuration lists to match the information in your list.

    b. For edit descriptions, do the following:

       Use the Work with Edit Descriptions (WRKEDTD EDTD(*ALL)) command to create edit descriptions to match the information in your list.

    c. For reply list entries, do the following:

       Use the Add Reply List Entry (ADDRPYLE) command to add reply list entries to match the information in your list.

    d. For IBM-supplied subsystem descriptions, do the following:

Use the Work with Subsystem Descriptions (WRKSBSD SBSD(*ALL)) command to change the IBM-supplied subsystem descriptions to match the information in your list.

11. This completes the restore operation.
12. If you are unsure what the QSECOFR password is, change it now. To see if the password has expired, type the following:

    ```
    DSPUSRPRF QSECOFR
    ```

    If the password expiration is active for the QSECOFR user profile, you will see the expiration date on the Date password expired field. If the date is the current system date or prior, change the password for the QSECOFR user profile.
13. Check the job log to ensure all objects were restored.

    The job log contains information about the restore operation. To verify that all objects were restored, you should spool the job log for printing, along with the job's remaining spooled output, if any.

    ```
    DSPJOBLOG * *PRINT
    ```

    Or

    ```
    SIGNOFF *LIST
    ```

    Message CPC3703 is sent to the job log for each library that was successfully restored. Message CPF3773 is sent to tell you how many objects were restored. It also tells you how many objects were not restored. Objects are not restored for various reasons. Check for any error messages, correct the errors, and then restore those objects from the media.

    Note: During a full system recovery (control panel function code 24), you may receive diagnostic message CPF7088: `Receiver xxx associated with journal QAUDJRN`, where xxx is the receiver name. No recovery is required for this message when the journal is QAUDJRN.

    QAUDJRN was created by the system (if security auditing is turned on) because it did not exist at the time of the restore operation. This causes the creation date of the journal on the system to be different than the creation date of the journal on the media when the receiver was saved. The journal receiver was restored and associated with QAUDJRN.
14. Perform a normal IPL and return the system to normal operations:
    a. Turn the keylock switch to the Normal position.
    b. Type the following on a command line and press the Enter key.

       ```
       PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
       ```
15. When the IPL is complete, sign on the system.
16. Start any other subsystems that need to be started, such as QTCP or QSNADS.

    ```
    STRSBS SBSD(subsystem-name)
    ```

Method 2. Using the Restore Commands

To use the commands to restore the system, do the following:

1. Sign on the system as the security officer; type QSECOFR in the User prompt and the password for QSECOFR in the Password prompt.

   Note: If you restored the Licensed Internal Code (function code 23), it is the user-assigned password. If you installed the Licensed Internal Code (function code 24), it is the default password QSECOFOR.

2. Press the Enter key.

3. Type the following command on the command line and press the Enter key.

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(60)
   ```

4. End all subsystems:

   ```
   ENDSBS SBS(*ALL) OPTION(*IMMED)
   ```

   Messages are sent indicating when the subsystems have ended and the system is in a restricted state.

5. Change the QSYSOPR message queue.

   ```
   CHGMSGQ MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(99)
   ```

   Note: Communications messages with a severity of 99 and that require a reply can stop an unattended restore operation. If you are using communications, you may need to identify the messages that may require a reply and then add them to the reply list or change the delivery of the QSYSOPR message queue to *NOTIFY with a severity of 99.

6. Ensure that the correct volume of your last set of save tapes is loaded and make the tape device ready. The tape should contain file labeled QFILEUPR. Run the DSPTAP command and specify DATA(*LABELS) to find the file labeled QFILEUPR.

   Note: Use the tapes from the most recent complete save operation (SAVSYS), or if the security data was saved since the last complete save operation, use the SAVSECDTA tapes.

   If the SAVSYS tape is used, type the following:

   ```
   RSTUSRPRF DEV(tape-device-name) USRPRF(*ALL) ENDOPT(*LEAVE)
   ```

   If the save security data tape (SAVSECDTA) is used, type the following:

   ```
   RSTUSRPRF DEV(tape-device-name) USRPRF(*ALL) ENDOPT(*UNLOAD)
   ```

   The time that this takes can vary significantly.

7. Ensure any device configuration objects not used in the restore operation are varied off.

8. Ensure that the devices you are using for the restore operation (workstations, tape devices, and tape controllers) are varied on. These configuration objects will be excluded from the restore operation (message CPF379C in the job log).

9. Restore the device configuration objects from your most recent SAVSYS tape or SAVCFG tape:

   If the SAVSYS media is used, type the following:

   ```
   RSTCFG OBJ(*ALL) DEV(tape-device-name) OBJTYPE(*ALL) ENDOPT(*LEAVE)
   ```

   If the SAVCFG media is used, type the following:

```
RSTCFG OBJ(*ALL) DEV(tape-device-name) OBJTYPE(*ALL) ENDOPT(*UNLOAD)
```

The time that this takes can vary significantly.

10. Restore the IBM and user libraries in one of the following ways:

    If you used SAVLIB LIB(*NONSYS) to save the IBM-supplied and user libraries, load the correct volume and then type the following:

    ```
    RSTLIB SAVLIB(*NONSYS) DEV(tape-device-name) ENDOPT(*LEAVE)
    ```

    Or, if you used SAVLIB LIB(*IBM) and SAVLIB LIB(*ALLUSR) to save the IBM and user libraries, load the correct tape and then type the following two commands. The first command must complete before entering the second command.

    ```
    RSTLIB SAVLIB(*IBM) DEV(tape-device-name) ENDOPT(*LEAVE)
          MBROPT(*ALL)
    ```

    ```
    RSTLIB SAVLIB(*ALLUSR) DEV(tape-device-name) ENDOPT(*LEAVE)
          MBROPT(*ALL)
    ```

    Note: If you saved individual libraries and objects with the SAVLIB, SAVOBJ, and SAVCHGOBJ commands, then you will have to restore the individual libraries and objects with the RSTLIB command (not RSTLIB SAVLIB(*NONSYS)) and the RSTOBJ command.

    Attention

    To ensure the journaling environment is restored correctly, the libraries containing the journals must be restored before the libraries containing the journaled files. If the journaled files are restored before the journals, journaling is not started again for the files.

If a media error occurs....

If an unrecoverable media error occurs during the RSTLIB procedure, you can restart the procedure using the STRLIB parameter on the RSTLIB command. The STRLIB parameter is valid only when *NONSYS, *ALLUSR, or *IBM is specified for the restore operation,

The basic recovery steps for a restore operation are:

1. Check the job log to determine the library where the previous RSTLIB SAVLIB(*NONSYS, *IBM, or *ALLUSR) command failed. Find the library that follows the last successfully restored library. It is indicated by a successful restore completion message in the job log. If the library is not identified in the job log, look at the output from the save operation or display the tape file QFILE to determine which library is next.
2. Load the first tape of the SAVLIB LIB(*NONSYS, *ALLUSR, or *IBM) media.
3. Type the following and press the Enter key:

   ```
   RSTLIB SAVLIB(*NONSYS, *IBM or *ALLUSR) DEV(tape-name)
       ENDOPT(*LEAVE) STRLIB(library-name) OMITLIB(library-name)
   ```

   where the *library-name* for the STRLIB and the OMITLIB parameters is where the RSTLIB failed. This starts the restore operation on the next library after the library where the RSTLIB failed.
4. You will be asked to load the volume containing the starting library.
5. After the restore operation is complete, restore the library that failed using the media from a previous save operation.

   Note: Consider eliminating the tape with the media error from the next save rotation cycle to avoid a tape error again.

11. If you have documents, folders, and mail to restore, load the correct tape and type the following:

    ```
    RSTDLO DLO(*ALL) SAVFLR(*ANY) DEV(tape-device-name) ENDOPT(*UNLOAD)
    ```

    Note: If an unrecoverable error occurs when running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command, see "Media or Device Error When Running the RSTDLO Command" on page 9-11.

    Note: If you are not using journaling, or do not have changed objects to restore, continue with the next step. Otherwise, continue with the task "Restore Changed Objects."

12. To restore the authority, type the following:

    ```
    RSTAUT
    ```

    Note: If users have private authority to many objects, the RSTAUT command can take a very long time to run.

13. If you used the distribution tapes to restore the operating system, some information was not restored. You must create or change this information again. You should have lists of this information that were created at the time you performed your save operation.

    The following may need to be created or changed:

    - Configuration lists

- Edit descriptions
- Reply list entries
- IBM-supplied subsystem descriptions

a. For the configuration lists, do the following:

   Use the Work Configuration List (WRKCFGL CFGL(*ALL)) command to create the configuration lists to match the information in your list.

b. For edit descriptions, do the following:

   Use the Work with Edit Descriptions (WRKEDTD EDTD(*ALL)) command to create edit descriptions to match the information in your list.

c. For reply list entries, do the following:

   Use the Add Reply List Entry (ADDRPYLE) command to create reply list entries to match the information in your list.

d. For IBM-supplied subsystem descriptions, do the following:

   Use the Work with Subsystem Descriptions (WRKSBSD SBSD(*ALL)) command to change the IBM-supplied subsystem descriptions to match the information in your list.

This completes the restore operation.

14. If you are unsure what the QSECOFR password is, change it now. To see if the password has expired, type the following:

    ```
    DSPUSRPRF QSECOFR
    ```

    If the password expiration is active for the QSECOFR user profile, you will see the expiration date on the Date password expired field. If the date is the current system date or prior, change the password for the QSECOFR user profile.

15. Check the job log to ensure all objects were restored.

    The job log contains information about the restore operation. To verify that all objects were restored, you should spool the job log for printing, along with the job's remaining spooled output, if any.

    ```
    DSPJOBLOG * *PRINT
    ```

    Or

    ```
    SIGNOFF *LIST
    ```

    Message CPC3703 is sent to the job log for each library that was successfully restored. Message CPF3773 is sent to tell you how many objects were restored. It also tells you how many objects were not restored. Objects are not restored for various reasons. Check for any error messages, correct the errors, and then restore those objects from the media.

    Note: During a full system recovery (control panel function code 24), you may receive diagnostic message CPF7088: `Receiver xxx associated with journal QAUDJRN`, where xxx is the receiver name. No recovery is required for this message when the journal is QAUDJRN.

    QAUDJRN was created by the system (if security auditing is turned on) because it did not exist at the time of the restore operation. This causes the creation date of the journal on the system to be different than the creation date of the journal on the media when the receiver

was saved. The journal receiver was restored and associated with QAUDJRN.

16. Perform a normal IPL and return the system to normal operations:
    a. Turn the keylock switch to the Normal position.
    b. Type the following on a command line and press the Enter key.

       ```
       PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
       ```

17. When the IPL is complete, sign on the system.
18. Start any other subsystems that need to be started, such as QTCP or QSNADS.

    ```
    STRSBS SBSD(subsystem-name)
    ```

Step 4. Restore Changed Objects

Attention!

If you are using journaling and need to apply journaled changes, continue with the following steps. Use these recommended steps to avoid a failed restore operation caused by restoring journal receivers with names that conflict with the journal receivers currently attached to the restored journals. Otherwise, ignore these steps and continue with "Restoring Changed Objects."

Note: If you are using OfficeVision/400 or PC Support/400 and are performing daily save operations using SAVDLO and SAVCHGOBJ LIB(QUSRSYS) OBJJRN(*NO) commands, you must perform the steps in "Working with Journals" for the system supplied journal QUSRSYS/QAOSDIAJRN. If you specified OBJJRN(*YES) on the SAVCHGOBJ command, you do not need to apply journal changes.

Working with Journals

1. Type the following and press the Enter key:

   ```
   WRKJRN
   ```

2. The Specify Journal Name display is shown. Specify *ALL for the *Library name* prompt and press the Enter key.
3. The Work with Journals display is shown. To display the name of the currently attached journal receiver, type a 5 (Display journal status) in the *Opt* field for each journal on which you want to apply changes. Write down all the names of the journals and their currently attached journal receivers.

   Notes:

   a. You only need to perform the following steps for those journals you plan to use for recovering journaled files by performing the APYJRNCHG command. If no database files have been journaled to a journal, the system cannot apply any journaled changes using the journal.
   b. If you are using OfficeVision/400 or PC Support/400, you must apply journaled changes to the files journaled to the system-supplied journal QUSRSYS/QAOSDIAJRN.

4. You cannot restore journal receivers from the SAVLIB, SAVOBJ, or SAVCHGOBJ media if they have the same names as the journal receivers that are attached. To later apply all journaled changes that have occurred since the

last complete save operation, you must restore the receivers to the system from the save media.

To avoid a failed restore operation of saved journal receivers because of name conflicts, do the following for each journal identified in the previous step.

a. Create a journal receiver that will be used as a temporary receiver. Give it a name that will identify it as a temporary receiver, for example, TEMPnn. You can enter a description in the text (TEXT parameter) that identifies it as a temporary receiver for disaster recovery.

```
CRTJRNRCV JRNRCV(library-name/TEMPnn)
       TEXT('temporary journal receiver for journal xxx')
```

Repeat this step for each journal found in step 3.

b. To detach the current receiver and attach the new TEMPnn receiver, type the following and press the Enter key.

```
CHGJRN JRN(library-name/journal-name) JRNRCV(library-name/TEMPnn)
```

Repeat this step for each journal found in step 3.

c. Delete the detached journal receiver (identified in step 3 where you wrote down the name of the journal and journal receiver) using the Delete Journal Receiver (DLTJRNRCV) command.

```
DLTJRNRCV JRNRCV(library-name/journal-receiver)
```

Repeat this step for each journal found in step 3.

If you receive message CPA7025 *Receiver never fully saved*, enter an I to ignore and press Enter to continue the delete.

This allows the journal receivers on the save media to be restored successfully.

Restoring Changed Objects

1. Load the SAVCHGOBJ tape.

   Note: Several commands found in library QUSRTOOL can help you during save and restore operations. If you create the RSTALLCHG command in library QUSRTOOL, you can use the RSTALLCHG command to restore the libraries with changed objects from the SAVCHGOBJ or SAVALLCHG media without the need to know the names of the saved libraries. You need to run only one RSTALLCHG command to restore all the libraries. For more information about these commands, see "Restore All Changes (RSTALLCHG) Command" on page D-9.

2. If you do not use the RSTALLCHG in library QUSRTOOL and you specified SAVCHGOBJ LIB(*ALLUSR), type the following to determine the libraries that were saved:

```
DSPTAP DEV(device-name) OUTPUT(*PRINT)
```

3. To restore changed objects, type the following and press the Enter key:

```
RSTOBJ OBJ(*ALL) DEV(tape-device) SAVLIB(library-name)
          OBJTYPE(*ALL) ENDOPT(*LEAVE) MBROPT(*ALL)
```

   You must repeat this step for every library saved using the SAVCHGOBJ command.

4. Do one of the following:

- If you are using journaling, perform the steps in "Applying Journal Changes" for each journal.
- If you need to restore changed documents and folders, with the steps in "Restoring Changed Documents and Folders."
- If you do not have no other restore steps to perform, continue with the following step.

5. Restore users' authority by entering:

   ```
   RSTAUT
   ```

   The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.

6. This completes the restore operation.
7. Perform a normal IPL and return the system to normal operations:
   a. Turn the keylock switch to the Normal position.
   b. Type the following on a command line and press the Enter key.

      ```
      PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
      ```

8. When the IPL is complete, sign on the system.
9. Start any other subsystems that need to be started, such as QTCP or QSNADS.

   ```
   STRSBS SBSD(subsystem-name)
   ```

Step 5. Apply Journaled Changes

Ensure that all the journal receivers required for the apply journaled changes operation are available on the system. In general, you will need all journal receivers that were attached to the journal for the length of time for which journaled changes are now to be applied to the restored files. Restore all necessary journal receivers, including ones that might have not been restored earlier because of name conflicts with the receivers attached to the restored journals. Use the Display Journal Receiver Attributes (DSPJRNRCVA) command to determine when a journal receiver was attached to and detached from a journal.

1. Determine the name of the last journal receiver (the last receiver restored) by entering the following:

   ```
   WRKJRNA JRN(library-name/journal-name)
   ```

2. Press the Enter key.
3. Press F15 (Work with receiver directory) from the Work with Journal Attributes display to show the last journal receiver with a status of SAVED or PARTIAL. Write down the name of the receiver.
4. Determine the chain of receivers to be used in the APYJRNCHG command from the Work with Receiver Directory display. Write down the first and last receiver that you restored (last receiver is prior to the TEMPnn receiver). Notice that the first and last receiver are the same if only one journal receiver was restored.

   Note: While looking at the receiver directory, you should also look for any receiver chain breaks. You can determine a chain break by looking at the first two digits in the *Number* column on the Work with Receiver

Directory display. You cannot apply journaled changes across receiver chain breaks. Therefore, you must write down the beginning and ending receiver names for each receiver chain. Then you need to run a series of apply journaled changes operations, one for each chain using these receivers. The *Advanced Backup and Recovery Guide* has more information about receiver chain breaks.

5. When applying journal changes, if the ending receiver has a status of PARTIAL (saved while attached), the TOENT parameter requires a sequence number to be specified on the APYJRNCHG command. Determine the last entry to be applied for the last receiver (identified in previous step).

   To determine the last receiver in the receiver range, type an 8 (Display attributes) in the *Opt* field next to the receiver name on the Work with Receiver Directory display.

   Write down the value for the *Last Sequence Number* field.

6. To ensure that the files are currently being journaled, do the following from the Work with Journal Attributes display:

   a. Press F13 (Display journaled files) from the Work with Journal Attributes display to show the list of files currently being journaled. To start journaling for a physical file that should be in the list, run the STRJRNPF command for each physical file not in the list.

   b. Press F14 (Display Journaled Access Paths) from the Work with Journal Attributes main display to display the list of currently journaled access paths. To start journaling access paths for a physical or logical file that should be in the list, run the STRJRNAP command for the physical or logical file that is not in the list.

   Notice that before journaling an access path, all physical files over which the access path is built must first be journaled to this journal. When you have ensured all files are correctly journaled, continue with the next step.

7. To continue the naming convention for your journal receivers, create a receiver that follows the same naming convention as the last receiver but assign it a number of one greater.

   ```
   CRTJRNRCV JRNRCV(library-name/journal-receiver-nameNN)
   ```

   By doing this, you are doing what the CHGJRN command would normally do if the last receiver saved was the current receiver being detached with a new receiver name being created.

8. Use the CHGJRN command to detach the temporary receiver and attach the new receiver you just created.

   ```
   CHGJRN JRN(library-name/journal-name)
          JRNRCV(library-name/journal-receiver-nameNN)
   ```

9. Enter the following command to apply the journaled changes using the first and last journal receivers identified on the Work with Receiver Directory display.

   ```
   APYJRNCHG JRN(library-name/journal-name)
             FILE((library-name/*ALL))
             RCVRNG(lib-name/first-receiver lib-name/last-receiver)
             FROMENT(*LASTSAVE) TOENT(last-entry)
   ```

   Note: If you determined in step 4 of this procedure that this journal had receiver chain breaks, then you must run an APYJRNCHG command

for each chain instead of one command as shown. For the RCVRNG parameter, specify the first and last receiver for each chain. For the FROMENT and TOENT parameters, specify:

a. FROMENT(*LASTSAVE) and TOENT(*LAST) for the first receiver chain.

b. FROMENT(*FIRST) and TOENT(*LAST) for the middle receiver chains.

c. FROMENT(*FIRST) and TOENT(last-entry) for the last receiver chain.

Attention

You must specify individual files on the FILE parameter instead of *ALL for the QAOSDIAJRN journal in library QUSRSYS. Do not apply journal changes to the document and folder search index database files (QAOSSS10 through QAOSSS15, QAOSSS17, and QAOSSS18) for journal QAOSDIAJRN in library QUSRSYS.

```
APYJRNCHG JRN(QUSRSYS/QAOSDIAJRN)
     FILE((QUSRSYS/QAOKPLCA) (QUSRSYS/QAOSAY05)
          (QUSRSYS/QAOKPX4A) (QUSRSYS/QAOSAY07)
          (QUSRSYS/QAOKP01A) (QUSRSYS/QAOKP02A)
          (QUSRSYS/QAOKP03A) (QUSRSYS/QAOKP04A)
          (QUSRSYS/QAOKP05A) (QUSRSYS/QAOKP06A)
          (QUSRSYS/QAOKP08A) (QUSRSYS/QAOKP09A))
      RCVRNG(lib-name/first-receiver lib-name/last-receiver)
      FROMENT(*LASTSAVE) TOENT(last-entry)
```

If you need to restore changed documents and folders, with the steps in "Restoring Changed Documents and Folders." Otherwise, continue with the next step.

10. Restore users' authority by entering:

    ```
    RSTAUT
    ```

    The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.

11. This completes the restore operation.

12. Perform a normal IPL and return the system to normal operations:

    a. Turn the keylock switch to the Normal position.

    b. Type the following on a command line and press the Enter key.

       ```
       PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
       ```

13. When the IPL is complete, sign on the system.

14. Start any other subsystems that need to be started, such as QTCP or QSNADS.

    ```
    STRSBS SBSD(subsystem-name)
    ```

Step 5. Restore Changed Documents and Folders

If you performed daily save operations for documents and folders, do the following steps. Otherwise, continue with the RSTAUT command.

1. Load the last daily SAVDLO tape.
2. If you performed daily save (SAVDLO DLO(*CHG)) operations to back up all new folders, new and changed documents, and mail since the last complete SAVDLO DLO(*ALL) FLR(*ANY) operation, type the following and press the Enter key.

   ```
   RSTDLO DLO(*ALL) DEV(TAP01) SAVFLR(*ANY)
   ```

   Note: If an unrecoverable error occurs when running the RSTDLO DLO(*ALL) SAVFLR(*ANY) command, see "Media or Device Error When Running the RSTDLO Command" on page 9-11.
3. Restore users' authority by entering:

   ```
   RSTAUT
   ```

   The time it takes for the RSTAUT command to complete can vary significantly. The time depends on the number of user profiles and private authorities that were saved during the save operation.
4. This completes the restore operation.
5. Perform a normal IPL and return the system to normal operations:
   a. Turn the keylock switch to the Normal position.
   b. Type the following on a command line and press the Enter key.

      ```
      PWRDWNSYS OPTION(*IMMED) RESTART(*YES)
      ```
6. When the IPL is complete, sign on the system.
7. Start any other subsystems that need to be started, such as QTCP or QSNADS.

   ```
   STRSBS SBSD(subsystem-name)
   ```

Step 6. Restoring Programming Temporary Fixes

If you are using this procedure to finish restoring the entire system and have applied program temporary fixes (PTFs) after the last save operation, you must restore the PTFs.

If you need to restore program temporary fixes (PTFs) as part of recovering the entire system, find the most recent cumulative program temporary fix tape. This package could be on a distribution tape or on a stand-alone tape.

You can use option 8 (Install program temporary fix package) on the Program Temporary Fix menu to install all of the PTFs. All of the PTFs in the cumulative PTF package will be installed for the licensed programs you have installed on your system. Refer to the *AS/400 System PTF Shipping Information Letter* for special instructions that are required.

If you are restoring individual PTFs, see the *System Operator's Guide*, SC41-8082, for more information about applying individual PTFs.

1. Print a list of all the licensed internal code PTFs currently on the system. Type the following and press the Enter key:

```
DSPPTF LICPGM(5738999) OUTPUT(*PRINT)
```

2. Compare the list of PTFs in the previous step with the list you printed when you saved the system.

   Any PTFs that are not found must be loaded again.

3. If you do not have the PTFs identified in the previous step, order them and then apply them.

Recovering the System/36 Environment Configuration

If you are experiencing a problem with the System/36 environment after restoring the system, it may be caused by the locking rules used during the installation process. The QS36ENV configuration object in library #LIBRARY may have been locked by the System/36 environment.

This object contains the System/36 environment names for the work station, printer, tape and diskette units on the system and default System/36 environment values used for all users. This object may have been modified by the Change S/36 Environment Configuration (CHGS36) command to customize the System/36 environment.

When the first subsystem is started on the system after the installation process is complete, a new #LIBRARY and a new QS36ENV object in #LIBRARY is created with the AS/400 system defaults. In addition to the creating the new objects, each subsystem holds a lock on the QS36ENV configuration object to ensure that it is not deleted. This lock will not allow the saved QS36ENV configuration object to be restored.

If the QS36ENV configuration object did not restore, start with step 1. If the configuration object did restore but you are experiencing problems with the System/36 environment configuration, go to step 5.

1. Rename the newly created #LIBRARY to something else (for example, #LIBNEW).
   - The locks held on QS36ENV object remain with the renamed library. This allows the saved System/36 environment configuration object to be restored.
2. Restore the saved copy of library #LIBRARY. This library was saved using SAVLIB LIB(*NONSYS) or SAVLIB LIB(*ALLUSR).
3. Perform an IPL of the system.
   - The QS36ENV object in the restored copy of #LIBRARY is the System/36 environment configuration again.
4. Delete the earlier renamed version of #LIBRARY (for example, #LIBNEW).
5. Use the Change S/36 Environment Configuration (CHGS36) command to refresh the configuration object.
   a. Select each of the device types you want to change.
      - Work station devices
      - Printer devices
      - Tape devices
      - Diskette devices
   b. Do the following for each device type you want to change:

1) Press the F5 key to ensure the configuration object matches the device descriptions on the system.
2) Do one of the following if any System/36 names are not specified:
   - Press the F10 key to use the AS/400 defaults for the System/36 names for those devices.
   - Update the System/36 names manually.

c. Save the changes to the configuration object.

See the topic on configuring the System/36 environment in the *Concepts and Programmer's Guide for the System/36 Environment* for more information about configuring the System/36 environment.

Recovering Devices that Will Not Vary On

If you have a problem with your devices, such as not being able to vary on a device, it may be because the system resource management (SRM) database that was restored does not match the device descriptions on the system.

Tape Controller - Tape Unit Types 3422, 3430, 3480, and 3490: To correct the problem for or tape controller, do the following:

1. Type the following and press the Enter key to display the Work with Storage Resources display.

   ```
   WRKHDWRSC TYPE(*STG)
   ```

2. Find the correct storage controller for the device that would not vary on.
3. Type a 9 (Work with resource) in the *Opt* column next to the resource name. The Work with Storage Controller Resources display is shown.
4. Find the valid resource name for the device type and model you tried to vary on.
5. Press F12 (Cancel) until you return to a display with a command line.
6. Type the following and press the Enter key to display the device description for the device that would not vary on.

   ```
   WRKCTLD CTLD(controller-name)
   ```

   The Work with Device Descriptions display is shown.
7. Type a 2 (Change) in the *Opt* column next to the device description you want to change and press the Enter key. The Change Device Description display is shown.
8. Change the name in the *Resource name* prompt to the correct name for the resource and press the Enter key. You will return to the Work with Device Descriptions display.
9. Type an 8 (Work with status) in the *Opt* column next to the device description you changed and press the Enter key. The Work with Configuration Status display is shown.
10. Type a 1 (Vary on) in the *Opt* column next to the device description name and press the Enter key to vary on the device.

Tape Units Other Than Types 3422, 3430, 3480, and 3490: To correct the problem for a tape unit, do the following:

1. Type the following and press the Enter key to display the Work with Storage Resources display.

   ```
   WRKHDWRSC TYPE(*STG)
   ```

2. Find the correct storage controller for the device that would not vary on.
3. Type a 9 (Work with resource) in the *Opt* column next to the resource name. The Work with Storage Controller Resources display is shown.
4. Find the valid resource name for the device type and model you tried to vary on.
5. Press F12 (Cancel) until you return to a display with a command line.
6. Type the following and press the Enter key to display the device description for the device that would not vary on.

   ```
   WRKDEVD DEVD(device-name)
   ```

   The Work with Device Descriptions display is shown.
7. Type a 2 (Change) in the *Opt* column next to the device description you want to change and press the Enter key. The Change Device Description display is shown.
8. Change the name in the *Resource name* prompt to the correct name for the resource and press the Enter key. You will return to the Work with Device Descriptions display.
9. Type an 8 (Work with status) in the *Opt* column next to the device description you changed and press the Enter key. The Work with Configuration Status display is shown.
10. Type a 1 (Vary on) in the *Opt* column next to the device description name and press the Enter key to vary on the device.

Local Work Station Controller: To correct the problem for a work station, do the following:

1. Type the following and press the Enter key to display the Work with Local Workstation Resources display.

   ```
   WRKHDWRSC TYPE(*LWS)
   ```

2. Find the correct controller description for the device that would not vary on.
3. Type a 5 (Work with configuration description) in the *Opt* column next to the controller description name and press the Enter key. The Work with Configuration Description display is shown.
4. Type a 5 (Display) in the *Opt* column to display the valid resource name for the work station controller.
5. Press F12 (Cancel) until you return to a display with a command line.
6. Type the following and press the Enter key to display the device description for the device that would not vary on.

   ```
   WRKCTLD CTLD(controller-name)
   ```

   The Work with Controller Descriptions display is shown.

7. Type a 2 (Change) in the *Opt* column next to the controller description you want to change and press the Enter key. The Change Controller Description display is shown.
8. Change the name in the *Resource name* prompt to the correct name for the resource and press the Enter key. You will return to the Work with Controller Descriptions display.
9. Type an 8 (Work with status) in the *Opt* column next to the controller description you changed and press the Enter key. The Work with Configuration Status display is shown.
10. Type a 1 (Vary on) in the *Opt* column next to the controller description name and press the Enter key to vary on the device.

    Note: It is possible that another device description is varied on for this resource. Vary off the device first and then vary on the changed device description. This situation can happen to the console device.

Section 8. Rebuilding Process

- Management Team must assemble to access damage and begin reconstruction of a new data center.
  - If the original facility must be restored or replaced, then the following are some of the factors to consider.
    1. What is the projected availability of all needed computer equipment?
    2. Will it be more effective and efficient to upgrade the computer systems with newer equipment?
    3. What is the estimate of the probable time needed for repairs or construction of the data site.
    4. Is there an alternative site that could more readily be upgraded for computer purposes?
- Once the decision to rebuild the data center has been made, then go to "Section 11. Disaster Site Rebuild."

Section 9. Information Services Backup Procedures

- AS/400 System
  - Daily, journals receivers are changed at _____ and at _____.
  - Daily, a save of changes objects in the following libraries is done at _____:
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____

    This procedure also saves the journals and journal receivers.
  - On _____ at _____ a complete save of the system is done.
  - All save media is stored off-site in a vault at _____ location.
- Personal Computer
  - It is recommended that all personal computers be backed up and the files loaded up to the AS/400 on _____ at _____ just before a complete save of the system is done. It is then saved with the normal system save procedure. This provides for a more secure backup of personal computer-related systems where a local area disaster could wipe out important personal computer systems.

Section 10. Testing the Disaster Recovery Plan

It is important in successful contingency planning to regularly test and evaluate the plan itself. Data Processing operations are volatile in nature, resulting in frequent changes to equipment, programs, documentation, etc. These actions make it critical to consider the plan a changing document.

The use of the following checklist for conducting a recovery test should be helpful.

Table B-8. Checklist for Testing the Disaster Recovery Plan

Item	Yes	No	Applicable	N/A	Comments
1. Conducting a Recovery Test					
a. Select the purpose of the test. What aspects of the plan are being evaluated?					
b. Describe the objectives of the test. How will you measure successful achievement of the objectives?					
c. Meet with management and explain the test and objectives. Gain their agreement and support.					
d. Have management announce the test and the expected completion time.					
e. Collect test results at the end of the test period.					
f. Evaluate results. Was recovery successful? Why or why not?					
g. Determine the implications of the test results. Does successful recovery in a simple case imply successful recovery for all critical jobs in the tolerable outage period?					
h. Make recommendations for changes. Call for responses by a given date.					
i. Notify other areas of results. Include users and auditors.					
j. Change disaster recovery plan manual as necessary.					
2. Areas to be Tested					
a. Recovery of individual application systems using files and documentation stored off-site.					
b. Ability to process on a different computer.					
c. Reload of system packs and IPL of system using files and documentation stored off-site.					
d. Ability of management to determine priority of systems with limited processing.					
e. Ability to recover and process successfully without key people.					
f. Ability of the plan to clarify areas of responsibility and chain of command.					
g. Effectiveness of security measures and security bypass procedures during the recovery period.					
h. Ability to accomplish emergency evacuation and basic first-aid responses.					
i. Ability of users of real-time systems to cope with a temporary loss of on-line information.					
j. Ability of users to continue day-to-day operations without "non-critical" processing.					
k. Ability to contact the key people, or their designated alternates, in a timely manner.					
l. Ability of data entry to provide input to critical systems using alternate sites and different input media.					
m. Availability of peripheral equipment and processing: printers, scanners, etc.					
n. Availability of support equipment: air conditioners, etc.					
o. Availability of support: supplies, transportation, communication.					
p. Distribution of output produced at recovery site.					
q. Availability of key forms and paper stock.					
r. Ability to adapt plan to lesser disasters.					

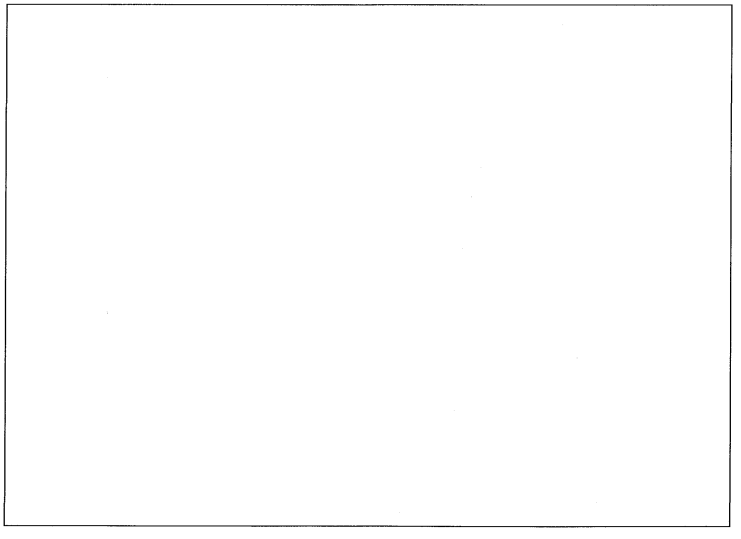
Section 11. Disaster Site Rebuild

- Floor plan of computer room.
- Determine current hardware needs and possible alternatives. (See configuration profile.)
- Data Center square footage, power requirements and security requirements.
  - Square footage _____
  - Power requirements _____
  - Security requirements - locked facility, preferably with combination lock on one door.
  - Floor to ceiling studding
  - High temperature, water, smoke, fire and motion detectors.
  - Raised floor.

Vendors

-
-
-
-
-

Floor Plan



Section 12. Record of Plan Changes

To get a list of local hardware, type the following:

```
DSPLCLHDW OUTPUT(*PRINT)
```

Attach the list here.

Appendix C. Save and Restore Performance

Before determining which tape unit to select, determine your backup strategy. Chapter 4, "Save and Restore Media Considerations" should be used to help you plan the backup strategy. Once a backup strategy is in place, the information in this appendix can be used to help you determine how long your save and restore operations will take. Because save operations are done more frequently than restore operations, more attention should be given to the save operations. Restore operations should be considered if object distribution is being done or data is being moved from one system to another using save and restore operations.

See Chapter 4, "Save and Restore Media Considerations" on page 4-1 for the device characteristics of the various tape units supported on the AS/400 system.

Attention

This appendix contains tables comparing the save and restore rates for different tape units. This information is approximate and may vary from each system.

The information in the tables is based on the V2R2M0 operating system except where specifically noted.

System Changes to Improve Save and Restore Performance for Version 2 Release 2.0+

The following is a list of changes to the AS/400 system for Version 2 Release 2.0+.

The V2R2M0+ changes listed are not reflected in the tables except where specifically noted.

1. The new 7208 Model 12, an 8-mm tape unit, provides twice as much capacity and data rate as the 7208 Model 02 tape unit.
2. The ability to attach the 3490 Model C10, C11, and C12 to the 9404 system unit using the 2622 IOP card provides greater reliability, reduced operating handling, and improved save and restore rates for the 9404 AS/400 systems.

System Changes to Improve Save and Restore Performance for Version 2 Release 2.0

The following is a list of changes to the AS/400 system for Version 2 Release 2.0.

The V2R2M0 changes listed are not reflected in the tables except where specifically noted.

1. The 6343, 6348, and 6368 1/4-inch tape units provide approximately 1.2GB per cartridge. These tape units also provide up to 50% greater throughput when using the *QIC1000 tape density than previously available 1/4-inch tape units.
2. The RSTDLO command performance has been improved significantly. In some cases, the RSTDLO command may complete up to 5 times faster than in the previous release.

3. The RSTOBJ or RSTLIB command performance when restoring many small source file members has been improved noticeably.
4. The save-while-active function can improve availability by avoiding the suspension of applications in order to save files. This function can help minimize the length of current dedicated save windows.
5. To further enhance save and restore capabilities of the AS/400 system, a removable media cluster box is available for the 9406 models. This rack-mounted unit has space for four 1/4-inch cartridge devices. They can provide an additional 4.8GB of unattended save and restore capacity.

System Changes to Improve Save and Restore Performance for Version 2 Release 1.1

The following is a list of changes to the AS/400 system for Version 2 Release 1.1.

1. The 3490 tape unit models C10, C11, and C22 provide rack-mounted, low-cost use of the 3490E tape model technology.
2. The 2644 I/O processor used for System/370 channel attach tape units can improve the time it takes to process large files by up to 40% when compared to 2622 input/ouput processor.
3. The 3490E 1/2-inch tape unit supports a cartridge tape system that doubles the storage capacity of most tapes. It is an extended-length cartridge.

System Changes to Improve Save and Restore Performance for Version 2 Release 1.0

The following is a list of changes to the AS/400 system for Version 2 Release 1.0.

1. The SAVCHGOBJ command is improved to more efficiently determine the changed objects when REFDATE(*SAVLIB) is specified on the command.
2. The AS/400 system supports the improved data recording capability (IDRC) feature on the 3480 and 3490 tape units.
3. The 3490 and 3490E tape models provide enhanced capabilities for higher cartridge capacity. They also eliminate rewinding when full cartridges are written. (Load and unload time, of course, is not eliminated.)
4. The 7208 8-mm cartridge tape unit has a storage capacity of approximately 2.3GB per cartridge.
5. The 6347 1/4-inch cartridge tape unit has a storage capacity of approximately 525MB per cartridge.
6. New I/O Processors are available for Version 2 hardware which improve hardware data compression capability when using the 9348, 2440, and 2440 high-speed feature tape units.
7. Recovery from tape-write errors is supported. Save jobs do not need to be started again when attempts are made to recover from tape-write media errors.
8. The system limit for the number of objects to be saved in a library is removed. Greater overlap processing within a library and for multiple library save operations is provided.

Save and Restore Work Loads

The following work loads were designed to help evaluate save and restore performance. Being familiar with the work loads helps you understand the differences in the save and restore rates presented below.

- The *User Environment* work load column in the tables consists of four libraries containing 640 objects with a total size of 250MB. The majority of the total size is represented by 240 1MB files. The four libraries were saved using a single SAVLIB command and restored using four consecutive RSTLIB commands. This combination of data, being heavily weighted toward large database files, is meant to represent a typical daily save operation done by the average user.
- The *Source File* work load column in the tables is a file of 2MB with 200 source members (a member is equivalent to an object), saved using the SAVOBJ command and restored using the RSTOBJ command. This work load represents the worst case performance scenario because of the large number of very small objects.
- The *Large File* work load column in the tables is a single file of 200MB saved using the SAVOBJ command and restored using the RSTOBJ command. This work load represents the best case performance scenario for save and restore operations.
- The work load described in "SAVDLO and RSTDLO Rates" on page C-25 consists of 1 000 documents contained in 9 folders with a combined size of 30MB. Unlike the other work loads, the SAVDLO and RSTDLO measurements were completed on a dedicated system running in the batch subsystem with a storage pool of 4500KB.

  The choice of 4500KB for the batch subsystem pool was made based on working set size studies for the 1000 Document work load. If a larger number of documents is to be saved, then a larger memory pool is required for the best performance. For example, when 2000 documents are being saved, a pool size of 8400KB proved the best; for 3000 documents, 11 500KB provided the best performance.

  The structure of the documents in the 1000 document work load is shared folders function type 1. If the documents were shared folders function type 2, they may require up to 50% longer to save and up to 10% longer to restore. The working set size would also increase.

Save and Restore Rates

The save and restore rates shown in the following tables were obtained from measurements done on a system that was in a restricted state. A restricted state measurement is performed when all subsystems are ended using the ENDSBS SBS(*ALL) command.

For all restore measurements gathered, it is assumed that each work load was new to the system. This represents the worst case performance scenario for the restore operation.

The rates shown in the tables include the processing time required to start and complete the operation. The rate in the farthest left column does not include the time required for the tape to rewind and the operator to unload and load the tapes. This rate represents using two tape units with overlap processing; tape 2 is being

written to while tape 1 is rewinding. The rate using two tape units is followed by an estimate of the achievable rate if only one tape unit is used. The rate using one tape unit includes the time required for the tape to rewind and operator unload and load a new tape. The estimated rates assume the following:

- Rewind time is the average time it takes for the tape unit to rewind the tape. For the 1/4-inch tape units, the time required to tighten the tape is added to the rewind time when calculating single tape unit rates. When the tape cartridge is inserted in the tape unit, it is automatically tightened. The time it takes to rewind, tighten, and unload and load the tape is a part of the total time required to change cartridges when multiple tape cartridges of data are processed.
- For 1/2-inch reel tape, a 2400-foot tape is assumed.
- Operator handling time consists of an estimate of the necessary time to load and unload a tape and the time to respond to the message on the console display. Operator time is 90 seconds for reel tape units and 60 seconds for cartridge tape units.
- The compression ratio for all scenarios is 2 to 1. This means the amount of data was compressed to one half the original size from the disk space.
- All reels and cartridges are to be filled to capacity.
- All configurations use one I/O processor for each group of four 9336 storage units or four 9335 model 400 storage units.
- For the 9406 model D measurements, the tape I/O processor and the four 2800 storage units were on Bus 0 and the additional storage units were spread evenly across the other system buses.

  Note: For 3480 and 3490 tapes units, if additional disk unit I/O processors were connected on the same system bus, the save rate can be reduced by 6 percent or more.
- The 6346, 9346, 6366, and 6341 tape units have the same performance characteristics. The 1/4-inch tape cartridge devices support only 10 000 bpi which have a cartridge capacity of approximately 120MB.
- The 6347 and 6342 tape units have the same performance characteristics. The 1/4-inch tape cartridge devices support 16 000 bpi that have a cartridge capacity of approximately 525MB. They also support 10 000 bpi tapes. When reading or writing at 10 000 bpi, the performance is the same as 6346-like devices. All numbers in this section are based on the 6347 or 6342 tape unit performance using 16 000 bpi.
- The 6343, 6348, and 6368 tape units have the same performance characteristics. The 1/4-inch tape cartridge devices support *QIC1000 density having a capacity of approximately 1.2GB. They also support *QIC120 (10 000 bpi) and *QIC525 (16 000 bpi) tapes. When reading or writing at *QIC120 or *QIC525 density, the performance is the same as the other 1/4-inch devices at those densities. All numbers in this section are based on the 6343, 6348, or 6368 tape unit performance using *QIC1000 density.
- *SAVF in the *Device Type* column refers to an online save file. The save files for these tests were created in the system ASP. Placing the save file in a user ASP with two or more storage units can show slightly better save rates than a save file in the system ASP due to separating the input and output operations between the data being saved and the data written to the save file.

The *Density* column in the table has units of bytes per inch (bpi), with the exception of the 1/4-inch tape cartridge devices (9346, 6346, 6341, 6366, 6347, and 6342) and the 8-mm tape cartridge tape unit (7208) which are measured in bits per inch. All of the rates in the following tables are expressed in terms of megabytes per hour.

E35 Save Rates (Megabytes/Hour)

Table C-1. E35 Save Rates (Megabytes/Hour)

E35 40MB 4-2800 10-9336			User Environment		Source File		Large File	
Device Type	**Density**	**ips[1]**	**2 Tape**	**1 Tape**	**2 Tape**	**1 Tape**	**2 Tape**	**1 Tape**
*SAVF[2]				539		201		518
*SAVF				1399		296		1621
6366[3,4]	QIC120	72	594	544	79	78	502	465
7208[3]	43200	0.43	1374	1361	71	71	1310	1298
9348[3]	6250	125	2913	2002	210	203	3733	2358
3490E[3]	FMT3490E[4]	79	2963	2802	202	201	3441	3226
6368[3]	QIC1000[4]	80	1840	1783	155	155	1815	1760

[1] Inches per second

[2] Software data compression

[3] Hardware data compression

[4] 6366 rates are V2R1 numbers measured on a D35

E35 Restore Rates (Megabytes/Hour)

Table C-2. E35 Restore Rates (Megabytes/Hour)

E35 40MB 4-2800 10-9336			User Environment		Source File		Large File	
Device Type	**Density**	**ips[1]**	**2 Tape**	**1 Tape**	**2 Tape**	**1 Tape**	**2 Tape**	**1 Tape**
*SAVF[2]				591		92		714
*SAVF				1030		97		1393
6366[3,4]	QIC120	72	468	436	47	47	516	478
7208[3]	43200	0.43	1104	1095	83	83	1509	1493
9348[3]	6250	125	1483	1204	98	97	3239	2151
3490E[3]	FMT3490E[4]	79	1556	1511	88	88	3947	3667
6368[3]	QIC1000[4]	80	1286	1258	99	99	1826	1770

[1] Inches per second

[2] Software data compression

[3] Hardware data compression

[4] 6366 rates are V2R1 numbers measured on a D35

E90 Save Rates (Megabytes/Hour)

Table C-3. E90 Save Rates (Megabytes/Hour)

E90 384MB 4-2800 20-9336			User Environment		Source File		Large File	
Device Type	**Density**	**ips[1]**	**2 Tape**	**1 Tape**	**2 Tape**	**1 Tape**	**2 Tape**	**1 Tape**
*SAVF[2]				1390		274		1456
*SAVF				1575		331		1789
7208[3]	43200	0.43	1382	1368	71	71	1303	1291
9348[3]	6250	125	3648	2324	254	244	3923	2432
3490E[3]	FMT3490E[4]	79	7213	6330	275	274	10929	9022
6368[3]	QIC1000[4]	80	1923	1861	210	209	1817	1761

[1] Inches per second

[2] Software data compression

[3] Hardware data compression

E90 Restore Rates (Megabytes/Hour)

Table C-4. E90 Restore Rates (Megabytes/Hour)

E90 384MB 4-2800 20-9336			User Environment		Source File		Large File	
Device Type	**Density**	**ips[1]**	**2 Tape**	**1 Tape**	**2 Tape**	**1 Tape**	**2 Tape**	**1 Tape**
*SAVF[2]				1037		132		1305
*SAVF				1272		128		1725
7208[3]	43200	0.43	1256	1245	105	105	1507	1491
9348[3]	6250	125	2049	1552	135	132	3466	2248
3490E[3]	FMT3490E[4]	79	2939	2781	130	130	10821	8948
6368[3]	QIC1000[4]	80	1543	1503	131	131	1840	1783

[1] Inches per second

[2] Software data compression

[3] Hardware data compression

As these results show, saving source files with many members is much slower than saving large files. Therefore, on a daily basis, you should save only large files; source files can be saved less frequently.

Save and Restore Rates for 3490 E Model Using a 2622 Attached to 9404 System Unit

The 3490E tape unit is attached to the 9404 system unit using the 2622 I/O processor. This feature adds speed and automatic loading capabilities to the 3490E on the 9404 system units. Replacing your tape unit with a 3490 is recommended if you require greater flexibility for unattended backups.

Save Rates for 3490 E Model

Table C-5. Save Rates (Megabytes/Hour) for 3490 Tape Unit Attached to 9404

3490 Tape Unit			User Environment		Source File		Large File	
Device Type	Model	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
D10	6 6107	40MB	1592e	1275e	109e	108e	1837e	1428e
E10	6 6107	40MB	2299e	1822e	157e	155e	2653e	1428e
F10	6 6107	40MB	2918	2292e	199	198e	3368e	2516e
D20	6 6107	40MB	2033e	1618e	139e	137e	2347e	1811e
E20	6 6107	40MB	2918e	2292e	199e	195e	3368e	2561e
F20	6 6107	40MB	3160	2439e	215	211e	4029	2926e
D25	6 6107	40MB	2918e	2292e	199e	195e	3368e	2561e
E25	6 6107	40MB	3160e	2439e	215	211e	4029e	2926e
F25	6 6107	40MB	3704	3751e	224	219e	4642	3236e

e=Estimate

Restore Rates (Megabytes/Hour) for the 3490E Tape Unit

Table C-6. Restore Rates (Megabytes/Hour) for 3490 Tape Unit Attached to 9404

3490 Tape Unit			User Environment		Source File		Large File	
Device Type	Model	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
D10	6 6107	40MB	798e	710e	47e	46e	2068e	1563e
E10	6 6107	40MB	1153e	1019e	69e	69e	2988e	2230e
F10	6 6107	40MB	1464	1278e	87	87e	3792	2798e
D20	6 6107	40MB	1020e	904e	61e	61e	2643e	1981e
E20	6 6107	40MB	1464	1278e	87e	87e	3792	2798e
F20	6 6107	40MB	1627	1412e	89	89e	4499	3166e
D25	6 6107	40MB	1464	1278e	87	87e	3792	2798e
E25	6 6107	40MB	1627	1412e	89	89e	4499	3166e
F25	6 6107	40MB	1745	1490e	96	96e	5148	3474e

e=Estimate

The following two tables provide save and restore data for the 3490 tape unit attached to the 2622 I/O processor on the 9406 model x35 and x45. These numbers are provided for comparison.

Save Rates for 3490 Tape Unit Attached to the 9406 System Unit

Table C-7. Save Rates (Megabytes/Hour) for 3490 Tape Unit Attached to 9406

3490 Tape Unit			User Environment		Source File		Large File	
Device Type	Model	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
D35	4 2800 8 9336	56MB	2257e	1784e	133e	132e	2605e	1991e
E35	4 2800 8 9336	56MB	2980	2330e	176	173e	3439	2598e
F35	4 2800 8 9336	56MB	3598e	2888e	248e	242e	4654e	3243e
D45	4 2800 8 9336	80MB	3116e	2300e	195e	190e	3664e	2585e
E45	4 2800 8 9336	56MB	3598	2888e	248	242e	4654	3242e
F45	4 2800 8 9336	80MB	4517	3576e	311	303e	5842e	4008

e=Estimate

Restore Rates for 3490 Tape Attached Using 2622 to 9406 System Unit

Table C-8. Restore Rates (Megabytes/Hour) for 3490 Tape Unit Attached to 9406

3490 Tape Unit			User Environment		Source File		Large File	
Device Type	Model	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
D35	4 2800 8 9336	56MB	1248	1104e	80e	79e	2953e	2192e
E35	4 2800 8 9336	56MB	1647	1447e	105	104e	3898	2856e
F35	4 2800 8 9336	56MB	2048e	1718e	119e	118e	5119e	3461e
D45	4 2800 8 9336	80MB	1612e	1362e	94e	93e	4030e	2027e
E45	4 2800 8 9336	56MB	2048	1718e	119	118e	5119	3461e
F45	4 2800 8 9336	80MB	2571e	2139e	149e	149e	6426e	4247e

e=Estimate

Save and Restore Rates for the 3490 Tape Unit

The 3490E (enhanced capability) tape unit is currently the best performing tape unit available for the 9406 models of the AS/400 system. With the cartridge system tape with enhanced capacity (double-length tapes), the 3490E tape unit has a uncompressed or uncompacted single cartridge capacity of 800MB. With the use of improved data rate capability (IDRC), there is 3-to-1 compaction that can provide up to 2.4GB per cartridge. With the use of an automatic cartridge loader, unattended save capacity can be increased to 14.4GB per tape unit.

The increased capacity due to compaction is a guideline, NOT a guarantee because compaction and compression ratios are data dependent.

To take full advantage of the 3490E tape unit's speed, the proper AS/400 configuration must be chosen. The most critical factors affecting performance are:

- Processing unit power
- Number of disk unit I/O processors
- Number of storage units (actuators)
- Size and types of objects being processed

A system with the majority of disk space occupied by many small database members or small document objects cannot use the 3490E throughput as well as a system with the majority of disk space occupied by a small number of large database files or members.

The 3490E should be considered mainly for the 9406 Exx models. The 3490E provides many benefits, such as:

- Reduced media size
- Increased media reliability
- Reduced operator time while using the optional Automatic Cartridge Loader (ACL)
- Unattended backup capability

The size of the processing unit can be a bottle-neck for this device, so it is recommended that the 3490E model *not* be attached to an AS/400 model below the D model.

For the 9406 model E systems, you should consider both performance and ease of use. For models E35 and E45, the ease of use should be the primary consideration.

The 3490E tape unit can also be attached for other reasons such as reduced media size, increased media reliability, reduced operator time while using the optional Automatic Cartridge Loader (ACL) feature, and for unattended backup capability. The two-tape, rewind overlap rate is given followed by an estimate of a single tape rate. The Automatic Cartridge Loader feature is not included in any of the rates unless the feature is specifically mentioned. However, if a 3490E tape unit with the Automatic Cartridge Loader feature is used with the extended-length tapes, then the one-tape rate may be within **5%** of the two-tape rate. All of the rates were obtained when the system was in a restricted state. Save and restore rates are severely limited if the system is not in a restricted state.

The AS/400 system supports the improved data recording capability (IDRC). It is provided as a base function on newer 3490E models and as a feature on earlier models of 3480 and 3490 tape units. IDRC can provide a noticeably greater capacity than hardware data compression. The default on save commands is to not use hardware data compression if IDRC is available.

The new models of the 3490E tape unit provide for even greater capacity over the 3480 tape unit and earlier models of the 3490 by doubling the density of data written to the tape cartridge. When full cartridges are written, the rewind time is eliminated. This saves approximately 40 seconds per cartridge in a single tape unit environment. If used in a single tape unit environment with an automatic cartridge loader, the 3940E tape unit requires approximately 25 seconds to switch volumes. Models other than the 3490E require approximately 65 seconds to switch volumes. This time savings and improved data recording capability makes the 3490E models more attractive from a performance standpoint when compared to a 3480 or 3490 in a single tape unit environment.

The models of the 3490E tape unit can read tapes written in the 3480 format. However, the 3490E tape unit cannot write in that format. Also, the system cannot distinguish between 3480 format and the 3490-2 format (3490E model written) tapes when using the DSPTAP command.

The following tables can be used as best-case performance configuration rates over the range of E35-E95 models. Each of the models in the following tables were configured with each 6112 attached to four 9336 disk units.

The data in these tables is similar to that in previous tables. The two-tape, overlapped rewind rate is given followed by an estimate of a single tape rate. The ACL is not included in any of the rates unless specifically mentioned, but when using 3490E model tape with an ACL and the extended length tapes, the one-tape rate may be within 5% of the two-tape rate. All rates were obtained from restricted state measurements. Save and restore rates are severely limited if the system is not in a restricted state.

Save Rates (Megabytes/Hour) Using a 2644 Attached to a 3490E Tape Unit

Table C-9. Save Rates (Megabytes/Hour) using a 2644 Attached to a 3490E Tape Unit

3490E with Hardware Data Compression			User Environment		Source File		Large File	
System Model	Disk Type	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
E35	4-2800 8-9336	72MB	2963	2802	202	201	3441	3226
E45	4-2800 8-9336	80MB	3690	3444	206	205	4620	4241
E50	4-2800 20-9336	128MB	5040	4592	236	235	6252	5577
E60	4-2800 20-9336	192MB	6533	5800	260	259	9322	7898
E70	4-2800 20-9336	256MB	6801	6010	268	267	11014	9079
E80	4-2800 20-9336	384MB	5976	5357	231	230	11035	9094
E90	4-2800 20-9336	512MB	7213	6330	275	274	10929	9022
E95	4-2800 20-9336	512MB	7178	6303	275	274	11195	9202
E95	4-2800 42-9337-120	512MB					11231	9226

Restore Rates (Megabytes/Hour) Using a 2644 Attached to a 3490E Tape Unit

Table C-10. Restore Rates (Megabytes/Hour) using a 2644 Attached to a 3490E Tape Unit

3490E with Hardware Data Compression			User Environment		Source File		Large File	
System Model	Disk Type	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
E35	4-2800 8-9336	72MB	1556	1511	88	88	3947	3667
E45	4-2800 8-9336	80MB	1764	1706	105	105	5257	4772
E50	4-2800 20-9336	128MB	2067	1988	119	119	7275	6377
E60	4-2800 20-9336	192MB	2556	2436	122	122	9628	8116
E70	4-2800 20-9336	256MB	2828	2681	130	130	11194	9201
E80	4-2800 20-9336	384MB	2878	2726	127	127	11261	9247
E90	4-2800 20-9336	512MB	2939	2781	130	130	10821	8948
E95	4-2800 20-9336	512MB	2948	2789	133	133	11138	9164
E95	4-2800 42-9337-120	512MB			141	141	8247	7112

The following two tables show the performance for the 3480 and 3490 tape units. The tables are for comparison with the previous two tables. The following two tables have not been updated since V2R1.

Save Rates (Megabytes/Hour) Using a 2622 Attached to a 3490 Tape Unit

Table C-11. Save Rates (Megabytes/Hour) using a 2622 Attached to a 3490 Tape Unit

3490E with Hardware Data Compression			User Environment		Source File		Large File	
System Model	Disk Type	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
D35	4-2800 4-9336	40MB	2417	2046	145	143	2891e	2376e
D45	4-2800 12-9336	96MB	3135	2538	171	169	3553	2805
D50	4-2800 20-9336	96MB	3414	2718	179	177	3931	3036
D60	4-2800 20-9336	96MB	5316e	3801e	201	198	6862	4530
D70	4-2800 20-9336	96MB	5351e	3819e	218	214	7214	4681
D80	4-2800 20-9336	96MB	5483	3885	228	224	7249	4696

e=Estimate

Restore Rates (Megabytes/Hour) Using a 2622 Attached to a 3490 Tape Unit

Table C-12. Restore Rates (Megabytes/Hour) using a 2622 Attached to a 3490 Tape Unit

3490E with Hardware Data Compression			User Environment		Source File		Large File	
System Model	Disk Type	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
D35	4-2800 4-9336	40MB	1048	972	48	48	4171	2562
D45	4-2800 12-9336	96MB	1261	1152	52	52	4157	3169
D50	4-2800 20-9336	96MB	1369	1242	63	63	4566	3401
D60	4-2800 20-9336	96MB	1678	1490	68	68	5816	4050
D70	4-2800 20-9336	96MB	1709	1515	71	71	5700	3993
D80	4-2800 20-9336	96MB	1735	1535	71	71	5742	4014

Comparisons of IDRC and HDC on the 3480, 3490, and 3490E Tape Units

Disclaimer: **Compaction and compression ratios are dependent upon the data**. Any attempt to give a *typical* value for all users is incorrect more often than it is correct, but does provide a basis for the presentation of the information.

Compaction may increase cartridge capacity by up to a factor of five (5:1), but realistic expectations are for a doubling (2:1) to tripling (3:1) of cartridge capacity. For the purposes of calculating a one-tape rate from the two-tape rate, a 3:1 ratio was used to determine cartridge capacity.

Hardware data compression (HDC) commonly increases tape capacity ranging from 20 percent (1.2:1) to a doubling of capacity (2:1). However, due to the algorithm used, capacity changes outside these ranges are possible based on the number of repeating characters in the data. (See Chapter 4, "Save and Restore Media Considerations" on page 4-1 for a discussion of this data compression method.) A 1.4:1 ratio (approximately a 30% increase in tape capacity) has been called *typical*. Office, mail, and source files may compress better than programs. It may be useful to test a sufficient quantity of sample data by saving one copy of compressed data to a save file and a second copy of data not compressed to a different save file and then comparing the save file object sizes to get some guidance on how well the data compresses. HDC compresses slightly better than the software data compression (SDC) used when saving to a save file.

A method of determining the compaction ratio between IDRC and HDC is to:

1. Have a sufficient quantity of data to fill a tape cartridge under all four cases (no HDC and no IDRC, HDC and no IDRC, IDRC and no HDC, IDRC and HDC). For devices with automatic cartridge loaders, you should have only one tape in the loader.
2. Run the save command and when prompted for the next volume, cancel the command.
3. Use the DSPTAP command to determine how many data blocks were written to the tape.
4. Repeat these steps for each of the four cases.
5. Use simple mathematics to determine the capacity gained in the different methods. As long as representative data is used, this is a good method for estimating unattended save capacity.

As you can see when comparing the 3480 or 3490 with the 3490E tape units in a two tape (overlap rewind) scenario, the performance is comparable. Doubling of cartridge capacity is the benefit of a 3490E tape unit in this scenario.

For the one-tape scenarios, the 3490E tape units double the cartridge capacity and reduce the rewind time significantly. This means fewer and faster volume changes and better performance than the 3480 and 3490 tape units, when full volumes of data are processed.

Comparing IDRC to HDC:

- Using IDRC increases the volume capacity more than the use of HDC.
- Using IDRC and HDC together may decrease cartridge capacity below the

capacity when using IDRC alone. However, the decrease is data dependent. You may chose to experiment and determine what is best for you.

- For models D60 and E50 or higher, the save performance in the two-tape scenario (overlapped rewind) is up to 10% faster using only HDC as opposed to using only IDRC. However, it requires more tape media to contain the data than IDRC requires. Again, this is data dependent. You should consider experimenting to determine what is best for you.
- For B30 through B70 and D35 through D50 models, where the processing unit can be a constraining factor to the save performance, IDRC should perform about the same as HDC. In the one tape scenarios, IDRC should perform comparable to or up to 5% better than HDC because of the higher cartridge capacity achieved when using IDRC.

HDC, IDRC, and HDC with IDRC using a 2644 Attached to 3490E Tape Unit

Table C-13. Save Rate HDC, IDRC, and HDC with IDRC using a 2644 Attached to a 3490E Tape Unit

3490E Tape Unit			User Environment			Large File		
System Model	Disk Type	Memory	2 Tape	1 Tape	ACL[4] Tape	2 Tape	1 Tape	ACL Tape
E90[1]	4-2800 20-9336	512MB	7213	6330	6846e[5]	10929	9022	10107e
E90[2]	4-2800 20-9336	512MB	6038	5705	5905e	8531	7881	8269e
E90[3]	4-2800 20-9336	512MB	7360	6871	7164e	11596	10427	11116e

1 Hardware data compression compressed this data at a 1.4:1 ratio.

2 Improved data recording capability compressed this data at a 2.8:1 ratio.

3 Hardware data compression and improved data recording capability compressed this data at a 2.8:1 ratio.

4 Automatic cartridge loader.

5 e=Estimate.

Table C-14. Restore Rate HDC, IDRC, and HDC with IDRC Using a 2644 Attached to a 3490E Tape Unit

3490E Tape Unit			User Environment			Large File		
System Model	Disk Type	Memory	2 Tape	1 Tape	ACL[4] Tape	2 Tape	1 Tape	ACL Tape
E90[1]	4-2800 20-9336	512MB	2939	2781	2876e[5]	10821	8948	7903e
E90[2]	4-2800 20-9336	512MB	2858	2781	2828e	7943	7376	7715e
E90[3]	4-2800 20-9336	512MB	2885	2807	2854e	10491	9524	10097e

1 Hardware data compression compressed this data at a 1.4:1 ratio.

2 Improved data recording capability compressed this data at a 2.8:1 ratio.

3 Hardware data compression and improved data recording capability compressed this data at a 2.8:1 ratio.

4 Automatic cartridge loader.

5 e= Estimate.

The automatic cartridge loader (ACL) eliminates the need for the operator to change tapes and to respond to the load volume messages.

The system uses IDRC by default. You can change the command default to use HDC by using the Change Command Default (CHGCMDDFT) command. For example, to change the data compress (DTACPR) parameter, you would use the following command:

```
CHGCMDDFT CMD(SAVLIB/QSYS) NEWDFT('DTACPR(*YES)')
```

Save and Restore Rates (Megabytes/Hour) for 7208 Tape on 9402 and 9404 Models

The 7208 Models 02 and 12 can be attached to the 9402 or 9404 models of the AS/400 to be used for data exchange or save and restore. The 7208 model 12 is an enhancement of the 7208 Model 02 with double the capacity and data rate of the older model.

The following tables show the performance of the 7208 model 12 tape unit when using IDRC. These rates are comparable to the rates on the 7208 model 02 tape unit when using HDC.

Save Rates (Megabytes/Hour) for the 7208-12 Tape Units with IDRC

Table C-15. Save Rates (Megabytes/Hour) for the 7208-12 Tape Units with IDRC

7208-12 Tape with IDRC[1]			User Environment		Source File		Large File	
Model	Disk Type	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
F06	6 6107	40MB	1326	1287	96	96	1423	1378
F10	6 6107	40MB	1334	1295e[2]	97	97e[2]	1413	1369e[2]

[1] Improved data recording capability

[2] e=Estimate

Restore Rates (Megabytes/Hour) for the 7208-12 Tape Units with IDRC

Table C-16. Restore Rates (Megabytes/Hour) for the 7208-12 Tape Units with IDRC

7208-12 Tape with IDRC[1]			User Environment		Source File		Large File	
Model	Disk Type	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
F06	6 6107	40MB	1016	993e[2]	86	86e[2]	1603	1547e[2]
F10	6 6107	40MB	1057	1032e[2]	90	90e[2]	1542	1536e[2]

[1] Improved data recording capability

[2] e=Estimate

The following two tables compare the data rates of the 7208 model 12 tape unit to the 7208 model 02 tape unit. Both tape units are using only HDC. The improvement in the data rates of the 7208 model 12 compared to the 7208 model 02 ranges from 81% with the F06 model processor to two times the data rate with the F35 model processor.

Save Rates (Megabytes/Hour) for the 7208-12 Tape Units with HDC

Table C-17. Save Rates (Megabytes/Hour) for the 7208-02 Tape Units with HDC

7208-12 Tape with HDC			User Environment		Source File		Large File	
Model	Disk Type	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
D06	6 6107	40MB	1620e	1557e	80e	80e	2200e	2122e
E06	6 6107	40MB	1850e	1795e	83e	83e	2500e	2400e
F06	6 6107	40MB	2184	2070e	96	96	2700e	2354e
D10	6 6107	40MB	1600e	1535e	79e	79e	2180e	2100e
E10	6 6107	40MB	1850e	1766e	83e	83e	2500e	2345e
F10	6 6107	40MB	2151	2046e	87	87	2815	2637e
D20	6 6107	40MB	1799	1706e	83	83	2287	2168e
E20	6 6107	40MB	2174	2066e	85	85	2915	2935e
F20	6 6107	40MB	2550	2404e	96	96	3044	2838e
D35	4 2800 8 9336	56MB	2073	1975e	95	95	2559	2413e
E35	4 2800 8 9336	56MB	2340	2216e	99	99	2915e	2725e
F35	4 2800 8 9336	56MB	2550e	2404e	105e	105e	3044e	2838e

e=Estimate

Restore Rates (Megabytes/Hour) for the 7208-12 Tape Units with HDC

Table C-18. Restore Rates (Megabytes/Hour) for the 7208-12 Tape Units with HDC

7208-12 Tape with HDC			User Environment		Source File		Large File	
Model	Disk Type	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
D06	6 6107	40MB	1125e	1090e	74e	74e	2435e	2308e
E06	6 6107	40MB	1150e	114e	77e	77e	2480e	2345e
F06	6 6107	40MB	1255	1219e	81	81	2600e	2446e
D10	6 6107	40MB	1120e	1080	73e	73e	2420e	2289e
E10	6 6107	40MB	1150e	1114e	77e	77e	2480e	2345e
F10	6 6107	40MB	1296	1257e	80	80	2600	2448e
D20	6 6107	40MB	1096	1068e	74	74	2404	2273e
E20	6 6107	40MB	1327	1268e	85	85	2626	2471e
F20	6 6107	40MB	1379	133e	91	91	2646	2488e
D35	4 2800 8 9336	56MB	1379	1335e	91	91	2982	2784e
E35	4 2800 8 9336	56MB	1540	1485e	102	102	3146	2926e
F35	4 2800 8 9336	56MB	1672	1608e	114	114	3160	2939e

e=Estimate

Save Rates (Megabytes/Hour) for the 7208-02 Tape Units with HDC

Table C-19. Save Rates (Megabytes/Hour) for the 7208-02 Tape Units with HDC

7208-12 Tape with HDC			User Environment		Source File		Large File	
Model	Disk Type	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
D06	6 6107	40MB	1280e	1254e	54e	54e	1280e	1263e
E06	6 6107	40MB	1325e	1297e	62e	62e	1295e	1273e
F06	6 6107	40MB	1360e	1331e	70	70	1300e	1278e
D10	6 6107	40MB	1280e	1254e	54e	54e	1280e	1254e
E10	6 6107	40MB	1325e	1297e	62e	62e	1295e	1273e
F10	6 6107	40MB	1358	1327e	68	68	1300e	1278e
D20	6 6107	40MB	1294	1265e	56	56	1294	1265e
E20	6 6107	40MB	1389	1356e	69	69	1292	1263e
F20	6 6107	40MB	1407	1373e	70	70	1306	1277e
D35	4 2800 8 9336	56MB	1390	1356e	68	68	1304	1276e
E35	4 2800 8 9336	56MB	1373e	1393	70	70	1306	1277e
F35	4 2800 8 9336	56MB	1377e	1397	72	72	1317	1288e

e=Estimate

Restore Rates (Megabytes/Hour) for the 7208-02 Tape Units with HDC

Table C-20. Restore Rates (Megabytes/Hour) for the 7208-02 Tape Units with HDC

7208-12 Tape with HDC			User Environment		Source File		Large File	
Model	Disk Type	Memory	2 Tape	1 Tape	2 Tape	1 Tape	2 Tape	1 Tape
D06	6 6107	40MB	950e	931e	60e	60e	1445e	1429e
E06	6 6107	40MB	1000e	980e	68e	68e	1465e	1438e
F06	6 6107	40MB	1035	1016e	75	75	1490e	1458e
D10	6 6107	40MB	950e	931e	60e	60e	1460e	1434e
E10	6 6107	40MB	990e	970e	68e	68e	1470e	1437e
F10	6 6107	40MB	1044	1025e	80	80	1478	1440e
D20	6 6107	40MB	968	952e	64	64	1475	1437e
E20	6 6107	40MB	1072	1052e	82	82	1488	1450e
F20	6 6107	40MB	1103	1082e	82	82	1504	1466e
D35	4 2800 8 9336	56MB	1083	1063e	84	84	1497	1459e
E35	4 2800 8 9336	56MB	1137	1115e	92	92	1508	1468e
F35	4 2800 8 9336	56MB	1163	1139e	98	98	1510e	1471e

e=Estimate

9348 Tape Unit on the 9402 or 9404 System Unit

The 9348 1/2-inch reel tape unit can be attached to the 9402 and 9404 System Units and can be used for data interchange or save and restore operations. The 9348 tape unit **cannot** be used as the alternate IPL device. Therefore, it should **not** be used when running the SAVSTG or SAVSYS command.

The following tables show the 9348 save and restore performance when using 6250 bpi density. (Only a single tape rate is given.)

Save Rates (Megabytes/Hour) Using a 9348 Tape Unit on 9402 or 9404 System Units with Hardware Data Compression

Table C-21. Save Rates (Megabytes/Hour) Using a 9348 Tape Unit on a 9402 or 9404 System Unit with Hardware Data Compression

9348 Tape Unit			User Environment	Source File	Large File
Model	**Disk Type**	**Memory**	**1 Tape**	**1 Tape**	**1 Tape**
E04	3-6103	24MB	1446	178	1690
E06	3-6103	40MB	1659	149	2013
E20	4-6107	40MB	2026	228	2361

Restore Rates (Megabytes/Hour) Using a 9348 Tape Unit on a 9402 or 9404 System Unit with Hardware Data Compression

Table C-22. Restore Rates (Megabytes/Hour) Using a 9348 Tape Unit on the 9402 or 9404 System Unit with Hardware Data Compression

9348 Tape Unit			User Environment	Source File	Large File
Model	**Disk Type**	**Memory**	**1 Tape**	**1 Tape**	**1 Tape**
E04	3-6103	24MB	857	67	1531
E06	3-6103	40MB	944	71	1782
E20	12-6107	40MB	1184	94	1910

Save and Restore Rates for the 6341 and 6342 1/4-Inch Tape Units

The following tables show the save and restore performance for the 6341 and 6342 tape units. The first set of tables shows the rates for the 6341 tape unit. These tables are followed by tables showing the rates for the 6342 tape unit. By comparison, the 6342 tape unit performs better than the 6341 tape unit. Replacing the 6341 tape unit with the 6342 or 6343 tape unit can provide significant improvements in save and restore performance. If save and restore times or the tape cartridge capacity for unattended save operations is important, consider replacing the 6341 tape unit with a 6342 or a 6343 tape unit.

Save Rates (Megabytes/Hour) Using a 6341 Tape Unit on the 9402 Model C04 and D02 System Unit

Table C-23. Save Rates (Megabytes/Hour) Using a 6341 Tape Unit on the C02 and D02 System Unit

6341 Tape Unit			User Environ-ment	Source File	Large File
Model	**Disk Type**	**Memory**	**1 Tape**	**1 Tape**	**1 Tape**
C04	3-6102	12MB	242	75	250
C04	3-6102	12MB	303	73	300
D02	2-6103	16MB	538	86	467

Restore Rates (Megabytes/Hour) Using a 6341 Tape Unit on the C04 and D02 System Unit

Table C-24. Restore Rates (Megabytes/Hour) Using a 6341 Tape Unit on the C04 and D02 System Unit

6341 Tape Unit			User Environ-ment	Source File	Large File
Model	**Disk Type**	**Memory**	**1 Tape**	**1 Tape**	**1 Tape**
C04	3-6102	12MB	206	32	253
C04	3-6102	12MB	290	29	403
D02	2-6103	16MB	396	34	473

Save and Restore Rates (Megabytes/Hour) Using a 6342 Tape Unit

The following tables show the save and restore performance for the 6342 tape unit attached to the E04 and an E06 model at a density of 16000 bpi. Notice the performance and capacity advantages of the 6342 tape unit when using a density of *QIC525. The performance can more than double, and the storage capacity is improved from approximately 120MB to 525MB for each cartridge (uncompressed data).

Save Rates (Megabyte/Hour) Using a 6342 Tape Unit on the E04 and E06 System Unit.

Table C-25. Save Rates (Megabytes/Hour) Using a 6342 Tape Unit

6342 Tape Unit			User Environment	Source File	Large File
Model	**Disk Type**	**Memory**	**1 Tape**	**1 Tape**	**1 Tape**
E04	3-6103	24MB	1115	141	1035
E06	3-6103	40MB	1098	114	1033

Restore Rates (Megabyte/Hour) Using a 6342 Tape Unit on the E04 and E06 System Unit.

Table C-26. Restore Rates (Megabytes/Hour) Using a 6342 Tape Unit

6342 Tape Unit			User Environment	Source File	Large File
Model	**Disk Type**	**Memory**	**1 Tape**	**1 Tape**	**1 Tape**
E04	3-6103	24MB	805	74	1058
E06	3-6103	40MB	826	73	1059

SAVDLO and RSTDLO Rates

The following tables show the SAVDLO and RSTDLO throughputs on a dedicated system with the work load being run in a 4500KB memory pool in a batch subsystem. The throughput is shown in megabytes per hour and documents per hour. The throughput is based on having sufficient memory for the number of documents being saved. Constraints on memory cause varying degrees of thrashing based on the number of documents being saved, the shared folders function type, and the storage available.

SAVDLO Rates (Megabytes/Hour) Using a 9348 Tape Unit with Hardware Data Compression

Table C-27. SAVDLO Rates (Megabytes/Hour) Using a 9348 Tape Unit with Hardware Data Compression

	Megabytes/Hour		Documents/Hour	
System Model	**2 Tape**	**1 Tape**	**2 Tape**	**1 Tape**
E35 4-2800 10-9336	1007	870	33567e	29000e
E60 4-2800 20-9336	1415	1159	47167e	38633e

e=Estimate

RSTDLO Rates (Megabytes/Hour) Using a 9348 Tape Unit with Hardware Data Compression

Table C-28. RSTDLO Rates (Megabytes/Hour) Using a 9348 Tape Unit with Hardware Data Compression

System Model	Megabytes/Hour		Documents/Hour	
	2 Tape	1 Tape	2 Tape	1 Tape
E35 4-2800 10-9336	350	332	11667e	11067e
E60 4-2800 20-9336	537	495	17000e	16500e

e=Estimate

Save-While-Active Function

This Version 2 release 2 function can improve system availability by avoiding the prolonged suspension of applications in order to save files. This function creates an image, an object, or a set of objects at a point in time, allowing the objects to be saved while the applications using the objects continue. The save file or tape that results reflects the status of the objects at the time of the "snapshot."

The save-while-active function runs at the library level, one library at a time. It applies to all objects supported by the SAVLIB, SAVOBJ, SAVCHGOBJ, and SAVDLO commands.

Before using the save-while-active function, thoroughly read Chapter 5 of the *Advanced Backup and Recovery Guide*.

The major factors that affect the performance of a save-while-active operation are:

- Additional activity on the system
- The amount of processing unit available for the save process
- Activity in the auxiliary storage
- Size of the machine pool
- Job priorities and pool uses
- Number and size of objects being saved

For the best performance during a save-while-active operation, low system activity is recommended. A few interactive jobs or batch jobs that are primarily read-only are excellent examples of the type of jobs that allow for better system performance during the save-while-active process. In general, save-while-active checkpoint processing is faster for a small number of large objects than for a large number of small objects.

The amount of processing unit that is available for the save process can have a large influence on the time required for the save operation to complete. Therefore, the save-while-active operation takes longer than a save operation that is done in a restricted state. The additional time depends on the system resources that are available for the save. This can be as little as 10% longer, or up to four or five times longer. As a guideline, allow only about 30% of the processing unit for work loads that are running in the background. In addition, add a minimum of 600KB of memory to the machine pool before starting the save operation.

The priorities and uses of pools also affect the performance of the save-while-active operation. To maintain the best response time for interactive jobs, give a lower priority to the save operation than to the interactive jobs.

The save operation should be given a separate memory pool. The size of this separate pool should be a minimum of 4MB if there are thousands of objects or file members being saved. This is especially true if they are small objects. In addition, using the *LIB parameter generally requires more memory pool pages, so an additional 1 or 2MB would achieve better performance.

The jobs that are active during the save-while-active operation affect both the response time and the duration of the save operation. This is especially true if the save-while-active job has low priority and the system is busy. Choose a time when the use of the processing unit is low and the amount of update activity occurring on the system is low. This is especially important for OfficeVision/400 users updating document library objects (DLOs). If the save-while-active operation is checkpoint processing the document library objects, the edit session will appear locked until the checkpoint processing has ended.

Save-While-Active Function with Commitment Control Processing

Using the save-while-active function while commitment control processing is active needs extra considerations. If an object is being updated under commitment control during the checkpoint processing of a save-while-active request, the system ensures that the object will be saved to the media at the commitment boundary. All objects that have reached a checkpoint will be saved to the media at the same common commitment boundary. It is important to make sure that all performance considerations have been correctly implemented if the objects being saved are being updated under commitment control or the system may never be able to reach a commitment boundary. This would mean that the system could not be able to obtain the image of the objects being saved. To be sure the save functions correctly when using save-while-active with objects under commitment control, read Chapter 5 of the *Advanced Backup and Recovery Guide* with special emphasis on the Save-While-Active Commitment Control Processing section.

E80 Save-While-Active Data

The following table provides measurement data for the save-while-active function. The background work load is an interactive application with a high number of updates. It is running under commitment control that operates four database files. The files range in size from 23KB, 82KB, 51MB, and 616MB. The library that is being saved contains these four files in addition to a 2MB source file that contains two source members.

The first set of numbers in the chart are the performance of the SAVLIB command with no other system activity and the background workload by itself. The additional data shows how the performance of the SAVLIB command and the background work load are affected as the performance characteristics of the SAVLIB job change. The SAVLIB is measured twice for each set of performance characteristic changes: once with *LIB specified for the SAVACT parameter, and once with *SYSDFN specified. A 3490E tape device is used to do the saves. The processing unit use and average response times are listed for the background work load.

Table C-29. E80 Save-While-Active Rates

SAVLIB Command					Background Work load			
Command	Priority	Pool Size	Sync. Point	Save Time	Priority	Pool Size	CPU Use	Average Response
SAVLIB	18	8000KB	N/A	4:14 minutes	20	354 766KB	29.5%	0.05
with *LIB	18	8000KB	0.12 minutes	5:48 minutes	20	354 766KB	33.4%	0.07
with *SYSDFN	18	8000KB	4:41 minutes	5:47 minutes	20	354 766KB	33.1%	0:07
with *LIB	30	8000KB	0:10 minutes	6:31 minutes	20	354 766KB	33.4%	0:07
with *SYSDFN	30	8000KB	6:19 minutes	6:28 minutes	20	354 766KB	32.9%	0:07
with *LIB	18	3000KB	0:23 minutes	8:04 minutes	20	354 766KB	34.2%	0:07
with *SYSDFN	18	3000KB	7:48 minutes	7:59 minutes	20	354 766KB	34.7%	0.07

Saving Storage

The SAVSTG command has not changed since Version 2 Release 1.

Note: The SAVSTG command does not make use of improved data recording capability (IDRC)

The SAVSTG command is intended to be used as disaster recovery backup of the system. It differs from other save commands by saving a sector-by-sector copy of permanent data in storage. It does not allow single objects to be saved or restored. See Chapter 11, "Save and Restore Storage Processes and Procedures" on page 11-1 for more considerations on the SAVSTG command.

The three basic parts of the SAVSTG command are:

Pre-IPL Part of the SAVSTG command operates as if PWRDWNSYS RESTART(*YES) was specified. It powers down the system and brings it back up to the dedicated service tool (DST) environment to automatically initiate the save of the data.

Save data Part of the SAVSTG command that saves the Licensed Internal Code (excluding the Model-Unique Licensed Internal Code) and a sector-by-sector copy of the remaining permanent data on disk.

Post-IPL Part of the SAVSTG command that performs a normal IPL after the SAVSTG command has completed the save operation.

To estimate the total time to do a SAVSTG operation:

1. Determine the amount of disk space using the WRKSYSSTS command.
2. Multiply the amount in the *System* column by the percentage in the *%Used* under the *Auxiliary Storage* The result is an estimate of the amount of data the SAVSTG command will save. The actual amount of data SAVSTG saved may be less, depending on the amount of disk sectors containing temporary data.

3. Use the appropriate tape unit in the table that follows to estimate the time, in hours, by dividing the amount of storage used by the save rate.
4. To the value in step 3, add a shutdown time and two times the normal IPL time for the system. This is the total time to run the save storage operation.

The rates in the following tables are estimates of the achievable SAVSTG rates. These estimates are based on actual SAVSTG performance measurements. Because the SAVSTG command can only use a single tape unit, operator handling and rewind time is included in the *Tape Rate* column. The pre-IPL and post-IPL times are not included in the *Tape Rate* column. Actual SAVSTG rates may vary depending on the number of storage units (actuators), the disk configuration, system unit and model, the amount of disk sectors containing temporary data, data compression factors on auxiliary storage, and operator speed.

Table C-30. Save Storage Rates

System Model	Tape Unit	Tape Rate	Disk storage (MB)	% Used
C04[2]	6341	298e[1]	961	72
D10[9]	6347	609e	961	74
B20[2]	6346	345e	2241	71
B40[3]	9347	475e[4]	3423	89
B40[3]	2440	1027e	3423	89
B40[3]	2440[4]	1040e	3423	89
B45[2]	9348	1197	3423	70
D35[9]	9348[5]	1315e	4710	79
B45[2]	9348[5]	1273e	3423	75
B60[3]	3422	3043e	6847	73
B70[2]	3490[8]	3700e	13694	71
D80[9]	3490[6,8]	4450e	21854	47
D80[9]	3490E[6,8]	5800e	21854	47
D80[9]	3490E[6,7,8]	6095e	21854	47

[1] e=Estimate

[2] Version 1 Release 3

[3] Version 1 Release 2

[4] High-speed feature

[5] Hardware data compression

[6] 2644 I/O processor

[7] Extended-length tape

[8] All 3490 runs with automatic cartridge loader

[9] Version 2 Release 1

Restoring Storage from the SAVSTG Tapes

The time required to restore a SAVSTG tape should be approximately 20% to 40% longer than the time required to run the SAVSTG command. The time varies based on the tape unit used, the amount of unused disk space, and the system configuration.

The tape unit used to restore a SAVSTG tape must be configured as the alternate IPL device. To reduce the overall recovery time if a restore of the SAVSTG tape should be necessary, systems with multiple tape units should be configured with the tape unit used for the save storage operation as the alternate IPL device. For example, consider a system with two tape drives: a 9348 and a 9347 tape unit. The 9347 tape unit is configured as the alternate IPL device. The 9347 tape unit would not be able to restore a SAVSTG tape saved on the 9348 tape unit at 6250 bpi. The system would have to be configured with the 9348 as the alternate IPL device because the 9347 tape unit does not support 6250 bpi.

Software Data Compression and Decompression

There are many benefits associated with data compression such as reduced operator handling time, rewind time, and tape media used. However, when saving to tape units that do not have the hardware data compression (HDC), data compression should be selected with extreme caution. Software data compression (SDC) can easily use all of the available processor cycles and actually cause the save throughput and the performance of other jobs running in the system to be reduced significantly.

If you use the 6341, 6346, or 9346 tape units, software data compression may improve performance for stand-alone saves operations. Avoid using software data compression for tape units that are faster than a 9347 tape unit or for concurrent saves. Software data compression has the potential to severely affect processing time for other jobs running on the system because software data compression use a large amount of central processing unit resources.

System/ 36 Migration Considerations

The performance of save operations may be slower for users migrating from a System/36 system to an AS/400 system. The slower performance occurs because:

- System/36 objects grow when migrated to the AS/400 system. Obviously, if there is more data to save or restore, the operation will take longer.
- The System/36 saves small objects more efficiently than the AS/400 system. When saving a library with many small objects, the System/36 system only performs authority checking for the library. However, the AS/400 system performs authority checking for each object in the library. Therefore, these operations take longer on the AS/400 system.

Configuration Considerations for Performance

As mentioned, the rates show the maximum capabilities of the system and the tape subsystem. However, there are some operations and configuration options that may reduce these capabilities. Some of these are included below to help you understand the system environment so that the appropriate performance expectation can be set.

Auxiliary Storage

When you review the tape options, you must consider the size and number of storage units (actuators) in the configuration. Large auxiliary storage configurations may require faster tape units to satisfy your required save rate. Systems with a limited number of storage units may not be able to achieve the data rates measured.

Another factor affecting save and restore data rates is the number of I/O processors connected to the system and their configuration. For best performance, a configuration of one disk controller (6110, 6111, or 6112) for two 9335 A0 controllers with every four 9335 B0 disk units is recommended. When using 9336 disk units, it is recommended that one 6111 or 6112 controller be used for every four 9336 storage units. When multiple 6110 or 6111 controllers are used on systems with multiple system buses (Models B50, B60, B70, or the 9406 D and E models), it is recommended that the 6110, 6111, or 6112 controllers be spread evenly across the system buses to balance the work load on the buses. This configuration increases the data collection capability of the system.

Disk and the 9347 Tape Unit on the Same Storage Controller

Performance for the 9347 tape unit may be affected if the tape unit and the disk units are sharing the same storage device controller. In some situations, save or restore performance may be improved by configuring the 9347 tape unit on different storage device controllers than the disk units. However, many users may see little or no difference by using a dedicated storage device controller for the tape unit.

The 9347 tape unit is the only tape unit that attaches to the 6110, 6111, and 6112 storage device controllers. The increased throughput capabilities of the 6111 or 6112 as compared to the 6110 significantly reduces any concerns over having the disk units and the 9347 tape unit attached to the same controller.

For 9406 B models only, if the 9347 is used for release upgrades or for exchanging data with other systems that are not using 9347 tape units, the performance when reading the tapes can be noticeably improved by attaching the 9347 tape unit to a 6111 storage device controller.

Effects of Checksum, Device Parity or Mirrored Protection

Checksum protection requires additional system resources when writing data to disk. Therefore, the effect to the save time is small. Saves operations should run 0 to 10% slower than the same data saved from a similar system that does not have checksum protection. However, the restore involves many writes to disk and this can require 2 to 2-1/2 times longer than the same data being restored to a similar system that does not have checksum protection.

Save and restore performance is better on the 9337-1x0 subsystems with device parity protection than on disk units with checksum protection. Restoring large files to a single 9337-120 disk unit subsystem using the 3490 tape units took only 2.2 times as long as restoring to unprotected disk units. If multiple 9337-1x0 disk unit subsystems are used, multiple sets of the write-assist disk unit are available to reduce the performance impact to write operations. Restoring large files to the 9337-120 disk unit subsystems using the 3490 tape units took only 1.4 times as long as restoring them to unprotected disk units.

Mirrored protection uses less run-time system resources than checksum protection. Therefore, the impact to save or restore performance is less. Save time can be

between 3% faster to 5% slower than the same data saved from a similar system that does not have mirrored protection. The restore as a rule of thumb may be from 0 to 10% slower than the same data being restored to a similar system that does not have mirrored protection.

The above guidelines do not include the use of software data compression or using save files as the media for the save or restore operation.

The *Advanced Backup and Recovery Guide* has more information on how these protection methods work.

RSTOBJ Command Performance Tip

Because of changes made to the RSTOBJ command in V2R1.0, you should specify the object types to be restored. If the object types are not specified, the system may search through additional tape data to determine whether or not other object types of the same names exist elsewhere on the tape media.

Memory Pool Considerations

The memory requirements are based on the number and types of objects being saved. If insufficient memory is available in the pool used by save or restore operation, the time required to complete the command increases and it may have varying impacts to other jobs in the system.

Working set size studies for saving 1000 program (*PGM) objects showed that a 3.5MB pool provided optimal performance. A severe decrease in performance occurs when there is less than 1MB in the pool.

Paging in the machine pool can also effect save and restore performance as well as many other system functions. See the chapter on performance tuning in the *Work Management Guide* for more information.

Priority and Save and Restore Operations in Interactive Environments

The process from which the save or restore command is issued will do preprocessing, post-processing, and other higher level management functions for the objects being saved or restored.

However, this process does not perform the input/output operations for the tape, diskette, or save file directly. It directs a network of Licensed Internal Code tasks which are created to perform some machine-level object management along with the transfer of the data to or from the device.

At the time the Licensed Internal Code tasks are created, their priority is set relative to the requesting process. The Licensed Internal Code tasks run at a priority between the controlling process priority and the next priority lower. For example, if the process is running a save command at priority 50, then the Licensed Internal Code tasks will run at a priority between priority 50 and 51.

If a save command is run at priority 50 and work load with a heavy processing unit usage is also running at that priority, the save operation will come before the Licensed Internal Code task and therefore could slow or stop the writing of the data to the device. If the processing unit is running near 100% utilized, a save or restore operation should not be started unless the save or restore operation is

running at a high enough priority than other jobs. The save or restore job could fail if it does not get enough resources to run.

Note: The priority of these Licensed Internal Code tasks before Version 2 Release 2.0 could not be changed once they were created.

Holding the job running the save or restore process does not affect the Licensed Internal Code tasks activity. They continue processing until they have completed the work requested or encounter a volume boundary or other condition that requires interaction from the process that requested the work.

The resources used by the Licensed Internal Code tasks are not charged to the process requesting them. Although the tape is still moving and objects are being saved or restored, using the WRKACTJOB command will not show processing unit usage.

When the save process is in event wait (EVTW) status, it may be waiting for the Licensed Internal Code tasks to indicate the requested work is completed. In V1R3 or earlier, the process of saving to tape would have shown a tape wait (TAPW) status.

Note: In V1R3, the Licensed Internal Code tasks were created at a fraction above the priority of the requesting process. In V2R1M0, the priority of the Licensed Internal Code tasks are created at a fraction below the priority of the requesting process. The reason for the change was to enhance the overlap between the requesting process and the Licensed Internal Code tasks performing the input/output operations.

Appendix D. Library QUSRTOOL and Programming Examples

QUSRTOOL is a library on the AS/400 containing programming tools, commands, and examples. These tools are used on the AS/400 system for developing and managing application programs.

This appendix contains information about the tools found in library QUSRTOOL and includes some programming examples.

Commands Available in QUSRTOOL Library

The following topics describe tools in library QUSRTOOL. The QUSRTOOL library contains CL source for commands you can create to help with backup and recovery tasks.

Display Overflowed Objects (DSPOVFOBJ) Command

This command displays all the objects that are overflowed from a user ASP into the system ASP. For each ASP, the following information is displayed.

- Overflowed ASP number
- Overflowed objects
  - Library in which the object was created
  - Object type
  - Object name
  - Object size
- Summary
  - Total size of overflowed objects, in bytes, for this ASP
  - Total size of all overflowed objects, in bytes

For instructions to create this command, see the information in member TSMINFO in file QATTINFO in library QUSRTOOL.

Check ASP Object (CHKASPOBJ) Command

The Check ASP Object (CHKASPOBJ) command is designed to assist you in determining if any old-style auxiliary storage pools (ASPs) exist.

The old style of ASP existed before Version 1 Release 3. The old-style ASP allowed save files, journals, and journal receivers to be placed in a user ASP even though the library was in the system ASP. The ASP parameter had to be specified when the individual object type was created in the user ASP.

The new-style ASP allows a library object and most object types to be placed into a user ASP. The ASP parameter on the CRTLIB command must be used. Any objects created into that library are automatically in the ASP specified on the CRTLIB command.

The system determines which style of ASP exists by which type of object is first created into an empty ASP. The style is not indicated externally. If a library is created first, it is the new style of ASP. The system prevents mixing the new and old styles within a single ASP. The only way to determine the type is to attempt to create a library into the ASP. If it is successful, it is a new-style ASP or you have

just specified it to be a new style. If the command fails with the escape message CPF2197, it is an old-style ASP.

The new style of ASPs offers more capability and easier recovery. Therefore, you should migrate to use the new-style ASPs.

The CHKASPOBJ command finds all of the objects that are in an ASP where the library object is not in the same ASP. Diagnostic messages are sent for any occurrences. If any diagnostics are sent, an escape message is sent when the command completes.

If the command finds no old-style ASPs, a completion message is sent and the command completes normally.

The CHKASPOBJ command is long-running and should be submitted to batch.

For instructions to create this command, see the information in member CHKASPOBJ in file QATTINFO in library QUSRTOOL.

Print ASP Libraries (PRTASPLIB) Command

The Print ASP libraries (PRTASPLIB) command prints a list of all the libraries in one or more ASPs. One line per library is printed. The libraries for each ASP are printed in alphabetic sequence.

Before Version 1 Release 3, certain object types (*SAVF, *JRN, or *JRNRCV) could be placed in a user ASP by specifying the ASP parameter when the object was created. Currently, most object types, including a library, can be in an ASP. If the old-style ASP is used, it is possible that certain objects exist in the ASP, but the library is in the system ASP. If this is the case, you need to check further to determine all of the objects in the ASP. See "Check ASP Object (CHKASPOBJ) Command" on page D-1 for more information about how to determine if an old-stype ASP exists.

For instructions to create this command, see the information in member PRTASPLIB in file QATTINFO in library QUSRTOOL.

Print ASP Use (PRTASPUSE) Command

The Print ASP Use (PRTASPUSE) command prints a listing with one line per ASP showing the total amount of storage and the percentage used by ASP. The information is taken from the WRKDSKSTS command output and converted by the TAA tool CVTDSKSTS.

For instructions to create this command, see the information in member PRTASPUSE in file QATTINFO in library QUSRTOOL.

Check Object Damage (CHKOBJDMG) Command

The Check Object Brain Damage (CHKOBJDMG) command checks all of the objects in one or all of the libraries for damage. The check occurs by saving each object to a save file in QTEMP.

A report is sent to the spooled file OBJDMG. Exceptions are noted:

- If the object is already marked as damaged, an exception line is printed.

- If the object cannot be successfully saved, an exception is printed. The most typical error found is that the object is locked and cannot be saved. To determine the actual cause for the object not being saved, the job log must be reviewed. The CPD3761 message indicates the locked condition.

  If damage is detected by the save command, the object is marked as damaged. Another execution of CHKOBJDMG shows the object as damaged in the printed listing. A diagnostic in the job log notes the damage condition.

Successfully executing the CHKOBJDMG command does not ensure that any undetected damage exists.

The objects are saved one at a time to a save file in QTEMP. The save file must have enough room to hold the largest object you check. If you have large database objects, you may not have enough room to save them on line. If so, specify CHKPF(*NO) to avoid checking these objects.

The checking that occurs by CHKOBJDMG only ensures that all of the pages of an object exist to be saved. This is a sanity test and does not ensure that the bytes will perform a valid function.

Database files take up the largest amount of storage on a typical system and can contain damage within the data portion of the object. The CHKOBJDMG command only detects certain damage. To do a better validation of database files, you should consider the use of the VALDBF tool (includes the VALMNYDBF command).

VALMNYDBF causes all physical members in a file, a library, or all user libraries to be processed. The processing includes reading all of the records, checking for valid numeric data (if there are any externally described numeric fields) and checking fields based on any DDS validity checking specifications (for example, RANGE).

If you suspect damage on your system, use CHKOBJDMG with CHKPF(*NO) and VALMNYDBF to test all user libraries. Note that both of these functions are very long-running. If you suspect damage in a library, both commands could be used against a specific library.

Check Save Strategy (CHKSAV) Command

The Check Save Strategy (CHKSAV) command allows you to determine if a library or libraries have had any objects or members changed since the last save. This allows you to determine quickly if your save strategy is being implemented correctly. If you use SAVLIB LIB(*NONSYS) on a daily basis, you do not need to use the CHKSAV command. Options on the CHKSAV command allow you to see the objects and members that have changed but have not been saved. The output also describes the last time a SAVSYS command was run. The information provided allows you to review the status of the backup of your system.

For each library, the following information is printed:

- Owner
- Number of objects
- Number of physical database members
- Total size of the library (The size of the library does not include the size of the library object in QSYS.)
- Number of members being journaled

- Number of objects and members changed
- Save date

The report does not describe any other form of backup (such as a CPYF to an online file). The report does not include some temporary or test objects that do not need to be backed up. If a member is being journaled and is changed but not saved, it appears as "not current" even though you have a successful backup strategy by saving the journal receiver.

For instructions to create this command, see the information in member CHKSAV in file QATTINFO in library QUSRTOOL.

Check Save/Restore Job Log for Problems (CHKSAVRST) Command

The Check Save/Restore Job Log for Problems (CHKSAVRST) command checks a job log that uses save and restore commands and prints a list with the completion messages and any error diagnostics. The command lists only what is important from the job log from a save and restore viewpoint.

This command should be included in your normal save and restore procedures to provide a printed file and an optional database file. The printed output occurs to the file SAVRSTMSGS.

For example, if you have multiple save operations during the week, the data processing manager can ensure that each job log is kept by including the CHKSAVRST command. Each job log is written to a different file or file member. If a problem arises, a good audit trail and the CHKSAVRST output exist. You can also run the CHKSAVRST command again using the same job log information.

For instructions to create this command, see the information in member CHKSAVRST in file QATTINFO in library QUSRTOOL.

Check Save Tape (CHKSAVTAP) Command

The Check Save Tape (CHKSAVTAP) command is designed to perform a read test of a save tape. This includes any media output from a save command, a new-release tape, or a PTF tape. This command is used to ensure that a tape can be read. Multi-volumes may be used.

The command uses CHKTAP and CPYF to see if the data on the tape can be read. This does not ensure that the tape can be successfully restored, but it does cause the entire tape to be read.

For instructions to create this command, see the information in member CHKSAVTAP in file QATTINFO in library QUSRTOOL.

Print Library Save Information (PRTLIBSAV) Command

The Print Library Save Information (PRTLIBSAV) command prints a simple list with one line for each library that describes the last save information. This includes the dates saved and the media names used.

This provides a convenient summary of what libraries exist and the important save information about each library.

Use this command in the following ways:

- Include it in your save and restore procedures to print the information when you run the SAVLIB command. You would use the same library names that you used on the SAVLIB command:

  ```
  PRTLIBSAV   LIB(LIB1 LIB2 LIB3)
  ```

- Use it following a SAVLIB LIB(*NONSYS) or anytime you want to save information for all the libraries.

  ```
  PRTLIBSAV   LIB(*ALL)
  ```

  The printed output occurs to the LIBSAVINFO spooled file.

For instructions to create this command, see the information in member PRTLIBSAV in file QATTINFO in library QUSRTOOL.

Print Save Status (PRTSAVSTS) Command

The Print Save Status (PRTSAVSTS) command prints a list with one line for each library that describes:

- Library name
- Save date
- Save command
- Volumes the library is saved on

The PRTSAVSTS command should be run following a save of multiple libraries. One to 50 libraries or all libraries can be specified. If you run the SAVLIB commands from CL programs, the PRTSAVSTS command can be included in the program using the same set of libraries as those specified on the SAVLIB command.

The printed output should be saved to offline media. If a restore is necessary, an external description exists of what libraries were saved and what volumes were used.

If you use SAVLIB LIB(*NONSYS) for your save operation, then RSTLIB LIB(*NONSYS) is used for the restore operation. If your backup strategy does not use SAVLIB LIB(*NONSYS), or you restore using commands other than RSTLIB LIB(*NONSYS), then you can specify only one library for each use of the RSTLIB commands. The output of the PRTSAVSTS command can be useful in determining which libraries exist and which media to load when restoring. To avoid the restriction of one library for each RSTLIB command, see "Restore All Changes (RSTALLCHG) Command" on page D-9.

For instructions to create this command, see the information in member PRTSAVSTS in file QATTINFO in library QUSRTOOL.

Save All Changes (SAVALLxxx) to Tape

The Save All Changes (SAVALLxxx) command does a SAVCHGOBJ command against all libraries on the system to tape and prints a summary list. This provides a good daily backup for many systems when used in conjunction with a periodic SAVLIB LIB(*NONSYS or *IBM) or SAVSTG command. This helps reduce the dependency of your strategy on the SAVLIB LIB(*NONSYS) command.

These commands are provided:

- SAVALLCHG: Saves all changed objects to tape.

- SAVALLCHG2: Saves all changed objects to save files in a specified library.
- SAVALLSAVF: Saves the SAVALLCHG2 save files to tape.

For the companion command to restore from the tape media created, see "Restore All Changes (RSTALLCHG) Command" on page D-9.

Any libraries that begin with the letter Q are implicitly bypassed except for QGPL, QUSRSYS, and QS36F. PTFs may be applied to IBM libraries that contain code and this would cause objects to be saved. However, the PTF index is saved only by a SAVLIB command. Consequently, restoring the SAVCHGOBJ media would save the library and the index at different levels. You should keep PTFs until the next full library save operation. The IBM-supplied '#' (except #LIBRARY) that are part of the S/36 environment are also bypassed for the same reason.

You may specify up to 100 libraries to be bypassed (not saved) by using the BYPASS parameter on the SAVALLCHG commands. This allows you to tailor your save strategy if you have some unique processing for certain libraries. For example, you may prefer to save the entire contents of some libraries and then use SAVALLCHG on the rest of the libraries.

A list is printed with one line for each library saved. The list describes the number of objects:

- Saved
- Not saved (some problem occurred such as an update lock exists on the object)
- Excluded (based on the reference date/time)

It also describes the creation date of the library (if it is later than the reference date) and the volume identification of where the objects were saved.

If a library is bypassed, it is listed along with an indication that it was bypassed. Bypassed libraries do not necessarily appear in alphabetical sequence.

Comparing the SAVALLxxx Command with SAVCHGOBJ

The SAVALLCHG command has been left in QUSRTOOL even though the system-supported SAVCHGOBJ command supports a similar function. The major differences are as follows:

- SAVALLCHG produces a list with one line per library stating the number of objects saved and the number that cannot be saved. This provides a simple summary of where the problems are, if any exist.
- SAVALLCHG2 allows all libraries to be saved to save files. SAVCHGOBJ can save only one library to a save file.
- SAVALLCHG has a restart capability using the BGNLIB parameter. No restart capability exists on SAVCHGOBJ.
- If a new library exists, it must be saved first with SAVLIB for SAVCHGOBJ to operate. SAVALLCHG recognizes the fact the library has never been saved and saves all objects.
- SAVCHGOBJ supports the LIB(*ALLUSR) value. The same function is supported by SAVALLCHG. The media must be saved with SAVALLCHG, but the media must be restored with the RSTALLCHG command.

- SAVALLCHG can save the changes from the last SAVSTG. SAVCHGOBJ does not recognize a recovery operation using the SAVSTG command.

More Information about the Save All Change Commands

Both Save All Change commands assume the use of standard labeled tapes. For the standard labeled tape, you must specify the NEWVOL parameter on the INZTAP command.

The SAVCHGOBJ command allows up to 50 libraries to be specified. The SAVALLCHG command finds the libraries that exist in the system and builds a list of 50 at a time. This allows an efficient use of SAVCHGOBJ. The system can better overlap the processing time on one library while writing out the changed objects for another library.

The SAVALLCHG2 command saves one library at a time to a save file in the specified library. All save files in the designated library are cleared at the beginning of the command. This allows you to follow the command with SAVALLSAVF and have the tape output represent only the changed objects on the system (it would be a mirror image of what you would have have saved with SAVALLCHG).

For instructions to create this command, see the information in member SAVALLCHG in file QATTINFO in library QUSRTOOL.

Save Spool Control (SAVSPLCTL) Command

The Save Spool Control (SAVSPLCTL) command is part of the spool control function SPLCTL. The spool control function provides a method of backing up, retrieving, and reprinting spooled files.

In some environments, users may want to print a report that was done several days ago again. The data used for the report may have changed significantly and it may not be practical to recreate the data. The spool control function lets you save the spooled file contents in the event reprinting is anticipated. You can also use the technique for job logs or other spooled output that may only need to be printed on request.

You specify by output queue whether you want the spooled files saved. The spool control function then copies the spooled files to a physical file (using CPYSPLF), saves the physical file to an online save file, and allows the save file to be backed up. A retrieval function that reprints the file is also available.

For instructions to create this command, see the information in member SPLCTL in file QATTINFO in library QUSRTOOL.

Save/Restore Spooled File (SAVRSTSPLF) Command

The Save/Restore Spooled File (SAVRSTSPLF) tool provides a method for saving spooled files into a designated library and creating them again at a later time.

The ZSAVSPLF command stores the files specified by the user to a designated library or device. On the ZSAVSPLF command, the spooled files to be saved can be selected by user, output queue, form type, or user data. Only printer spooled files are saved.

The ZRSTSPLF command restores those files from the library or device to the output queue in which they were originally spooled.

Limitations

Only spooled files intended for printing can be saved. Spooled files intended for diskette are skipped.

When user space names are generated for each spooled file, the first 6 characters of the job name and a 4-digit number are used. This limits the number of spooled files saved to 9999.

Any error condition reported to the save and restore programs ends the operation.

For instructions to create this command, see the information in member TSRINFO in file QATTINFO in library QUSRTOOL.

Save One Library (SAVONELIB) Command

The Save One Library (SAVONELIB) command is a simple front-end interface to the SAVLIB command. This provides a simple interface when a library must be moved from one system to another, or when a single library needs to be backed up.

The device uses TAP01 as the default tape name. The SEQ and CLEAR parameters exist, but the defaults differ from the normal SAVLIB command so that the file is written to file 1 and the tape is cleared.

For instructions to create this command, see the information in member SAVONELIB in file QATTINFO in library QUSRTOOL.

Save While Active (SAVWHLACT) Command

The Save While Active (SAVWHLACT) command saves a database file while it is active. An active file is one that is open for update and one or more programs are making changes while the save occurs. The companion command, Restore While Active (RSTWHLACT), restores from the copy made by the SAVWHLACT command. Then, it applies the changes that occurred during the copy operation.

These two commands are specifically designed for those environments where the file must be available for update at all times. When this type of situation exists, the environment typically requires a save window in the early hours of the morning to back up the system. The save window is a time when users are signed off or not using the application program. The SAVWHLACT command eliminates the need for a save window and makes the file available all of the time.

The file being saved must be journaled. The journal changes are used to bring the file back to a proper state. It is possible to start journaling just before running the SAVWHLACT command and then to end journaling after the command completes. However, the start and end journaling commands require the file to be exclusively allocated. See the later comments about temporarily journaling the file.

The SAVWHLACT command does not save the file offline or to a save file. It only makes a copy of the file that can be saved with the journal receiver to produce an offline backup of the file.

For instructions to create this command, see the information in member SAVWHLACT in file QATTINFO in library QUSRTOOL.

Restore All Changes (RSTALLCHG) Command

The Restore All Changes (RSTALLCHG) command is the companion command for the Save All Changes (SAVALLCHG) and the Save All Changes 2 (SAVALLCHG2) commands. It is used to restore from the tape created by either of the SAVALLCHG commands. This allows a simple recovery for disaster protection.

The RSTALLCHG command uses the CHKTAP and the RSTOBJ commands to restore all of the objects that are found on the media. The CHKTAP command retrieves the tape file name for each file sequence number. By default, the library name is stored in the tape file name field. The RSTOBJ command is then run for the appropriate library. Therefore, you do not have to know the library names to restore the libraries successfully.

Printed output occurs to QPRINT with one line for each library containing the counts for how many objects were or were not restored. For the specific objects that were not restored and the reasons, you need either the output from the RSTOBJ command or the job log. This can be provided, in a more readable format, by using the CHKSAVRST command (the default provided on the command). For some low- level messages, you will need the job log.

The RSTALLCHG command can also be used against any save tape to perform the same function. This avoids having to know the library names in order to perform the restore.

You can use RSTALLCHG against a tape created by SAVLIB, SAVOBJ or SAVCHGOBJ command.

If you want to restore only some of the libraries or objects on the media, you must issue individual RSTOBJ commands. You can restore all of the libraries beginning at a specified sequence number on the tape.

Because the command is most useful in a disaster recovery situation, you should ensure that it will be on your system when needed. If you do a RSTLIB SAVLIB(*NONSYS) first, the RSTALLCHG command exists. If you use some other technique, you may want to duplicate the objects needed into a library that you restore first.

You should have a disaster recovery plan with the steps you plan to use. If you use the default for SAVALLCHG to save from the last SAVLIB LIB(*NONSYS) date (or the default from SAVCHGOBJ), only one RSTALLCHG command should be needed. If you specify a reference date on the SAVALLCHG command, you will need the RSTALLCHG command for each set of media.

For instructions to create this command, see the information in member RSTALLCHG in file QATTINFO in library QUSRTOOL.

Restore All Libraries (RSTALLLIB) Command

The Restore All Libraries (RSTALLIB) command restores all libraries found on a tape. You do not need to know the name of the libraries on the tape.

The normal RSTLIB command allows only a single library to be restored for each command unless a special value was used for the library on the SAVLIB command.

RSTALLLIB has these restrictions:

- The tape must have been saved with the SAVLIB command. Objects saved by SAVOBJ, SAVCHGOBJ, and SAVDLO are not restored.
- The file on the tape must be the same name as the library to be restored. You must use the default LABEL parameter when using SAVLIB.

The RSTALLLIB command uses the CHKTAP and the RSTLIB commands to restore all of the libraries that are found on the media. The CHKTAP command retrieves the tape file name for each file sequence number. By default, the library name is stored in the tape file name field. The RSTLIB command is then run for each library. Therefore, you do not have to know the library names to restore successfully.

If you want to restore only some of the libraries or some of the objects on the media, you must issue individual RSTLIB or RSTOBJ commands.

A restart capability exists by allowing all libraries beginning at a specified file sequence number on the tape to be restored.

For instructions to create this command, see the information in member RSTALLLIB in file QATTINFO in library QUSRTOOL.

Restore Any Library (RSTANYLIB) Command

The Restore Any Library (RSTANYLIB) command is designed for those cases where the system operator must restore a library that has programs that adopt the owner's authority. This is typical of a disaster recovery situation where all libraries must be restored.

To prevent security exposures, the system normally first determines who is doing the restore operation. Then, the system changes the authority to AUT(*EXCLUDE) for any programs that adopt their owner's authority and are being restored by a user other than the owner or the security officer.

To avoid losing authority when these programs are restored, the RSTANYLIB command can be used. The RSTANYLIB command allows the system operator to perform the task without requiring the operator to be signed on as the Security Officer. RSTANYLIB adopts the authority of the Security Officer (QSECOFR) user profile while the command is running.

Notice that a security exposure exists when a user is authorized to RSTANYLIB. This allows the user to restore a simple program that adopts the user profile of the security officer and to act as the security officer.

For instructions to create this command, see the information in member RSTANYLIB in file QATTINFO in library QUSRTOOL.

Restore One Library (RSTONELIB) Command

The Restore One Library (RSTONELIB) command restores a single library from a tape or diskette. It is a front-end interface to RSTLIB and eliminates some of the prompts.

By default, the first library on tape on device TAP01 is restored to the same library as the library name.

For instructions to create this command, see the information in member RSTANYLIB in file QATTINFO in library QUSRTOOL.

Commands to Verify a Backup Design

Verify what objects are being saved, and when, by doing the following:

- Locate objects not being saved
- Review the save and restore job logs
- Find out when and where libraries are saved

How to Locate Objects That are Not Being Saved

Your best chance of avoiding a recovery exposure is to know exactly what you are saving (or perhaps more importantly, what you are not saving). Although you may save objects weekly, if the objects are changed daily, you may not be in a position to recover the changes.

To prevent such an exposure, you should periodically verify your backup strategy by reviewing when objects and changes made to these object are being saved. This can be done by using the Check Save (CHKSAV) command in library QUSRTOOL.

The CHKSAV command allows you to determine whether one or more libraries have had any objects or members changed since the last save operation. CHKSAV can be used on any or all libraries except library QSYS. When library QSYS is saved using the SAVSYS command, individual object descriptions are not updated. Instead, a SAVSYS updates the object description of two data areas named QSAVSYS and QSAVUSRPRF in library QSYS.

To determine when a SAVSYS command was run, use the DSPOBJD command to display the object description of these two data areas (SAVSECDTA updates the object description of the data area QSAVUSRPRF only). You do not display the data area itself. You display the object description of the data area using the DSPOBJD or WRKOBJD command.

Once you determine that all objects and changes are being saved to your satisfaction, consider using the CHKSAV command on a periodic basis, perhaps monthly, semi-annually, or yearly. As new applications are placed on the system, or as existing applications are changed, use the CHKSAV command to make sure these additions or changes have not created an exposure in your backup and recovery strategy.

How to Review the Save Job Logs

It is also important to make sure that the save command completes successfully. This can be done by reading through the job log created during the save. However, this can be a tedious task for large save operations. To help automate this function, the Check Save Status (CHKSAVSTS) command in library QUSRTOOL can be used.

The CHKSAVSTS command reads the job log that includes the save or restore commands and prints a list of completion messages for that save operation, as well as any diagnostic messages found. The CHKSAVSTS command basically summarizes the job log used during the save or restore process and nets out what is important from a save or restore viewpoint. CHKSAVSTS command allows you to direct the output to either a printer or a database file.

How to Find Out When and Where Libraries Are Saved

Using the Display Object Description (DSPOBJD) command against a specific library can tell when and where the library was saved (date, time, and what tape volume). The DSPOBJD command works for single libraries. However, to help verify your backup and recovery strategy, you may want to look at multiple libraries. This can be accomplished by using the Print Save Status (PRTSAVSTS) command in library QUSRTOOL.

The PRTSAVSTS command is intended for use following a save of multiple libraries. The PRTSAVSTS command creates printed output that contains a description of one or more library names, save date, save command, and the volumes the libraries are saved to. This list should then be saved to tape in the event a restore is necessary. An external description exists for the libraries that were saved and what tape volumes contain the libraries.

Verify Integrity of the Save or Restore Tapes

The time spent saving an object is wasted if the tape used for the save operation is unusable. All tapes are subject to wear over a period of time. To help monitor the quality of your tapes, use the *Work with tape or diskette statistics* option accessed using the System Service Tools functions. This shows you the number of temporary and permanent read or write errors that have occurred for a particular tape volume as well as the total amount of data read or written to the tape.

Programming Examples

This section provides some example programs used for save and restore operations, for commitment control, and for controlling an uninterruptible power supply.

Program to Schedule an Unattended SAVSYS Command

The following example CL program allows you to schedule and run an unattended SAVSYS command without operator intervention.

This program needs to run from the console. Once the program is called, the console is not available for use until the program completes.

```
0001   PGM         PARM(&TIME)
0002
0003   DCL         VAR(&TIME) TYPE(*CHAR) LEN(6)
0004
0005   MONMSG      MSGID(CPF0000)
0006
0007   DLYJOB      RSMTIME(&TIME)
0008     MONMSG      MSGID(CPF0001) EXEC(GOTO) CMDLBL(EXIT)
0009
0010   CHGMSGQ     MSGQ(QSYSOPR) DLVRY(*BREAK) SEV(99)
0011
0012   /*************************************************************/
0013   /Commands to end applications and subsystems gracefully        */
0014   /*************************************************************/
0015   SNDBRKMSG   MSG('Subsystems ending in 1 minute.  Please sign off +
0016                    immediately.') TOMSGQ(*ALLWS)
0017
0018   DLYJOB      DLY(60)
0019
0020   ENDSBS      SBS(*ALL) OPTION(*IMMED)
0021
0022LOOP:
0023  ENDSBS       SBS(*ALL) OPTION(*IMMED)
0024    MONMSG       MSGID(CPF1035) EXEC(D0)
0025      RCVMSG       MSGTYPE(*EXCP) RMV(*YES)
0026      DLYJOB       DLY(15)
0027      GOTO         CMDLBL(*LOOP)
0028    ENDDO
0029
0030  SAVSYS       DEV(TAP01)
0031
0032CLEANUP:
0033
0034  /*************************************************************/
0035  /*Start subsystems and any other start up processes           */
0036  /*************************************************************/
0037  STRSBS       SBSD(QSYS/QCTL)
0038
0039  CHGMSGQ      MSGQ(QSYSOPR) DLVRY(*NOTIFY) SEV(0)
0040
0041
0042EXIT:
0043
0044  ENDPGM
```

Retrieving the Device Name from Save Completion Messages

The CL program in Figure D-1 on page D-14 retrieves the device name from the CPC3701 message (found in positions 126 through 135 of the message data) and uses the information to determine which device is used by the next save command.

```
SEQNBR *... ... 1 ... ... 2 ... ... 3 ... ... 4 ... ... 5 ... ... 6 ... ... 7

  1.00              PGM
  2.00              DCL         &MSGDTA *CHAR LEN(250)
  3.00              DCL         &MSGID *CHAR LEN(7)
  4.00              DCL         &DEV *CHAR LEN(10)
  5.00              DCL         &DFV1 *CHAR LEN(10) VALUE(TAP01)
  6.00              DCL         &DEV2 *CHAR LEN(10) VALUE(TAP02)
  7.00              SAVLIB      LIB(LIB1) DEV(&DEV1 &DEV2) ENDOPT(*LEAVE)
  8.00  L00P:       RCVMSG      RMV(*NO) MSGDTA(&MSGDTA) MSGID(&MSGID)
  9.00              IF          (&MSGID *NE CPC3701) GOTO L00P /* Compltn */
 10.00              CHGVAR      &DEV %SST(&MSGDTA 126 10) /* Device name */
 11.00              IF          (&DEV *EQ 'TAP01') DO /* Last was TAP01   */
 12.00              CHGVAR      &DEV1 'TAP01' /* Set for first device */
 13.00              CHGVAR      &DEV2 'TAP02' /* Set for second device */
 14.00              ENDDO       /* Last was TAP01 */
 15.00              ELSE        DO /* Last was not TAP01 */
 16.00              CHGVAR      &DEV1 'TAP02' /* Set for first device */
 17.00              CHGVAR      &DEV2 'TAP01' /* Set for second device */
 18.00              ENDDO       /* Last was not TAP01 */
 19.00              SAVLIB      LIB(LIB2) DEV(&DEV1 &DEV2) /* Save Lib 2 */
 20.00              ENDPGM
```

Figure D-1. Example CL Program

If any objects cannot be saved, the operation attempts to save remaining objects and sends an escape message (CPF3771 for single libraries, CPF3751/CPF3778 for more than one library, and CPF3701 for save operations to save files) stating how many objects were saved and how many were not. To continue with the next library, the Monitor Message (MONMSG) command must be used to handle the escape condition. The format of the message data for the CPF3771 message is similar to the CPC3701 message and also identifies the last device used.

The SAVCHGOBJ command operates in a similar manner, but uses CPC3704 as a completion message, CPF3774 as an escape message for single libraries, and CPC3721 or CPF3751 for multiple libraries. For save operations to save files, these messages are CPC3723 as a completion message and CPF3702 as an escape message. These messages also contain the last device or save file used in the message data.

Using a Status Program for Saving Source Files

The following program sends a message to the external (*EXT) program message queue if all the source files cannot be saved. This same technique can be used for other objects.

```
PGM             /* SAVE SOURCE */
SAVLIB          LIB(SRCLIB) DEV(TAPE1) PRECHK(*YES)
MONMSG          MSGID(CPF0000) EXEC(DO)

SNDPGMMSG       MSG('Objects were not saved - Look at the job +
                log for messages') TOPGMQ(*EXT)
SNDPGMMSG       MSG('SRCLIB library was not backed up') +
                TOPGMQ(xxxx)
RETURN
ENDDO
SNDPGMMSG
ENDPGM
```

Using the Retrieve Journal Entry (RTVJRNE) Command in a Program

Use the Retrieve Journal Entry (RTVJRNE) command in a control language program to retrieve a journal entry and place it in variables in the program. You can retrieve the following:

- Sequence number
- Journal code
- Entry type
- Journal receiver name
- Library name for the journal receiver
- Journal entry

For example, you can use this command to automate your recovery procedures or to change the journal receivers and then save them.

In the following example, the RTVJRNE command determines when job 000666/QPGMR/WORKST01 last opened file ORDENTP:

```
PGM
DCL &SEQ# TYPE(*DEC) LEN(10 0)
DCL &JRNE TYPE(*CHAR) LEN(200)
DCL &DATE TYPE(*CHAR) LEN(6)
DCL &TIME TYPE(*CHAR) LEN(6)
RTVJRNE JRN(DSTJRN/JRNLA) FILE(DSTPRODLIB/ORDENTP) +
        RCVRNG(DSTJRN/RCV30 DSTJRN/RCV27) FROMENT (*LAST) +
        TOENT(*FIRST) SEARCH(*DESCEND) +
        JRNCDE(F) ENTTYP(OP) JOB(000666/QPGMR/WORKST01) +
        RTNSEQNBR(&SEQ#) RTNJRNE(&JRNE)
CHGVAR &DATE (%SST(&JRNE 19 6))
CHGVAR &TIME (%SST(&JRNE 25 6))
ENDPGM
```

The *CL Reference* manual has a description of the received journal entry format.

CL Program to Handle Escape Conditions

The WRKJRN command offers recovery functions that can perform file recovery. Figure D-2 on page D-16 demonstrates how this escape condition can be handled in the CL program by prompting for restoration of the required receiver.

```
FILERECOV: PGM
           .
           .
           APYJRNCHG JRN(JRNLIB/JRNA) FILE((LIBA/FILEA)) +
                 RCVRNG(RCVLIB/RCV1 *CURRENT)
           MONMSG MSGID(CPF7053 CPF9801) +
              EXEC(CALL PGM(FIXLIB/RSTRCV) PARM(FILERECOV))
           .
           .
           ENDPGM
           .
           .
RSTRCV: PGM PARM(&PGMNM)
        /* Recover a nonexistent or unusable receiver        */
        /* in RCVRNG by prompting for a restore of           */
        /* receiver.
DCL &PGMNM TYPE(*CHAR) LEN(10)         /* name of program    */
                                       /* calling RSTRCV     */
                                       /* that received      */
                                       /* CPF7053 or         */
                                       /* CPF9801            */
DCL &MSGDTA TYPE(*CHAR) LEN(22) /* variable for   */
                                       /* CPF7053 or         */
                                       /* CPF9801            */
DCL &MSGDID TYPE(*CHAR) LEN(7) /* escape message  */
                                       /* ID                 */
DCL &RCVNAME TYPE(*CHAR) LEN(10) /* name of       */
                                       /* receiver to        */
                                       /* restore            */
DCL &RCVLIB TYPE(*CHAR) LEN(10) /* library name   */
                                  /* of receiver to          */
                                  /* restore                 */
DCL &RCODE TYPE(*CHAR) LEN(2) VALUE(x'0001')
                           /* reason code 1 of CPF7053       */
RCVMSG PGMQ(*SAME &PGMNM) MSGTYPE(*EXCP) WAIT(0) +
   RMV(*NO) MSGDTA(&MSGDTA) MSGID(&MSGID)
```

Figure D-2 (Part 1 of 2). Example Program Prompts for Restoring the Required Receiver

```
IF COND(&MSGID *EQ 'CPF9801') THEN(DO)   /* CPF9801 occurred */
   CHGVAR &RCVNAME (%SST(&MSGDTA 1 10))  /* get receiver     */
                                         /* from message     */
                                         /* data             */
   CHGVAR &RCVLIB (%SST(&MSGDTA 11 10))  /* get library      */
                                         /* name from        */
                                         /* message data     */
   ? RSTOBJ OBJ(&RCVNAME) SAVLIB(&RCVLIB) OBJTYPE(*JRNRCV)
                                    /* display RSTOBJ prompt */
  ENDDO
ELSE DO
IF COND((&MSGID *EQ 'CPF7053') & (%SST(&MSGDTA 1 2) +
   *EQ &RCODE)) THEN(DO)  /*CPF7053 RC(1) occurred*/
   CHGVAR &RCVNAME (%SST(&MSGDTA 3 10))  /* get receiver     */
                                         /* name from        */
                                         /* message data     */
   CHGVAR &RCVLIB (%SST(&MSGDTA 13 10))  /* get library      */
                                         /* name from        */
                                         /* message data     */
     ? RSTOBJ OBJ(&RCVNAME) SAVLIB(&RCVLIB) OBJTYPE(*JRNRCV)
                                   /* display restore prompt */
    ENDDO
  ELSE
.
.
 ENDDO
ENDPGM
```

Figure D-2 (Part 2 of 2). Example Program Prompts for Restoring the Required Receiver

Using an Application Program to Apply Journal Changes

The APYJRNCHG command has three restrictions:

- Journal entries can be applied only to the file and member being journaled.
- If a restore occurs, the object restored must have been journaling at the time of the save in order to apply journal entries.
- Journal entries can be applied from a journal receiver and not be converted (for example, by the DSPJRN or RCVJRNE commands).

In some recovery situations and applications you may need to bypass these restrictions by using the DSPJRN (or alternatively, RCVJRNE or RTVJRNE) command to extract entries from the journal and direct them to a database file. You then use an application program to apply the journaled changes to files.

The APYUSRCHG tool in library QUSRTOOL provides an example of how to apply journal entries from the output created by the Display Journal (DSPJRN) command.

Writing Output Using the Receive Journal Entry Command

The following example shows an RPG program that is being used as the exit program for the Receive Journal Entry (RCVJRNE) command. The sample program in Figure D-3 on page D-20 writes output onto tape. See "Differences for Writing to an ICF File" on page D-19 for a discussion of changing the sample to write output to an OS/400-ICF file. You need a user-written application program to

apply the entries. (See the sample program in "Using an Application Program to Apply Journal Changes.")

Writing to Tape

A separate job must be in continuous operation and dedicated to converting entries to tape. Before issuing RCVJRNE the command, your job should issue an OVRTAPF command, specifying fixed-length blocked records, to direct the RPG file TAPE to a tape device.

You should not consider this approach with a streaming tape device. A user auxiliary storage pool (ASP) is a preferred solution instead of a tape. However, this approach is similar to writing journal entries to a communications line.

The RPG program is written assuming that the largest journal entry to be passed is 300 bytes. This is the size given to the data structure JRNENT. It allows a record size of 175 bytes plus the 125 bytes of journal entry identifier and qualifier information. A check is made in the program to ensure that the record image is not being truncated:

- If a code of 1 is passed from the RCVJRNE command, the program ensures that the journal entry does not exceed 300 bytes. If it does, the program sets on the H1 indicator and returns. The program adds 1 to the counter and writes the record to the tape output file. Because this is an output-only file, RPG automatically blocks the records within the RPG program.

  When full, the block is passed to tape data management, where additional blocking can occur and double-buffering to the tape device is provided. This ensures that the tape performance is optimal. Because the records are not written directly to tape when the program requests the output, there can be some interval of time before the records are written to the external media.

- When a code of 0 is passed from the RCVJRNE command, no more entries exist in the journal. On the return to the RCVJRNE command, the DELAY parameter value specified on the RCVJRNE command is used to wait before checking for additional entries. To avoid keeping the records in the various buffers while the delay occurs, the program forces the records to the tape device by using the force end-of-data operation (FEOD).

  This causes all records in either the RPG or tape data management buffers to be written to the tape device, and a device completion notification to be received before proceeding to the next instruction. If there is less than a full block of records, a short block is written to tape. Tape data management correctly handles the short block if the tape is read in a subsequent program. When the return occurs to the RCVJRNE command, the delay time occurs whether or not any journal entries have arrived since the last time the exit program was called.

The RPG program increments a counter each time a record is written and resets it when the FEOD operation is used. The program issues the FEOD operation only if a record has been written which avoids calling tape data management when there are no records to be written. (If tape data management has no records in its buffers when the FEOD operation occurs, no empty block is written, but system overhead occurs.)

The RPG program uses the SHTDN operation code to check for requests to end the job from external functions such as an End Job (ENDJOB) or End Subsystem (ENDSBS) command with OPTION(*CNTRLD). If end-of-job is requested, the program forces the records from the buffers, sets the counter to 9 (which tells the RCVJRNE command to complete normally, and sets the LR indicator on). The RETRN operation is then issued and:

- If LR is on, the program's working storage is returned to the system.
- If LR is off, the program remains active and waits to be called again by the RCVJRNE command.

Writing to tape occurs either by the buffers being full or when the FEOD operation is used. This trade-off allows good performance when many journal entries are written and minimizes the number of times the FEOD operation is used to ensure that the entries are actually on the tape. With the sample program, the value of the DELAY parameter and the work management specifications for your job (for example, pool size and priority) are the major factors controlling the frequency with which the entries are written and the performance implications on the system for this function.

If the system ends abnormally while the job is running, so that a successful end-of-file indication is not written, the subsequent reading of the tape can produce results that cannot be predicted. Blocks that were successfully written can be correctly read. The last block and any subsequent data that is on the tape from a previous use can produce results that cannot be predicted. Copy the tape to a database file and examine the contents before using the data.

The journal sequence numbers are in ascending sequence (unless they have been reset) and can be used to determine where the logical end-of-file exists. To avoid confusion, delete the tapes used for this type of approach.

Assume, for example, that the largest record size journaled was 175 bytes and the tape record size 300 bytes, as in Figure D-3 on page D-20. If you need to increase the tape record size, change the value of 300 in the RPG file description specification, the input specification, and factor 2 of the CABGT operation code. If there are some significantly larger records being journaled, consider how much excess media is used. An alternative would be to examine the individual fields (*JOENTL*) and write two or more small records for each large record.

Differences for Writing to an ICF File

If you use an ICF file to transmit journal entries to another system, the FEOD operation does not apply. Instead, there are data description specifications (DDS) words (for example, FRCDTA) to force records from the buffers.

Usually the number of blocks transmitted to tape by records less than 175 bytes is a minimal performance consideration. On communications lines, however, this number can be significant. To avoid sending unnecessary trailing blanks, consider decreasing the length of the record being transmitted by the variable length function (VARLEN DDS keyword). For a discussion of the variable length function, see the *ICF Programmer's Guide*.

If binary synchronous equivalence link (BSCEL) is used, trailing blanks will be truncated automatically if the TRUNC parameter is specified on the Add ICF Device Entry (ADDICFDEVE) or the Override ICF Device Entry (OVRICFDEVE) command.

Refer to the *BSC Equivalence Link Programmer's Guide* for more information about the function of the TRUNC parameter.

Figure D-3 contains the RPG source for your program:

```
SEQNBR *... ... 1 ... ... 2 ... ... 3 ... ... 4 ... ... 5 ... ... 6 ... ... 7

  1.00      FTAPE    O   F     300           SEQ
  2.00      IJRNENT      DS                        300
  3.00      I                                   1   5OJOENTL
  4.00      C           *ENTRY    PLIST
  5.00      C                     PARM          JRNENT
  6.00      C                     PARM          CALLCD  1
  7.00      C           CALLCD    IFEQ '1'                      Entry rcvd
  8.00      C* Ensure journal entry is not being truncated
  9.00      C           JOENTL    CABGT300      RETURN     H1   If GT output
 10.00      C                     ADD  1        OUTRCD  70      Bump ctr
 11.00      C                     EXCPTOUTPUT                   Output
 12.00      C                     END                           Entry rcvd
 13.00      C           CALLCD    IFEQ '0'                      Rdy to wait
 14.00      C                     EXSR FORCE                    Force out
 15.00      C                     END                           Rdy to wait
 16.00      C                     SHTDN                    31   Test shtdwn
 17.00      C   31                DO                            If shtdwn
 18.00      C                     EXSR FORCE                    Force out
 19.00      C                     MOVE '9'      CALLCD          Set to end
 20.00      C                     SETON                    LR   Set LR
 21.00      C                     END                           If shtdwn
 22.00      C           RETURN    TAG                           Return tag
 23.00      C                     RETRN                         Return
 24.00      C           FORCE     BEGSR                         Force out
 25.00      C           OUTRCD    IFNE *ZERO                    If rcds
 26.00      C                     FEOD TAPE                     FEOD
 27.00      C                     Z-ADDO        OUTRCD          Reset
 28.00      C                     END                           If rcds
 29.00      C                     ENDSR                         End subr
 30.00      OTAPE    E                OUTPUT
 31.00      O                         JRNENT
```

RV2W357-0

Figure D-3. RPG Source for Writing Output

Appendix E. Using Operational Assistant to Back Up Information

The OS/400 licensed program is shipped with a safe, ready-to-go backup strategy. Using this method, you can back up all of your user data (including user libraries, folders, calendars, security and configuration information, and OfficeVision/400 calendars and mail) daily, weekly, and monthly. Automatic backup using Operational Assistant uses a batch job to run your backup at night, or while the system is not in use. The heading for the printed output for the following Operational Assistant backup operations is called Backup Information.

Note: You must be enrolled in the system distribution directory and have *SAVSYS and *SECADM special authorities to use the backup operations supplied by Operational Assistant.

One master backup list exists with daily, weekly, and monthly lists built in. A **backup list** is a list of all folders and libraries on the system. With this list you can specify which folders or libraries should be backed up. New libraries and folders are automatically added to this list when they are created. All libraries and folders backed up daily are included in the weekly backup and all weekly backups are included in the monthly backup.

Note: Right after your system is installed, back up the entire system using two sets of identical tapes, keeping one on-site in a safe place and another off-site where it is safe from fire and water damage. For information on how to back up your entire system, see "When You Back Up the Entire System" on page E-15.

Before you start backing up system data, initialize enough tapes to hold the data. To determine how many tapes to initialize, compare the number of megabytes of information you want to back up to the number of megabytes that a tape will hold. Specific information on determining the number of tapes to initialize can be found in Chapter 4, "Save and Restore Media Considerations" on page 4-1.

Tape Rotation Example

To make sure your system is properly backed up, use tape sets and rotate them on a regular basis. For example, if your daily backup takes two tapes each and you want a three-set rotation (sets A, B, and C), the rotation schedule would be as follows:

Table E-1. Tape Rotation

Daily	Tape 1	Tape 2	Weekly	Tape 1	Tape 2	Monthly	Tape 1	Tape 2
Monday	DAYA01	DAYA02	Week 1	WEKA01	WEKA02	January	MTHA01	MTHA02
Tuesday	DAYB01	DAYB02	Week 2	WEKB01	WEKB02	February	MTHB01	MTHB02
Wednesday	DAYC01	DAYC02	Week 3	WEKC01	WEKC02	March	MTHC01	MTHC02
Thursday	DAYA01	DAYA02	Week 4	WEKA01	WEKA02	April	MTHA01	MTHA02
Friday	DAYB01	DAYB02	⋮			⋮		
Saturday	DAYC01	DAYC02						
⋮								

Before Initializing Tapes

The tape you decide to use may or may not contain active files. An **active file** is any file on a tape with an expiration date that has not passed. If you check the tape for these files before initializing it, you will not lose data by mistake. If you check the tape for active files, a message is displayed if active files exist. You can then decide whether to cancel the function or continue and erase the files. This can take a long time for a tape with a large first file.

If you do not check for active files nor clear the tape, when the tape is initialized again, the volume table of contents is cleared and new data may be written to the entire tape.

If you are using a tape that has never stored data, has been bulk erased, or was not initialized on an AS/400 system, do not check the tape for active files.

If you have problems initializing tapes, you may need to specify values for fields that are not available on the Initialize a Tape Set or Initialize a Tape display. Use the Initialize Tape (INZTAP) command.

This naming convention allows you to add tapes and sets if you want.

Initializing Tapes for Backup

To initialize multiple tape sets for your backups:

1. Select option 21 (Initialize a tape set) on the Backup Tasks (BACKUP) menu.
2. Fill in the name of the tape set in the *Tape set name* field.

   For example, to initialize two tapes for your daily backup, type `DAYA` in the field, `01` in the *Number of first tape* field, and `02` in the *Number of last tape* field. You can initialize up to 99 tapes in one tape set.
3. Press the Enter key when you are finished filling in the rest of the fields.

The system automatically initializes the tapes in the tape set, calculating the last two digits of the name. After each tape is finished, a window is displayed asking you to mount the next tape and press the Enter key. The system checks to make sure the tape names are not the same. If you press the Enter key before mounting a tape, an error message is displayed.

To initialize one tape at a time, select option 20 (Initialize a tape) on the Backup Tasks (BACKUP) menu.

Using Automatic Backup

Before You Start

Do a monthly backup before you start automatic backup. This allows the automatic backup function to save only the changed objects in your libraries and folders on a daily basis. If the libraries and folders have never been backed up before, the changes to those libraries cannot be saved. To run a monthly backup, select option 3 (Run monthly backup) on the Run a Backup (RUNBCKUP) menu.

To use the automatic backup function:

1. Select option 20 (Change backup schedule) on the Set Up Backup (SETUPBCKUP) menu.
2. Type a Y in the *Run backup using this schedule* field and press the Enter key.

The system sends a message to the system operator message queue (QSYSOPR) each day at 5:00 p.m. to remind the system operator to load the tape for the backup scheduled at 2:00 a.m. To change this schedule, see "Changing When Backups are Run" on page E-4.

User Information Automatically Backed Up

Table E-2 shows what the system is set up to save automatically and how often. These defaults coincide with the recommended backup strategy. If you want to change these settings, see "Your Own Backup Strategy" on page E-4.

Table E-2. Automatic Backup Defaults

Daily	Weekly	Monthly
• Changes to user libraries selected on backup list • Folders selected on backup list • All OfficeVision/400 mail and calendars	• All user libraries • All folders • All OfficeVision/400 mail and calendars	• All user libraries • All folders • Security data • Configuration data • All OfficeVision/400 mail and calendars

The system is shipped to back up changes to all libraries and folders daily. The contents of all libraries and folders are saved weekly and monthly. To back up only those libraries and folders that contain important information regularly, select those libraries and folders on the library and folder backup lists. This saves you the extra time and tapes that would be needed for a complete backup. For information on how to change the backup lists, see "Changing Which Folders to Back Up" on page E-7.

The following list describes specifically what is included when you back up all user information.

- **User libraries** are libraries that contain objects created by the user. See Table 5-1 on page 5-4 to determine which libraries are user libraries or IBM-supplied libraries.

  Every day the changes to objects that are important to your operations are saved. Saving only the changed objects decreases the number of tapes needed for backup.

- **Folders** are directories used to group related documents and folders.

- **Root folders** are folders that are not included in another folder. Root folders may include both documents and other folders.

  Note: If you specify to save only the changes for the folders selected in the folder backup list, each folder selected is saved in its entirety. You can specify to save only the changes for all of the folders. In that instance, any folders or documents created or changed since the last time you specified No for *Save changes only* field and All for the *Folders* field are saved.

- **Security data** is what the system uses to determine what objects users are authorized to see. This includes user profiles, authorization lists, and authority holders. Security data is automatically backed up monthly. You should back up security after making significant changes, such as adding new user profiles.
- **Configuration data** is the physical and logical arrangement of devices that make up your system. Configuration data is automatically backed up monthly. You should back up configuration data after making significant changes, such as adding new devices.

  The configuration data backed up includes:

  - Advanced program-to-program communications (APPC) and Advanced Peer-to-Peer Networking (APPN) function
  - Class-of-service descriptions (used only with APPN)
  - Configuration lists
  - Connection lists
  - Controller descriptions
  - Device descriptions
  - Line descriptions
  - Mode descriptions
  - Network interface descriptions
  - System resource management objects
- **OfficeVision/400 mail and calendars** includes all appointments and correspondence you make using the IBM Systems Application Architecture* (SAA*) OfficeVision/400 licensed program. OfficeVision/400 mail and calendars are automatically backed up every day. Saving all folders also saves all mail. Saving the QUSRSYS library also saves calendars.

Your Own Backup Strategy

You can change many of the features of automatic backup to fit your needs. For an example backup strategy and how to set it up, see "Backup Strategy Example" on page E-8.

Changing When Backups are Run

You can run your daily, weekly, or monthly backups immediately or change the automatic schedule.

1. To run a backup immediately, use the Run Backup (RUNBCKUP) menu. You can also type `RUNBCKUP` and press F4 (Prompt) to specify *DAILY, *WEEKLY, or *MONTHLY for the Backup Option (BCKUPOPT) parameter and the tape device name for the Device (DEV) parameter. You can use *BCKUPOPT to use the tape device name stored in the backup options.

   Security Consideration

   You must have save system (*SAVSYS) or all object (*ALLOBJ) special authority to run backups.

   Figure E-1 on page E-5 shows the Run Daily Backup display.

```
                              Run Daily Backup                    SYSTEM01
                                                                05/05/92  10:00:00
Tape set to use . . . . . . . . . . . . :   DAYA
  Load tape volume . . . . . . . . . . . :     DAYA01

Type choices below, then press Enter.

  Backup device . . . . . . . . . . . . .   TAP01_____   Name, F4 for list
                                            _________
                                            _________
                                            _________
```

Figure E-1. Run Daily Backup Display

Note: When option 2 (weekly) and option 3 (monthly) are selected on the Run Backup (RUNBCKUP) menu, you see the "Run Weekly Backup" and "Run Monthly Backup" displays.

The first two fields show the tape set to use for this backup and which tape volume to load. The defaults for the *Backup device* field are the names of the devices specified in the backup options. Press F4 to select from tape devices available on the system.

2. To change the times when your daily, weekly, and monthly backups are run, select option 20 (Change backup schedule) on the Set Up Backup (SETUPBCKUP) menu. Figure E-2 shows the Change Backup Schedule display.

```
                          Change Backup Schedule

Type choices below, then press Enter. Press F4 for list of backups.

  Run backup using this schedule . . . . . .   N   Y=Yes, N=No

                             Backup         Backup Time

  Sunday . . . . . .
  Monday . . . . . .         *DAILY         17:00:00
  Tuesday . . . . . .        *DAILY         17:00:00
  Wednesday . . . . . .      *DAILY         17:00:00
  Thursday . . . . . .       *DAILY         17:00:00
  Friday . . . . . .         *DAILY         17:00:00
  Saturday . . . . . .       *WEEKMONTH     12:00:00

  Occurrence of day in month to run monthly
    backup . . . . . .  . . . . . .  *LAST        1-4, *LAST

  Hours before backup to send load tape
    message . . . . . .  . . . . . .  3           1-24, *NO
                                                                  Bottom
F1=Help   F3=Exit   F5=Refresh   F12=Cancel
```

Figure E-2. Change Backup Schedule Display

The schedule shown is the default.

3. To activate the schedule, change the *Run backup using this schedule* field to Y (Yes).

Note: The QEZBACKUP job description is shipped with your system and can be found in the QGPL library. The first QEZBACKUP job description found in your library list is used when you run backup as a batch job.

You can change this job description to specify where the batch job runs or what user profile controls it.

Warning: The system job schedule function is used to schedule backups. The entry names for scheduling backups are QEZBKTMSUN, QEZBKTMMON, QEZBKTMTUE, QEZBKTMWED, QEZBKTMTHU, QEZBKTMFRI, and QEZBKTMSAT (for scheduling a specific time each day of the week). For scheduling the load tape message, the entry names are QEZBKMGSUN, QEZBKMGMON, QEZBKMGTUE, QEZBKMGWED, QEZBKMGTHU, QEZBKMGFRI, and QEZBKMGSAT. Do not change these entries using the job scheduling commands.

Changing What to Back Up

To change what you want backed up on a daily, weekly, or monthly basis:

1. Select option 1 (Change daily backup options), option 2 (Change weekly backup options), or option 3 (Change monthly backup options) on the Set Up Backup (SETUPBCKUP) menu.
2. Press the Page Down key on the Change Daily, Weekly, or Monthly Backup Options display.

   Figure E-3 shows the second part of the Change Daily Backup Options display.

```
                    Change Daily Backup Options
                                                        System:   SYSTEM01
Type choices below, then press Enter.

What to back up:
  User libraries . . . . . . . . . . . . .  1          1=Selected from list
                                                       2=All
                                                       3=None
  Folders  . . . . . . . . . . . . . . . .  1          1=Selected from list
                                                       2=All
                                                       3=None
  Security data  . . . . . . . . . . . . .  N          Y=Yes, N=No
  Configuration  . . . . . . . . . . . . .  N          Y=Yes, N=No
  OfficeVision/400 mail  . . . . . . . . .  Y          Y=Yes, N=No
  OfficeVision/400 calendars . . . . . . .  Y          Y=Yes, N=No

How to back up:
  Save changed objects only  . . . . . . .  Y          Y=Yes, N=No
  Submit backup as a batch job . . . . . .  Y          Y=Yes, N=No
  Print detailed report  . . . . . . . . .  Y          Y=Yes, N=No
                                                                    Bottom
F1=Help   F3=Exit   F5=Refresh   F12=Cancel
```

Figure E-3. Change Daily Backup Options - Second Display

Changing Which Libraries to Back Up

All user libraries and root folders are initially selected for backup. To change the libraries you want backed up on a regular basis:

1. Select option 10 (Change library backup list) on the Set Up Backup (SETUPBCKUP) menu.

   You can also use the Edit Backup List (EDTBCKUPL) command to change the backup list, specifying *LIB or *FLR for the Backup List (BCKUPL) parameter.

   Figure E-4 on page E-7 shows the Change Library Backup List display.

```
                        Change Library Backup List
                                                              System:   SYSTEM01
Find library . . . . . _________   Starting characters

Type options below, then press Enter.
  2=Change backup   5=Display library contents   8=Display details

                  -----------Backup-----------  Last
Opt  Library      Daily      Weekly     Monthly   Backup    Changed
 _   #LIBRARY     Yes        Yes        Yes       01/01/91  No
 _   AMES         Yes        Yes        Yes       01/01/91  No
 _   BALYLE       Yes        Yes        Yes       01/01/91  No
 _   BETH         Yes        Yes        Yes       01/01/91  No
 _   BURT         Yes        Yes        Yes       01/01/91  No
 _   B5738C01     Yes        Yes        Yes       01/01/91  No
 _   CLOA         Yes        Yes        Yes       01/01/91  No
 _   CLOE         Yes        Yes        Yes       01/01/91  No
 _   CLB          Yes        Yes        Yes       01/01/91  No
 _   COVER        Yes        Yes        Yes       01/01/91  No
 _   CSALIB       Yes        Yes        Yes       01/01/91  No
                                                                      More...
F1=Help   F3=Exit   F5=Refresh   F11=Display descriptions   F12=Cancel
F14=Select other libraries       F15=Change all
```

Figure E-4. Change Library Backup List Display (Option 10)

2. To change the selections, use option 2 (Change backup) next to the libraries you want to change.
3. In the Change Backup Window, you can choose to have the library or folder backed up:

   Daily, weekly, and monthly
   Weekly and monthly
   Monthly
   Not at all

Changing Which Folders to Back Up

To select the folders you want to back up on a regular basis:

1. Select option 11 (Change folder backup list) on the Set Up Backup (SETUPBCKUP) menu.
2. Follow the same steps as Figure E-5 on page E-8.

Figure E-5 on page E-8 shows the Change Folder Backup List display.

```
                          Change Folder Backup List
                                                              System:   SYSTEM01
Find folder . . . . . .  __________   Starting characters

Type options below, then press Enter.
  2=Change backup   5=Display documents   8=Display next level

                    ----------Backup----------  Last
Opt  Folder         Daily     Weekly    Monthly   Backup    Changed
 _   QIWSADM        Yes       Yes       Yes       02/02/91  Yes
 _   QIWSFLR        Yes       Yes       Yes       02/02/91  Yes
 _   QIWSFL2D       Yes       Yes       Yes       02/02/91  Yes
 _   QIWSOS2        Yes       Yes       Yes       02/02/91  Yes
 _   QIWSTOOL       Yes       Yes       Yes       02/02/91  Yes
 _   QOTTMFLR       Yes       Yes       Yes       02/02/91  Yes
 _   UNDDERWOOD     Yes       Yes       Yes       02/02/91  Yes




                                                                      Bottom
F1=Help   F3=Exit   F5=Refresh   F11=Display descriptions   F12=Cancel
F14=Select other folders         F15=Change all
```

Figure E-5. Change Folder Backup List (Option 11)

Security Consideration

If you are not authorized to change the backup list, you will see the Display Library List or Display Folder List display. To change the backup lists, you need:

- Save system (*SAVSYS) authority
- All object (*ALLOBJ) special authority
- Change authority for the QEZBACKUPL user index in the QUSRSYS library for the library backup list
- The QEZBACKUPF user index in the QUSRSYS library for the folder backup list. This is where the backup list is saved.

Backup Strategy Example

The following is an example of a customized backup strategy and the directions for setting it up. In this example, you decide to back up some data on Mondays, Wednesdays, and Fridays at 5:00 p.m., other data on Saturdays at 11:00 p.m., and all data on the fourth Sunday of every month at 11:00 p.m.

Table E-3 on page E-9 shows the specific data you want backed up during these intervals.

Table E-3. Example Backup Strategy

Mondays, Wednesdays, and Fridays at 5:00 p.m.	Saturdays at 11:00 p.m.	Fourth Sunday of every month at 11:00 p.m.
• Changes to PAYROLL, TESTLIB, and PROBLIB libraries	• JOYLIB, BCKLIB, UPSLIB, PAYROLL, TESTLIB, and PROBLIB libraries • FLR1 and FLR3 folders • All OfficeVision/400 mail • Print a list of the objects that were backed up	• All user libraries • All folders • Security data • Configuration data • All OfficeVision/400 mail and calendars • Print a list of objects that were backed up

Setting Up a Backup Strategy Example

To set up this backup strategy, do the following things.

Set Up the Daily Backup Options

1. Type `go setupbckup` on any command line and press the Enter key.
2. Select option 1 (Change daily backup options) on the Set Up Backup (SETUPBCKUP) menu.
3. On the Change Daily Backup Options display, type the following as appropriate for the *Where to back up* field:
   a. Your backup device name
   b. Tape sets to rotate
   c. Whether or not to erase the tape for backup
4. Press the Page Down key and fill in the fields as shown in Figure E-6 on page E-10.

```
                        Change Daily Backup Options
                                                          System:   SYSTEM01
Type choices below, then press Enter.

What to back up:
  User libraries . . . . . . . . . . . . .  1          1=Selected from list
                                                       2=All
                                                       3=None
  Folders  . . . . . . . . . . . . . . . .  3          1=Selected from list
                                                       2=All
                                                       3=None
  Security data  . . . . . . . . . . . . .  N          Y=Yes, N=No
  Configuration  . . . . . . . . . . . . .  N          Y=Yes, N=No
  OfficeVision/400 mail  . . . . . . . . .  N          Y=Yes, N=No
  OfficeVision/400 calendars . . . . . . .  N          Y=Yes, N=No

How to back up:
  Save changed objects only  . . . . . . .  Y          Y=Yes, N=No
  Submit backup as a batch job . . . . . .  Y          Y=Yes, N=No
  Print detailed report  . . . . . . . . .  N          Y=Yes, N=No
                                                                   Bottom
F1=Help   F3=Exit   F5=Refresh   F12=Cancel
```

Figure E-6. Setting Up Daily Backup Options

5. Press the Enter key.

Set Up the Weekly Backup Options

1. Select option 2 (Change weekly backup options) on the Set Up Backup (SETUPBCKUP) menu.
2. On the Change Weekly Backup Options display, type the following as appropriate for the *Where to back up* field:
   a. Your backup device name
   b. Tape sets to rotate
   c. Whether or not you want to erase the tape for backup
3. Press the Page Down key and fill in the fields as shown in Figure E-7 on page E-11.

```
                        Change Weekly Backup Options
                                                              System:   SYSTEM01
Type choices below, then press Enter.

What to back up:
  User libraries . . . . . . . . . . . . . .   1          1=Selected from list
                                                          2=All
                                                          3=None
  Folders  . . . . . . . . . . . . . . . . .   1          1=Selected from list
                                                          2=All
                                                          3=None
  Security data  . . . . . . . . . . . . . .   N          Y=Yes, N=No
  Configuration  . . . . . . . . . . . . . .   N          Y=Yes, N=No
  OfficeVision/400 mail  . . . . . . . . . .   Y          Y=Yes, N=No
  OfficeVision/400 calendars . . . . . . . .   N          Y=Yes, N=No

How to back up:
  Save changed objects only  . . . . . . . .   N          Y=Yes, N=No
  Submit backup as a batch job . . . . . . .   Y          Y=Yes, N=No
  Print detailed report  . . . . . . . . . .   Y          Y=Yes, N=No
                                                                    Bottom
F1=Help   F3=Exit   F5=Refresh   F12=Cancel
```

Figure E-7. Setting Up Weekly Backup Options

4. Press the Enter key.

Set Up the Monthly Backup Options:

1. Select option 3 (Change monthly backup options) on the Set Up Backup (SETUPBCKUP) menu.
2. On the Change Monthly Backup Options display, type the following as appropriate for the *Where to back up* field:
   a. Your backup device name
   b. Tape sets to rotate
   c. Whether or not you want to erase the tape for backup
3. Press the Page Down key and fill in the fields as shown in Figure E-8 on page E-12.

```
                    Change Monthly Backup Options
                                                          System:   SYSTEM01
Type choices below, then press Enter.

What to back up:
  User libraries . . . . . . . . . . . . .  2          1=Selected from list
                                                       2=All
                                                       3=None
  Folders  . . . . . . . . . . . . . . . .  2          1=Selected from list
                                                       2=All
                                                       3=None
  Security data  . . . . . . . . . . . . .  Y          Y=Yes, N=No
  Configuration  . . . . . . . . . . . . .  Y          Y=Yes, N=No
  OfficeVision/400 mail  . . . . . . . . .  Y          Y=Yes, N=No
  OfficeVision/400 calendars . . . . . . .  Y          Y=Yes, N=No

How to back up:
  Save changed objects only  . . . . . . .  Y          Y=Yes, N=No
  Submit backup as a batch job . . . . . .  Y          Y=Yes, N=No
  Print detailed report  . . . . . . . . .  Y          Y=Yes, N=No
                                                                    Bottom
F1=Help   F3=Exit   F5=Refresh   F12=Cancel
```

Figure E-8. Setting Up Monthly Backup Options

4. Press the Enter key.

Change the Library Backup List

1. Select option 10 (Change library backup list) on the Set Up Backup (SETUPBCKUP) menu.
2. Select option 2 (Change backup) for all of the libraries on the Change Library Backup List display. The display should look like Figure E-9 when you are finished.

```
                        Change Library Backup List
                                                          System:   SYSTEM01
Find library  . . . . . .  _________   Starting characters

Type options below, then press Enter.
  2=Change backup   5=Display library contents   8=Display details

                  ----------Backup----------  Last
Opt  Library      Daily     Weekly    Monthly   Backup    Changed
 _   BCKLIB       No        Yes       Yes       03/12/92  Yes
 _   JOYLIB       No        Yes       Yes       03/12/92  Yes
 _   PAYROLL      Yes       Yes       Yes       03/12/92  Yes
 _   PROBLIB      Yes       Yes       Yes       03/12/92  Yes
 _   QGPL         Yes       Yes       Yes       03/12/92  Yes
 _   QUSRSYS      No        No        No        03/12/92  No
 _   WUMLIB       No        No        No        03/12/92  No
 _   XXXLIB       No        No        No        03/12/92  No
 _   YYYLIB       No        No        No        03/12/92  No
 _   ZZZLIB       No        No        No        03/12/92  No

                                                                    Bottom
F1=Help   F3=Exit   F5=Refresh   F11=Display descriptions   F12=Cancel
F14=Select other libraries       F15=Change all
```

Figure E-9. Changing the Library Backup List

3. Press the Enter key.

Change the Folder Backup List

1. Select option 11 (Change folder backup list) on the Set Up Backup (SETUPBCKUP) menu.
2. Select option 2 (Change backup) for all of the folders on the Change Folder Backup List display. The display should look like Figure E-10.

```
                          Change Folder Backup List
                                                                System:   SYSTEM01
Find folder . . . . . .   __________   Starting characters

Type options below, then press Enter.
  2=Change backup   5=Display documents   8=Display next level

                     -----------Backup-----------  Last
Opt  Folder          Daily     Weekly    Monthly   Backup    Changed
 _    FLR1           No        Yes       Yes       02/02/92  Yes
 _    FLR2           No        No        Yes       02/02/92  No
 _    FLR3           No        Yes       Yes       02/02/92  Yes
 _    FLR4           No        No        Yes       02/02/92  No
 _    FLR5           No        No        Yes       02/02/92  No
```

Figure E-10. Changing the Folder Backup List

3. Press the Enter key.

Change the Backup Schedule

1. Select option 20 (Change backup schedule) on the Set Up Backup (SETUPBCKUP) menu.
2. On the Change Backup Schedule display, fill in the fields as shown in Figure E-11.

```
                          Change Backup Schedule

Type choices below, then press Enter. Press F4 for list of backups.

  Run backup using this schedule . . . . . .   Y   Y=Yes, N=No

                           Backup         Backup Time

  Sunday . . . . . .       *MONTHLY       23:00:00
  Monday . . . . . .       *DAILY         17:00:00
  Tuesday . . . . . .      _____          ________
  Wednesday . . . . . .    *DAILY         17:00:00
  Thursday . . . . . .     _____          ________
  Friday . . . . . .       *DAILY         17:00:00
  Saturday . . . . . .     *WEEKLY        23:00:00

  Occurrence of day in month to run monthly
    backup . . . . . .                    4          1-4, *LAST

  Hours before backup to send load tape
    message . . . . . .                   1          1-24, *NO
                                                                        Bottom
F1=Help   F3=Exit   F5=Refresh   F12=Cancel
```

Figure E-11. Changing the Backup Schedule

3. Press the Enter key.

Now the example backup is set up to run automatically to your specifications.

Displaying and Printing Backup Information

You can display and print information about your backup strategy. You may want to print the following reports to keep with your backup records.

Printing a Detailed Backup Report

A detailed backup report includes printer output for all of the save commands that are run while the daily, weekly, or monthly backup is taking place and information on what was backed up.

To print a detailed backup report:

1. Select option 1 (Change daily backup options), option 2 (Change weekly backup options) or option 3 (Change monthly backup options) on the Set Up Backup (SETUPBCKUP) menu.
2. Press the Page Down key.
3. Type a Y in the *Print Detailed Report* field and press the Enter key.

Keep this printer output with your backup tapes to make restoring the system easier. The detailed report is printed when the backup operation is run.

Displaying and Printing Your Backup Options

To display and print your daily, weekly, and monthly backup options:

1. Enter the Display Backup Options (DSPBCKUP) command and press F4 (Prompt).
2. Specify *DAILY, *WEEKLY, or *MONTHLY for the backup option (BCKUPOPT) parameter on the Display Backup Options (DSPBCKUP) display.
3. Press the Enter key to display the output or specify *PRINT for the output (OUTPUT) parameter and press the Enter key to print the output.

To retrieve the options in one of your pre-defined backups into CL variables, use the Retrieve Backup Options (RTVBCKUP) command.

Displaying and Printing the Backup Lists

To display and print your user library and folder backup lists:

1. Enter the Display Backup List (DSPBCKUPL) command and press F4 (Prompt).
2. Specify *LIB or *FLR for the backup list (BACKUPL) parameter on the Display Backup List (DSPBCKUPL) display.
3. Press the Enter key to display the output or specify *PRINT for the Output (OUTPUT) parameter and press the Enter key to print the output.

Displaying and Printing Backup Status

The backup status shows the last time each type of information was saved and what tape it was saved on. It only shows information about the daily, weekly, and monthly backups using the backup options. It does not include information about IBM-supplied library or entire system backups.

To display and print the status of your backups:

1. Select option 2 (Display backup status) on the Backup Tasks (BACKUP) menu or use the Display Backup Status (DSPBCKSTS) command.

2. To print the backup status, use the Display Backup Status (DSPBCKSTS) command with *PRINT specified for the Output (OUTPUT) parameter.

Displaying and Printing the Backup History

The backup history is the last time each of the tape sets was used and what was saved on each set.

To display the backup history:

1. Press F22 (Display backup history) on the Display Backup Status display. To see what user data was saved for the selected backup, use option 5 (Display backup details) on the Display Backup History display.
2. To print the backup status and history, use the Display Backup Status (DSPBCKSTS) command with *PRINT specified for the Output (OUTPUT) parameter.

Backing Up IBM-Supplied Libraries

To back up IBM-supplied libraries, select option 10 (Back up IBM-supplied libraries) on the Run Backup (RUNBCKUP) menu.

IBM-supplied system libraries are used specifically by a licensed program. Except for a few libraries, all IBM-supplied system libraries begin with the letter Q. Option 10 (Back up IBM-supplied libraries) saves all system (IBM) libraries. To determine which libraries are IBM-supplied or user libraries, see Table 5-1 on page 5-4.

When You Back Up the Entire System

You should back up the entire system:

- When you first install your system (2 tape sets)
- Quarterly
- After applying a PTF cumulative tape
- After installing a new release

When you back up the entire system, you save:

- Licensed Internal Code
- The operating system library (QSYS)
- Configuration data
- Security information
- System values
- Network attributes
- All libraries
- All folders
- All documents
- All mail
- Descriptions of:
  - Job queues
  - Output queues
  - Data queues

The data contents are not saved.

Before Backing Up the Entire System

- Make sure you have save system (*SAVSYS) and job control (*JOBCTL) special authorities in your user profile. Also, you should have change (*CHANGE) authority to the system operator (QSYSOPR) message queue and be enrolled in the system distribution directory.
- Make sure you are not using a personal computer running the PC Support/400 licensed program because your backup may not be successful.
- Initialize a set of tapes to back up all of the information. See "Tape Rotation Example" on page E-1 for instructions on initializing a tape set.
- Have all users sign off the system:
  1. Type `go managesys` to display the Manage Your System, Users and Devices menu, then select option 12 (Work with Signed-On Users).
  2. Press F10 (Send message to all) to send a message to all users asking them to sign off the system on the Work with Signed-On Users display. To sign them off individually, use option 4 (Sign off).
  3. Check the Work with Jobs display (option 2 from the Operational Assistant (ASSIST) menu) and end any batch jobs running on the system.

Backing Up the Entire System

To back up the entire system:

1. Sign on to the console you are going to use to back up the system.
2. Check to see if you are using the controlling subsystem. To find out which subsystem is controlling, type `DSPSYSVAL QCTLSBSD` on any command line and press the Enter key. Use the Work with Subsystems (WRKSBS) command and option 8 (Work with subsystem jobs) for the controlling subsystem. If your job is listed, go to step 3.

   If your job is not listed, move your job to the controlling subsystem by typing the Transfer Job (TFRJOB) command and pressing F4 (Prompt). Type the name of the controlling subsystem in the *Job queue* field and press the Enter key.
3. Select option 11 (Back up the entire system) on the Run Backup (RUNBCKUP) menu.

   Figure E-12 shows the Specify Command Defaults display.

```
                          Specify Command Defaults

Type choices, press Enter.

  Tape devices . . . . . .   TAP01       Names
                             _____
                             _____
                             _____

  Prompt for commands  . . . . .    N          Y=Yes, N=No

  Check for active files . . . .    Y          Y=Yes, N=No

  Message queue delivery . . . .    *BREAK     *BREAK, *NOTIFY
```

Figure E-12. Specify Command Defaults Display

4. Type the names of the tape devices to be used during the system backup. Type an N in the *Prompt for commands* field to bypass command prompting. Type an N in the *Check for active files* field if you are working with a set of backup tapes you rotate every 3-4 weeks.

   Note: The default for saving access paths is different than the normal save commands. The default in Operational Assistant is set to ACCPTH(*YES) and cannot be changed.

5. Type a value in the *Message queue delivery* field to specify how messages will be sent to the QSYSOPR message queue. The possible values are:

   *BREAK - When messages arrive at the QSYSOPR message queue, any severity 99 message will interrupt the backup operation and the message will be displayed on the system console.

   *NOTIFY - When messages arrive at the QSYSOPR message queue, only severity 99 messages associated with the backup operation will interrupt the backup operation. The message *Waiting for a reply on message queue QSYSOPR* is displayed on the system console. You will be notified by the *message waiting* light on the console display.

   Note: If you are doing an unattended save and you are using communications, type ***NOTIFY** in the *Message queue delivery* prompt. *NOTIFY allows the messages to be sent to the QSYSOPR message queue without interrupting the backup operation with communication messages.

   The following commands are run during backup:

   ENDSBS
   The End Subsystem command is used to end all active subsystems.

   SAVSYS
   The Save System command is used to save all the objects in the QSYS library and to save other objects such as user profiles and configuration objects.

   SAVLIB LIB(*NONSYS)
   The Save Library command with *NONSYS specified saves all user libraries and IBM-supplied libraries (such as QGPL, QRPG, and QCBL, but not QDOC). The libraries are saved in alphabetical order by library name.

   Note: The default with this command is to save access paths (ACCPTH(*YES)). Unlike the Save menu option, this parameter cannot be changed.

   SAVDLO DLO(*ALL)
   The Save Document Library Object (SAVDLO) command with *ALL specified saves all documents and folders. If a document is being distributed on the system, copies of the document are saved.

Note: If you plan to use the Operational Assistant backups later, you may want to skip the SAVLIB LIB(*NONSYS) and SAVDLO(*ALL) commands. Instead, you can run SAVLIB LIB(*IBM) and RUNBCKUP BCKUP(*MONTHLY). This saves the same information as the SAVLIB LIB(*NONSYS) and the SAVDLO DLO(*ALL). This allows the automatic backup function to save only the changed objects in your libraries and

folders on a daily basis. If the libraries and folders have never been backed up before, the changes to those libraries cannot be saved.

6. After the backup is complete, remember to start up any subsystems that were ended before the backup was started.

Bibliography

This section lists publications that provide additional information about topics described or referred to in this manual. The manuals in this section are listed with their full title and order number, but when referred to in text, a shortened version of the title is used.

Programming Information

- *Communications and Systems Management Guide (Alerts and Distributed Systems Node Executive)*, SC41-9661
  Short Title: *Alerts and DSNX Guide*

  This manual provides the system operator, programmer, or system administrator with information for configuring the AS/400 system to use the remote management support.

- *Communications: Distribution Services Network Guide*, SC41-9588
  Short Title: *Distribution Services Network Guide*

  This manual provides the system operator or system administrator with information about configuring a network for Systems Network Architecture Distribution Services (SNADS) and the Remote Spooling Communications Subsystem/Professional Office System (RSCS/PROFS) bridge. In addition, object distribution functions and document library and distribution services are discussed.

- *Communications: Intersystem Communications Function Programmer's Guide*, SC41-9590
  Short Title: *ICF Programmer's Guide*

  This manual provides provides the AS/400 programmer with information to write application programs that use the AS/400 communications and OS/400 intersystem communications function.

- *Device Configuration Guide*, SC41-8106
  Short Title: *Device Configuration Guide*

  This manual provides the system operator or system administrator with information on how to do an initial configuration and how to change the configuration. This manual also contains conceptual information about device configuration.

- *Licensed Programs and New Release Installation Guide*, SC41-9878
  Short Title: *Licensed Programs and New Release Installation Guide*

  This manual provides the system operator or system administrator with step-by-step procedures for initially installing, installing licensed programs, program temporary fixes (PTFs), and secondary languages from IBM.

  This guide is also for users who already have an AS/400 system with an installed release and want to upgrade to a new release.

- *Migrating from System/38 Planning Guide*, GC41-9624
  Short Title: *Migrating from System/38 Planning Guide*

  This manual provides the application programmer, system administrator, or data processing manager with information to help them migrate their products and applications using the System/38 to AS/400 Migration Aid. It includes information for planning the details of migration and an overview of the functions on the System/38 Migration Aid.

- *Office Services Concepts and Programmer's Guide*, SC41-9758
  Short Title: *Office Services Concepts and Programmer's Guide*

  This manual provides information about writing applications that use OfficeVision/400 functions. This manual also includes an overview of directory services, document distribution services, document library services, document and folder save and restore and storage management, security services, word processing services, and information on finding new ways to integrate your applications with OfficeVision/400.

- *Physical Planning Guide and Reference*, GA41-9571
  Short Title: *Using OfficeVision/400* Word Processing*

  This manual provides provides the data processing manager, system administrator, and installation planning representative with information for planning to set up the AS/400 system. This guide also includes information on cable considerations, physical specifications, electronic customer support (ECS), and unpacking considerations.

Operations

- *New User's Guide*, SC41-8211
  Short Title: *New User's Guide*

  This manual provides display station operators with information about how to sign on and off; send and receive messages, respond to keyboard error messages, use function keys; and use display, command, and help information to control and manage their own jobs.

- *System Operator's Guide*, SC41-8082
  Short Title: *Operator's Guide*

This manual provides the system operator or system administrator with information about how to use the system unit control panel and console, send and receive messages, respond to error messages, start and stop the system, use control devices, work with program temporary fixes (PTFs), and process and manage jobs on the system.

- *Programming: Control Language Programmer's Guide*, SC41-8077
  Short Title: *CL Programmer's Guide*

  This manual provides the application programmer or programmer with a wide range discussion of the AS/400 programming topics.

- *Programming: Control Language Reference*, SC41-0030
  Short Title: *CL Reference*

  This manual provides the application programmer with a description of the AS/400 control language (CL) and its commands. Each command includes a syntax diagram, parameters, default values, keywords, and an example.

- *Cryptographic Support/400 User's Guide*, SC41-8080
  Short Title: *Cryptographic Support/400 User's Guide*

  This manual provides the system operator or programmer with a description of the data security capabilities of the AS/400 Cryptographic Support. Cryptographic support is not a part of the operating system. You can order the cryptographic licensed program from the IBM Software Division.

- *Distributed Data Management Guide*, SC41-9600
  Short Title: *DDM Guide*

  This manual provides the application programmer or programmer with information about remote file processing. It describes how to define a remote file to OS/400 DDM (distributed data management), how to create a DDM file, what file utilities are supported through DDM, and the requirements of OS/400 DDM as related to other systems.

- *Systems Application Architecture* Structured Query Language/400 Reference*, SC41-9608
  Short Title: *SQL/400* Reference*

  This manual provides the application programmer, programmer, or database administrator with information that describes SQL/400 statements and their parameters.

- *Data Management Guide*, SC41-9658
  Short Title: *Data Management Guide*

  This manual provides the application programmer with information about using files in application programs. Files allow data that is external to an application program to be read from or written to devices attached to the system, such as database files, device files, and files used to communicate with the system.

- *Programming: Performance Tools/400 Guide*, SC41-8084
  Short Title: *Performance Tools/400 Guide*

  This manual provides the programmer with information about what AS/400 Performance Tools are, gives an overview of the tools, and tells how the tools can be used to help manage system performance.

- *Security and Auditing Considerations*, GC24-3501-00
  Short Title: *Security and Auditing Considerations*

  This redbook provides information about basic security concepts and auditing considerations on the system. It does not describe security for specific licensed programs, languages, and utilities.

- *Security Reference*, SC41-8083
  Short Title: *Security Reference*

  This manual provides the programmer (or someone who is assigned the responsibilities of a security officer) with information about system security concepts, planning for security, and setting up security on the system. This guide does not describe security for specific licensed programs, languages, and utilities.

- *Advanced Backup and Recovery Guide*, SC41-8079
  Short Title: *Advanced Backup and Recovery Guide*

  This manual provides information about planning a backup and recovery strategy, the different types of media available to save and restore system data, as well as a description of how to record changes made to database files using journaling and how that information can be used for system recovery. This manual describes how to plan for, and set up user auxiliary storage pools (ASPs), mirrored protection, and checksums along with other availability recovery topics. It also provides the system operator with information about how to install the system again from backup.

- *System Operator's Quick Reference*, SX41-9573
  Short Title: *Operator's Quick Reference*

  This manual provides the system operator with quick reference information when working with the AS/400 system. This guide contains summaries of information such as system values and OS/400 DDS keywords.

- *Programming: Work Management Guide*, SC41-8078
  Short Title: *Work Management Guide*

  This manual provides the programmer with information about how to create a work management environment and how to change it.

- *System Operator's Guide*, SC41-8082
  Short Title: *Operator's Guide*

  This manual provides the system operator or system administrator with information about how to use the system unit operator display, send and receive messages, respond to error messages, start and stop the system, use control devices, work with program temporary fixes (PTFs) and process, and manage jobs on the system.

- *System/36 to AS/400 Migration Aid User's Guide and Reference*, SC09-1166
  Short Title: *System/36 to AS/400 Migration Aid User's Guide and Reference*

  This manual provides the system operator, applications programmer, systems programmer and data processing manager with information about using the S/36* to AS/400* migration aid to move S/36 items to the AS/400 System using menus and displays or commands.

- *System/38 to AS/400 Migration Aid User's Guide and Reference*, SC09-1165
  Short Title: *System/38 to AS/400 Migration Aid User's Guide and Reference*

  This manual provides the system operator, application programmer, programmer, or data processing manager with information about using the System/38 to AS/400 Migration Aid to move System/38 objects to the AS/400 system using menus and displays, or commands.

- *9406 System Installation and Upgrade Guide*, SY44-0700
  Short Title: *9406 System Installation and Upgrade Guide*

  This manual provides the service representative with information about upgrading equipment on the 9406 System Unit. It provides information on an entire range of upgrades such as simple memory card additions, device and rack additions, and model upgrades. It is used with the instruction packets that are shipped with the upgrade equipment.

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Basic Backup and Recovery Guide
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