Oracle Rdb7™

Introduction to SQL

Release 7.0

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Introduction to SQL

Release 7.0

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Contents

3 Displaying Information About a Database

4 Retrieving Data

5 Inserting, Updating, and Deleting Data

6 Advanced Data Manipulation

7 Using Multischema Databases

8 Using Date-Time Data Types

Index

Examples

Figures

Tables

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Preface

SQL (structured query language) serves as the primary database interface supplied with Oracle Rdb software.

Purpose of This Manual

This manual provides an introduction to the SQL language as implemented by Oracle Rdb and the interactive SQL interface. This manual introduces you to SQL language through an extensive set of examples. You can enter and experiment with the examples interactively at your terminal or workstation using an Oracle Rdb sample database. You create the sample database from files supplied with the kit. To become familiar with using SQL with host language programs, read the *Oracle Rdb7 Guide to SQL Programming*.

Intended Audience

This manual primarily addresses users who have little or no knowledge of SQL and who want a basic understanding of the SQL interactive interface. To profit most from your reading, you should know the basic concepts and terminology of relational database management systems and of your operating system.

How This Manual Is Organized

This manual contains the following chapters:

Chapter 1	Provides an overview of the SQL interactive environment on OpenVMS.
Chapter 2	Provides an overview of the SQL interactive environment on Digital UNIX.
Chapter 3	Describes how to display information about an Oracle Rdb database using interactive SQL.
Chapter 4	Describes how to retrieve data from an Oracle Rdb database using basic SQL statements.

Chapter 5	Explains how to insert, update, and delete data in an Oracle Rdb database using interactive SQL.
Chapter 6	Explains how to construct advanced queries using interactive SQL.
Chapter 7	Provides information about naming and storing schema objects in a multischema Oracle Rdb database.
Chapter 8	Explains how to use date-time data types in interactive SQL.

Related Manuals

The following manuals contain information pertinent to your work with SQL:

- *Oracle Rdb7 SQL Reference Manual*
- *Oracle Rdb7 Guide to SQL Programming*
- *Oracle Rdb7 Guide to Database Design and Definition*
- *Oracle Rdb7 Release Notes*
- *Oracle Rdb7 Installation and Configuration Guide*

See the *Oracle Rdb7 Release Notes* for a complete list of the manuals in the Oracle Rdb documentation set.

Conventions

In examples, an implied carriage return occurs at the end of each line, unless otherwise noted. You must press the Return key at the end of a line of input.

OpenVMS means both the OpenVMS Alpha operating system and the OpenVMS VAX operating system.

Oracle Rdb refers to Oracle Rdb for OpenVMS and Oracle Rdb for Digital UNIX software. Version 7.0 of Oracle Rdb software is often referred to as V7.0.

The SQL interface to Oracle Rdb is referred to as SQL. This interface is the Oracle Rdb implementation of the SQL standard ANSI X3.135-1992, ISO 9075:1992, commonly referred to as the ANSI/ISO standard or SQL92.

Oracle CDD/Repository software is referred to as the dictionary, the data dictionary, or the repository.

The following conventions are also used in this manual:

Ctrl/x	This symbol indicates that you hold down the Ctrl (control) key while you press another key or mouse button (indicated here by x).
Return	In examples, a boxed symbol indicates that you must press the named key. For example, this symbol indicates the Return key.
. . .	Vertical ellipsis points in an example mean that information not directly related to the example has been omitted.
. . .	Horizontal ellipsis points in statements or commands mean that parts of the statement or command not directly related to the example have been omitted.
e, f, t	Index entries in the printed manual may have a lowercase e, f, or t following the page number; the e, f, or t is a reference to the example, figure, or table, respectively, on that page.
boldface text	Boldface type in text indicates a term defined in the text.
< >	Angle brackets enclose user-supplied names.
[ ]	Brackets enclose optional clauses from which you can choose one or none. When brackets enclose several options, the options are separated by the word “or.”
$	The dollar sign represents the DIGITAL Command Language prompt in OpenVMS and the Bourne shell prompt in Digital UNIX.

Oracle Rdb for Digital UNIX Samples Directory

This manual uses the term Samples directory to refer to the /usr/lib/dbs/sql/vnn/examples subdirectory, where nn is replaced with the version of Oracle Rdb you are using. (For example, if you are using Oracle Rdb V7.0, the samples directory is /usr/lib/dbs/sql/v70/examples.) This subdirectory contains sample programs and the script that creates the sample databases.

Technical Changes and New Features

This section identifies the new and updated portions of this manual since it was last released with Version 6.0 of Oracle Rdb.

The major new features and technical changes that are described in this manual include:

- Examples use the mf_personnel database

  Prior to this update of the *Oracle Rdb7 Introduction to SQL*, examples used the single-file personnel database. Examples now use use the multifile mf_personnel database.

- TRIM built-in function

  The TRIM built-in function lets you remove leading and trailing characters from a character string. Refer to Section 4.13.4 for a description of the TRIM built-in function.

- POSITION built-in function

  The POSITION built-in function lets you search for a particular substring within another string. Refer to Section 4.13.5 for a description of the POSITION built-in function.

- Multistring comments

  You can now specify comments that contain more than one string literal. This was implemented as a workaround to the limitation that comments can only be 1,024 characters in length. See Section 3.1.1 for a description of the COMMENT ON statement.

1 Getting Started with Interactive SQL on OpenVMS

SQL is a data definition and data manipulation language for relational databases; it is one of the interfaces supplied with Oracle Rdb. By using SQL you can create a database, load it with data, and read and update both data and data definitions. Variations of SQL are offered by most major vendors for their relational database products. This fact often makes SQL the interface of choice at sites using relational database products from a variety of vendors.

This manual discusses data manipulation using SQL. For an extensive discussion of data definition using SQL, see the *Oracle Rdb7 Guide to Database Design and Definition*.

This chapter provides an overview of the SQL interactive environment. You should be familiar with the basic terms and concepts of relational database management systems generally, and with SQL specifically.

1.1 Creating a Sample Database

Throughout this manual, examples use versions of the personnel sample database that you can build by using the files supplied with the Oracle Rdb installation kit. You can create the database in the following three forms:

- A single-file form named personnel
- A multifile form named mf_personnel
- A multischema form named corporate_data

Most of the examples in the first part of this manual are created using the multifile form of the personnel sample database. You can create your own copy of the mf_personnel database in one of your directories and try the examples for yourself. To do this, display or print the following file from the SQL$SAMPLE directory:

    about_sample_databases.txt

This file contains instructions that explain how to create the mf_personnel sample database.

Table 1–1 lists commands for creating the various types of sample databases available with the Oracle Rdb kit. In this manual, the multifile mf_personnel database without Oracle CDD/Repository is used for most of the examples. The chapters on using multischema databases and date-time arithmetic include examples using the multischema corporate_data sample database. You may want to build that database in your account to practice with examples in those chapters.

Table 1–1 Common Commands for Creating Sample Databases

Sample Database	Oracle CDD/Repository	Command
Single-file personnel[1]	No	@SQL$SAMPLE:personnel
Single-file personnel	Yes	@SQL$SAMPLE:personnel SQL S CDD
Multifile mf_personnel	No	@SQL$SAMPLE:personnel SQL M NOCDD
Multifile mf_personnel	Yes	@SQL$SAMPLE:personnel SQL M CDD
Multischema corporate_data[2]	No	@SQL$SAMPLE:personnel SQL S NOCDD MSDB

[1]Without any parameters, the personnel.com command procedure creates a single-file personnel database without use of Oracle CDD/Repository.

[2]SQL does not allow you to store database definitions for a multischema database in Oracle CDD/Repository.

1.2 Invoking Interactive SQL

To use interactive SQL on OpenVMS, you must run the executable SQL$ image. Oracle Corporation recommends that you run this image by first defining and then using a symbol in DIGITAL Command Language (DCL). For repeated use, include the symbol definition in your login command file. For example, you can define the symbol to be SQL:

```
$ SQL :== $SQL$ Return
```

To run the SQL$ image, type the symbol and press the Return key. The SQL prompt (SQL>) indicates that you can interactively enter SQL statements. For example:

```
$ SQL  Return
SQL>
```

To exit interactive SQL, press Ctrl/Z or type EXIT (in full) at the SQL prompt and press the Return key. To quit interactive SQL, causing SQL to cancel any changes that you made to the database and to exit the SQL session, type QUIT (in full) at the SQL prompt and press the Return key.

1.3 Using Online HELP

You can type HELP at the SQL prompt to receive assistance on using SQL statements and understanding the concepts and components of the Oracle Rdb system. After you type HELP followed by the Return key, a menu of topics is displayed. The cursor will then be positioned at the Topic? prompt. Typing any of the menu items will give you assistance on that topic. The following example shows how to access HELP:

```
$ SQL
SQL> HELP
```

You can exit help by either pressing the Return key until you reach the prompt from which you first entered the HELP command, or by pressing Ctrl/Z at any point.

1.4 Typing SQL Statements

Generally, typed SQL statements have the following characteristics:

- They can continue over several lines.
- They terminate with a semicolon (;).
- You can insert comments after a double hyphen (--).
- You can prevent the execution of an SQL statement by pressing Ctrl/Z.

The following example shows how to enter a typical SQL statement:

```
SQL>
SQL> -- Attach to the mf_personnel database
SQL> --
SQL> ATTACH 'FILENAME mf_personnel';
```

1.5 Attaching to a Database

Use the ATTACH statement to identify the database that you want to access. For example, you might have created the multifile mf_personnel database in Section 1.1. You can attach to it as follows:

```
$ SQL
SQL> ATTACH 'FILENAME mf_personnel';
SQL>
```

Instead of using the ATTACH statement to specify the database that you want to work with, you can have SQL automatically attach to a database after you invoke SQL. Refer to Section 1.8.2.

1.6 Detaching from a Database

After you attach to a database in interactive SQL and complete a set of operations, you can detach from that Oracle Rdb database in a number of ways. The simplest way to detach from a database is by exiting your interactive session. For example:

```
$ SQL
SQL> ATTACH 'FILENAME mf_personnel';
SQL> EXIT
$
```

You can also detach from the current database and continue the interactive SQL session either by entering another ATTACH statement to override the first attach, or by entering the DISCONNECT statement as follows:

```
SQL> DISCONNECT DEFAULT;
SQL>
```

1.7 Correcting Mistakes

If you make a typing or syntax error while entering a statement, SQL displays a message giving you information about the error and what was expected. For example, you might make a typing error trying to attach to the mf_personnel database:

```
SQL> ATTACH 'FILENAME mf_personne';
%SQL-F-ERRATTDEC, Error attaching to database mf_personne
-RDB-E-BAD_DB_FORMAT, mf_personne does not reference a database known to Rdb
-RMS-E-FNF, file not found
-COSI-E-FNF, file not found
SQL>
```

If you entered a single-line statement as shown in the preceding example, you can press the up arrow key (↑) to display and correct the statement. But if you made a mistake in a command that used several lines, use the EDIT statement to correct your mistakes. When you type the EDIT keyword and press the Return key, SQL places the last statement you entered in an editing buffer. (If you type a digit after the EDIT keyword, SQL puts that number of preceding statements in the buffer.)

You can correct and add to statements in the buffer by using your default text editor. (For information about how to invoke the editor of your choice, see Section 1.8.5.) When you exit the editor, SQL processes the statements in the buffer. The following example shows how to invoke the EDIT statement:

```
SQL> EDIT  [Return]
   .
   .
   .
  (Correct the statements and exit the editor.
   SQL displays and processes the statements.)
   .
   .
   .
*EXIT  [Return]
```

1.8 Making Interactive SQL Easier to Use

This section describes how to make working with interactive SQL easier.

1.8.1 Executing DCL Commands from the SQL Interactive Interface

You can issue DCL (DIGITAL Command Language) commands while at the SQL prompt within interactive SQL. Precede the command with the dollar sign ($), which informs SQL that you want to access the DCL environment. SQL spawns a subprocess and passes the command to the operating system for processing. For example, to display a listing of the files in the directory from which you invoked SQL, enter the following command:

```
SQL> $ DIR

Directory DISK:[USER]
FILE1.TXT  FILE2.COM  FILE 3.PS

Total of 3 files.
SQL>
```

1.8.2 Defining a Logical Name for the Database

You can more easily complete the interactive examples throughout this book if you define the logical name SQL$DATABASE to identify the database with which you want to work. Defining SQL$DATABASE means that you will not have to enter the ATTACH statement to specify a database after you invoke interactive SQL. When you enter the first SQL statement that requires database access, SQL evaluates the logical name SQL$DATABASE to find if a database has been assigned to it. It then accesses the database to process your statement.

Assign only the file name to SQL$DATABASE if your system directory default will always be the directory in which the file is located when you invoke SQL. For example:

```
$ DEFINE SQL$DATABASE mf_personnel
```

Include the disk and directory in your file name assignment if your OpenVMS disk and directory defaults might vary when you invoke SQL. For example:

```
$ DEFINE SQL$DATABASE DISK01:[FIELDMAN.DBS]mf_personnel
```

1.8.3 Using SQL Command Procedures

You can create an OpenVMS Record Management Services (RMS) file that contains SQL statements, and then execute this command procedure using interactive SQL. Command procedures are useful for storing SQL statements that you frequently enter and for testing SQL statements that you plan to include in programs. SQL ignores text on a line following double hyphens (**--**) so that you can include comments in your command procedure.

A command procedure named start.sql that attaches to the mf_personnel database and displays the database name is shown in the following example:

```
-- Attach to the mf_personnel database
--
ATTACH 'FILENAME mf_personnel';
--
-- Display database name
--
SHOW DATABASE
```

In interactive SQL, you execute an SQL command procedure by typing the at sign (@) and then the name of the procedure. If you omit the file type, SQL searches for the command procedure with the .sql file type. To execute the start.sql command procedure type @start as shown in the following example:

```
SQL> @start
Default alias:
    Oracle Rdb database in file mf_personnel
SQL>
```

If you type SET VERIFY before executing the command procedure, SQL displays the contents of the command procedure as it executes the statements.

Reference Reading

In the chapter on SQL statements in the *Oracle Rdb7 SQL Reference Manual*, the sections on Execute (@) and SET have more information about SQL command procedures. In the section on the SET statement, see the SET VERIFY information.

1.8.4 Controlling Session Output

You can use the statements in Table 1–2 to control the output from an interactive SQL session.

Table 1–2 Statements That Control Output

If You Want to . . .	Use the Statement . . .
Display a message to the user	PRINT 'message-string';
Echo commands and comments from a command file to the screen	SET VERIFY
Stop echo	SET NOVERIFY
Log the session output to a file	SET OUTPUT filename
Stop the log	SET NOOUTPUT
Specify the length of the output line in the log file	SET LINE LENGTH *n*

1.8.5 Using Editors with SQL

Interactive SQL includes an EDIT statement that allows you to correct mistakes that you make when entering SQL statements. The EDIT statement invokes the text editor of your choice.

Within SQL, you can use EDT, the DEC Text Processing Utility (DECTPU), or the DEC Language-Sensitive Editor (DEC LSE). EDT is the default text editor; however, you can assign a logical name to invoke the editor of your choice.

If you prefer to use DECTPU, make the following assignment:

```
$ ASSIGN TPU SQL$EDIT
```

If you prefer to use DEC LSE, make the following assignment:

```
$ ASSIGN LSE SQL$EDIT
```

Reference Reading

The chapter on SQL statements in the *Oracle Rdb7 SQL Reference Manual* contains sections for the EDIT and SET statements. Read those sections for a complete discussion of your editing options and restrictions. In the section on the SET statement, see the SET EDIT information.

The DEC Language-Sensitive Editor (DEC LSE) is an advanced text editor that is layered on DECTPU.

To use DEC LSE within interactive SQL, you must first assign DEC LSE as your default SQL editor (as described earlier in this section). In addition, you must define the logical name LSE$ENVIRONMENT as shown below:

```
$ DEFINE LSE$ENVIRONMENT SYS$COMMON:[SYSLIB]LSE$SYSTEM_ENVIRONMENT.ENV
```

Table 1–3 lists editing statements that you can use from within SQL.

Table 1–3 SQL Editing Statements

If You Want to . . .	Use the Statement . . .
Edit the last line	↑
Edit the last statement	EDIT
Edit the last *n* number of statements	EDIT *n*
Edit all statements in the edit buffer	EDIT *
Keep the last *n* statements in the buffer	SET EDIT KEEP *n*
Prevent statements from accumulating in the buffer	SET EDIT NOKEEP
Clear the edit buffer	SET EDIT PURGE

You can also invoke DEC LSE from the DCL level. For example, you can type the following command to edit a file named sample.sql:

```
$ LSEDIT sample.sql
```

Reference Reading

For more information about DEC LSE, see the DEC Language-Sensitive Editor documentation.

1.8.6 Tailoring the Interactive SQL Environment

You can create an SQL command procedure to tailor your interactive SQL environment. If you assign the logical name SQLINI to the full file specification for the command procedure that you create, SQL executes the command procedure each time you invoke SQL. This is called an SQL initialization file. For example:

```
$ ASSIGN DISK01:[CHESHIRE]sqlini.sql SQLINI
```

Include this assignment in your login.com file if you want SQLINI defined the same way each time you log on to your system.

Consider the following SQL command procedure, sqlini.sql:

```
-- sqlini.sql
--
-- Greeting
--
PRINT 'Good Morning!';
--
-- Write the session output to a log file named sql_session.log
--
SET OUTPUT sql_session.log
--
-- Attach to the mf_personnel database
--
ATTACH 'FILENAME mf_personnel';
--
-- Display database tables
--
SHOW TABLE
```

In addition to defining the logical name SQLINI in your login.com file, you should include an assignment to SQL$EDIT if your preferred editor is not EDT.

2 Getting Started with Interactive SQL on Digital UNIX

SQL is a data definition and data manipulation language for relational databases; it is one of the interfaces supplied with Oracle Rdb. By using SQL you can create a database, load it with data, and read and update both data and data definitions. Variations of SQL are offered by most major vendors for their relational database products. This fact often makes SQL the interface of choice at sites using relational database products from a variety of vendors.

This manual discusses data manipulation using SQL. For an extensive discussion of data definition using SQL, see the *Oracle Rdb7 Guide to Database Design and Definition*.

This chapter provides an overview of the SQL interactive environment. You should be familiar with the basic terms and concepts of relational database management systems generally, and with SQL specifically.

2.1 Creating a Sample Database

Throughout this manual, examples use versions of the personnel sample database that you can build by using the files supplied with the Oracle Rdb installation kit. You can create the database in the following three forms:

- A single-file form named personnel
- A multifile form named mf_personnel
- A multischema form named corporate_data

Most of the examples in the first part of this manual are created using the multifile form of the mf_personnel sample database. You can create your own copy of the mf_personnel database in one of your directories and try the examples for yourself. To do this, display or print the following file from the Samples directory. (See the *Samples Directory* section in the Preface for information on the samples directory.)

    about_sample_databases.txt

This file contains instructions that explain how to create the mf_personnel sample database.

Table 2–1 lists commands for creating the various types of sample databases available with the Oracle Rdb kit.

The following shows the format of the command you enter to create a sample database:

```
$ /usr/lib/dbs/sql/vnn/examples/personnel <database-form> <dir>
```

The directory specification and the two parameters are specified as follows:

1. vnn

   Replace the subdirectory specification, v*nn*, with the version of Oracle Rdb you are using. For example, if you are using Oracle Rdb V7.0, the directory specification is as follows:

   ```
   /usr/lib/dbs/sql/v70/examples/personnel
   ```

2. database-form: Enter S, M, or MSDB.

   This specifies the creation of a single-file (S) database, a multifile (M) database, or a multischema (MSDB) database. A single-file database is the default.

   You can use uppercase or lowercase to specify this parameter.

3. dir: Enter a directory specification where you want the database created.

   If you do not specify this parameter, the script will prompt you for a directory specification. If you do not provide a directory specification at the prompt, Oracle Rdb will create the database in your present working directory. You must terminate the directory specification with a slash (/).

   For example, to build the multifile version and specify the directory specification on the command line, enter the following command:

   ```
   $ /usr/lib/dbs/sql/v70/examples/personnel m /tmp/
   ```

The chapters on using multischema databases and date-time arithmetic include examples using the multischema corporate_data sample database. You may want to build that database in your account to practice with examples in those chapters.

Table 2–1 Common Commands for Creating Sample Databases

Sample Database	Command
Single-file personnel	/usr/lib/dbs/sql/v70/examples/personnel s
Multifile mf_personnel	/usr/lib/dbs/sql/v70/examples/personnel m
Multischema corporate_data	/usr/lib/dbs/sql/v70/examples/personnel msdb

2.2 Invoking Interactive SQL

To use interactive SQL on Digital UNIX, type sql and press the Return key:

```
$ sql [Return]
SQL>
```

The SQL prompt (SQL>) indicates that you can interactively enter SQL statements.

To exit interactive SQL, type EXIT (in full) at the SQL prompt and press the Return key. To quit interactive SQL, causing SQL to cancel any changes that you made to the database and to exit the SQL session, type QUIT (in full) at the SQL prompt and press the Return key.

2.3 Using Online HELP

You can type HELP at the SQL prompt to receive assistance on using SQL statements and understanding the concepts and components of the Oracle Rdb system. After you type HELP followed by the Return key, a menu of topics is displayed. The cursor will then be positioned at the "Topic?" prompt. Typing any of the menu items will give you assistance on that topic. The following example shows how to access HELP:

```
$ sql
SQL> HELP
```

You can exit help by either pressing the Return key until you reach the prompt from which you first entered the HELP command, or by pressing Ctrl/d at any point.

2.4 Typing SQL Statements

Generally, typed SQL statements have the following characteristics:

- They can continue over several lines.
- They terminate with a semicolon (;).
- You can insert comments after a double hyphen (--).

The following example shows how to enter a typical SQL statement:

```
SQL>
SQL> -- Attach to the mf_personnel database
SQL> --
SQL> ATTACH 'FILENAME mf_personnel';
```

2.5 Attaching to a Database

Use the ATTACH statement to identify the database that you want to access. For example, you might have created the multifile mf_personnel database in Section 2.1. You can attach to it as follows:

```
$ SQL
SQL> ATTACH 'FILENAME mf_personnel';
SQL>
```

Instead of using the ATTACH statement to specify the database that you want to work with, you can have SQL automatically attach to a database after you invoke SQL. Refer to Section 2.8.2.

2.6 Detaching from a Database

After you attach to a database in interactive SQL and complete a set of operations, you can detach from that Oracle Rdb database in a number of ways. The simplest way to detach from a database is by exiting your interactive session. For example:

```
$ SQL
SQL> ATTACH 'FILENAME mf_personnel';
SQL> EXIT
$
```

You can also detach from the current database and continue the interactive SQL session either by entering another ATTACH statement to override the first attach, or by entering the DISCONNECT statement as follows:

```
SQL> DISCONNECT DEFAULT;
SQL>
```

2.7 Correcting Mistakes

If you make a typing or syntax error while entering a statement, SQL displays a message giving you information about the error and what was expected. For example, you might make a typing error trying to attach to the mf_personnel database:

```
SQL> ATTACH 'FILENAME mf_personne';
%SQL-F-ERRATTDEC, Error attaching to database mf_personne
-RDB-E-BAD_DB_FORMAT, /usr/db/mf_personne does not reference a database
 known to Rdb
-COSI-E-FNF, file not found
SQL>
```

If you entered a single-line statement as shown in the example, you can press the up arrow key (↑) to display and correct the statement. But if you made a mistake in a command that used several lines, use the EDIT statement to correct your mistakes. When you type the EDIT keyword and press the Return key, SQL places the last statement you entered in an editing buffer. (If you type a digit after the EDIT keyword, SQL puts that number of preceding statements in the buffer.)

You can correct and add to statements in the buffer by using your default text editor. (For information about how to invoke the editor of your choice, see Section 2.8.5.) When you exit the editor, SQL processes the statements in the buffer. The following example shows how to invoke the EDIT statement:

```
SQL> EDIT [Return]
   .
   .
   .
  (Correct the statements and exit the editor.
   SQL displays and processes the statements.)
   .
   .
   .
*EXIT [Return]
```

2.8 Making Interactive SQL Easier to Use

This section describes how to make working with interactive SQL easier.

2.8.1 Executing Shell Commands from the SQL Interactive Interface

You can issue shell commands while at the SQL> prompt within interactive SQL. Simply precede the command with the dollar sign ($), which informs SQL that you want access to the shell environment (whichever shell you were using when you invoked interactive SQL). SQL forks a subprocess and passes the command to the shell for processing. For example, to display a listing of the files in the directory from which you invoked SQL, enter the following command:

```
SQL> $ls
file1   file2   file3   file4
file5   file6   file7
```

2.8.2 Defining a Configuration Parameter for the Database

You can more easily complete the interactive examples throughout this book if you define the configuration parameter SQL_DATABASE to identify the database with which you want to work. Defining SQL_DATABASE means that you will not have to enter the ATTACH statement to specify a database after you invoke interactive SQL. When you enter the first SQL statement that requires database access, SQL evaluates the configuration parameter SQL_DATABASE to find if a database has been assigned to it. It then accesses the database to process your statement.

You define SQL_DATABASE as a configuration parameter in your .dbsrc file. Assign only the file name to SQL_DATABASE if your Digital UNIX directory default will always be the directory in which the file is located when you invoke SQL. For example:

```
$ SQL_DATABASE mf_personnel
```

Include the directory in your file name assignment if your Digital UNIX directory defaults might vary when you invoke SQL. For example:

```
$ SQL_DATABASE /usr/fieldman/dbs/mf_personnel
```

2.8.3 Using SQL Indirect Command Files

You can create a flat file that contains SQL statements, and then execute this indirect command file using interactive SQL. Indirect command files are useful for storing SQL statements that you frequently enter and for testing SQL statements that you plan to include in programs. SQL ignores text on a line following double hyphens (--) so that you can include comments in your command file.

An indirect command file named start that attaches to the mf_personnel database and displays the database name is shown in the following example:

```
-- Attach to the mf_personnel database
--
ATTACH 'FILENAME mf_personnel';
--
-- Display database name
--
SHOW DATABASE
```

In interactive SQL, you execute an SQL indirect command file by typing the at sign (@) and then the name of the file. To execute the start indirect command procedure type @start as shown in the following example:

```
SQL> @start
Default alias:
    Oracle Rdb database in file mf_personnel
SQL>
```

If you type SET VERIFY before executing the command procedure, SQL displays the contents of the command procedure as it executes the statements.

Reference Reading

In the chapter on SQL statements in the *Oracle Rdb7 SQL Reference Manual*, the sections on Execute (@) and SET have more information about SQL command procedures. In the section on the SET statement, see the SET VERIFY information.

2.8.4 Controlling Session Output

You can use the statements in Table 2–2 to control the output from an interactive SQL session.

Table 2–2 Statements That Control Output

If You Want to . . .	Use the Statement . . .
Display a message to the user	PRINT 'message-string';
Echo commands and comments from a command file to the screen	SET VERIFY
Stop echo	SET NOVERIFY
Log the session output to a file	SET OUTPUT filename
Stop the log	SET NOOUTPUT
Specify the length of the output line in the log file	SET LINE LENGTH n

2.8.5 Using Editors with SQL

Interactive SQL includes an EDIT statement that allows you to correct mistakes that you make when entering SQL statements. The EDIT statement invokes the text editor of your choice.

The vi (visual editor) is the default text editor. However, you can assign the configuration parameter, SQL_EDIT, or the environment variable, EDITOR, to invoke the editor of your choice.

For example, if you prefer to use the Emacs editor, define the SQL_EDIT configuration parameter in your .dbsrc file, as follows:

```
SQL_EDIT emacs
```

Reference Reading

The chapter on SQL statements in the *Oracle Rdb7 SQL Reference Manual* contains sections for the EDIT and SET statements. Read those sections for a complete discussion of your editing options and restrictions. In the section on the SET statement, see the SET EDIT information.

2.8.6 Tailoring the Interactive SQL Environment

You can create an SQL command file, sqlini.sql, called an SQL initialization file, to tailor your interactive SQL. To ensure that SQL executes the initialization file each time you invoke SQL, do one of the following:

- Ensure that your sqlini.sql file is in the same directory from which you invoke SQL.
- Define the DBSINIT variable to point to your sqlini.sql file.

  For example:

  ```
  setenv DBSINIT "-i /usr/mydir/sqlini.sql"
  ```

Consider the following SQL initialization file, sqlini.sql:

```
-- sqlini.sql
--
-- Greeting
--
PRINT 'Good Morning!';
--
-- Write the session output to a log file named sql_session
--
SET OUTPUT sql_session

--
-- Attach to the mf_personnel database
--
ATTACH 'FILENAME mf_personnel';
--
-- Display database tables
--
SHOW TABLE
```

3

Displaying Information About a Database

The main method for displaying information about a database in the SQL language is the SHOW statement. This chapter explains how to use this statement to display information about objects stored in an Oracle Rdb database.

3.1 Using the SHOW Statement

To display a simple list of all tables and views in a database, use the SHOW TABLES statement, as shown in Example 3–1.

Example 3–1 Displaying All Tables

```
SQL> --
SQL> -- Display all tables and views:
SQL> --
SQL> SHOW TABLES
User tables in database with filename mf_personnel
     CANDIDATES
     COLLEGES
     CURRENT_INFO                    A view.
     CURRENT_JOB                     A view.
     CURRENT_SALARY                  A view.
     DEGREES
     DEPARTMENTS
     EMPLOYEES
     JOBS
     JOB_HISTORY
     RESUMES
     SALARY_HISTORY
     WORK_STATUS
```

To display information about a particular table, such as the WORK_STATUS table from the mf_personnel database, enter the SHOW TABLE statement and specify a table name, as shown in Example 3–2.

Example 3–2 Displaying Information on a Particular Table

```
SQL> --
SQL> -- Display information about the WORK_STATUS table:
SQL> --
SQL> SHOW TABLE WORK_STATUS
Information for table WORK_STATUS

Comment on table WORK_STATUS:
information related to work status codes

Columns for table WORK_STATUS:
Column Name                     Data Type        Domain
-----------                     ---------        ------
STATUS_CODE                     CHAR(1)          STATUS_CODE_DOM
 Primary Key constraint WORK_STATUS_PRIMARY_STATUS_CODE
 STATUS_NAME                    CHAR(8)          STATUS_NAME_DOM
 STATUS_TYPE                    CHAR(14)         STATUS_DESC_DOM

Table constraints for WORK_STATUS:
STATUS_NAME_VALUES
 Check constraint
 Table constraint for WORK_STATUS
 Evaluated on COMMIT
 Source:
        CHECK         (
                        STATUS_NAME IN ('ACTIVE', 'INACTIVE')
                        OR STATUS_NAME IS NULL
                        )

   .
   .
   .
```

To display all views in the database, use the SHOW VIEWS statement, as shown in Example 3–3.

Example 3–3 Displaying All Views

```
SQL> --
SQL> -- Display all views:
SQL> --
SQL> SHOW VIEWS

User tables in database with filename mf_personnel
     CURRENT_INFO                     A view.
     CURRENT_JOB                      A view.
     CURRENT_SALARY                   A view.
```

To display information about a particular view, such as the CURRENT_SALARY view from the mf_personnel database, enter the SHOW VIEW statement and specify a view name, as shown in Example 3–4.

Example 3–4 Displaying Information on a Particular View

```
SQL> --
SQL> -- Display information about the CURRENT_SALARY view:
SQL> --
SQL> SHOW VIEW CURRENT_SALARY
Information for table CURRENT_SALARY

Columns for view CURRENT_SALARY:
Column Name ➊              Data Type       Domain
-----------                  ---------       ------
LAST_NAME                    CHAR(14)
FIRST_NAME                   CHAR(10)
EMPLOYEE_ID                  CHAR(5)
SALARY_START                 DATE VMS
SALARY_AMOUNT                INTEGER(2)
 Source: ➋
        SELECT  E.LAST_NAME,
                E.FIRST_NAME,
                E.EMPLOYEE_ID,
               SH.SALARY_START,
               SH.SALARY_AMOUNT
          FROM SALARY_HISTORY SH,
               EMPLOYEES E
         WHERE SH.EMPLOYEE_ID = E.EMPLOYEE_ID
           AND SH.SALARY_END IS NULL;
```

The following callouts are keyed to Example 3–4:

➊ The view definition gives the list of columns used in the view.

➋ This section gives the actual SQL query that is used to create the view. A view is like a predefined query that runs when you access the view.

To list domains in the database, use the SHOW DOMAINS statement, as shown in Example 3–5.

Example 3–5 Displaying Domain Information

```
SQL> --
SQL> -- Display all domains:
SQL> --
SQL> SHOW DOMAINS
User domains in database with filename mf_personnel
ADDRESS_DATA_1_DOM              CHAR(25)
ADDRESS_DATA_2_DOM              CHAR(20)
BUDGET_DOM                      INTEGER
   .
   .
   .
DATE_DOM                        DATE VMS ❶
   .
   .
   .
STATUS_NAME_DOM                 CHAR(8)
WAGE_CLASS_DOM                  CHAR(1)
YEAR_DOM                        SMALLINT
SQL> --
SQL> -- Display information about the DATE_DOM domain:
SQL> --
SQL> SHOW DOMAIN DATE_DOM
DATE_DOM                        DATE VMS ❷
 Comment:       standard definition for complete dates
 Edit String:   DD-MMM-YYYY ❸
```

The following callouts are keyed to Example 3–5:

❶ When listing all domains, you get only the domain name and data type.

❷ The description of a single domain includes an explanation (comment) and the output format (edit string) for interactive SQL. DATE_DOM is a domain that includes values of the data type DATE VMS.

DATE VMS is the default date data type on both Oracle Rdb for OpenVMS and Oracle Rdb for Digital UNIX and corresponds to the standard OpenVMS date. Domains can be created for other date data types that can be used in date-time arithmetic (discussed in Chapter 8).

❸ Edit string determines the output format for the date information.

To display information about indexes defined on a database, use the SHOW INDEXES statement, as shown in Example 3–6.

Example 3–6 Displaying Index Information

```
SQL> --
SQL> -- Display information about all indexes:
SQL> --
SQL> SHOW INDEXES *
User indexes in database with filename mf_personnel
Indexes on table COLLEGES:
COLL_COLLEGE_CODE              with column COLLEGE_CODE
  ❶ No Duplicates allowed
  Type is Sorted
  Compression is DISABLED

Indexes on table DEGREES:
DEG_COLLEGE_CODE               with column COLLEGE_CODE
  ❷ Duplicates are allowed
  Type is Sorted
  Compression is DISABLED

DEG_EMP_ID                     with column EMPLOYEE_ID
  Duplicates are allowed
  Type is Sorted
  Compression is DISABLED
    .
    .
    .
SQL> --
SQL> -- Display information about the indexes on the
SQL> -- SALARY_HISTORY table:
SQL> --
SQL> SHOW INDEXES ON SALARY_HISTORY

Indexes on table SALARY_HISTORY:
SH_EMPLOYEE_ID                 with column EMPLOYEE_ID
  Duplicates are allowed
  Type is Sorted
  Compression is DISABLED
SQL> --
SQL> -- Display information about the DEG_EMP_ID index:
SQL> --
SQL> SHOW INDEX DEG_EMP_ID
Indexes on table DEGREES:
DEG_EMP_ID                     with column EMPLOYEE_ID
  Duplicates are allowed
  Type is Sorted
  Compression is DISABLED
```

The following callouts are keyed to Example 3–6:

❶ In the COLLEGES table, the COLLEGE_CODE column is the primary key. (A **primary key** is a column in a table whose value uniquely identifies its row in the table.) An index is defined on this column for faster access.

Because it is a primary key, no duplicate values are allowed in this column, so the index does not allow duplicates either.

❷ An index was also defined on the COLLEGE_CODE column in the DEGREES table. This index allows duplicate values because the COLLEGE_CODE column is not a primary key in this table, and column values are expected to have duplicates.

3.1.1 Adding Comments to Database Displays

Although the SHOW statements display any comments that were made when the database structures were created, you may find that you want to add more comments or change existing comments. The SQL COMMENT ON statement gives you the ability to do this.

Use the COMMENT ON statement, as shown in Example 3–7.

Example 3–7 Using the COMMENT ON Statement

```
SQL> --
SQL> -- Display the original comment on the EMPLOYEES table:
SQL> --
SQL> SHOW TABLE EMPLOYEES
Information for table EMPLOYEES

Comment on table EMPLOYEES:
personal information about each employee
      .
      .
      .
SQL> --
SQL> -- Create a new comment on the EMPLOYEES table:
SQL> --
SQL> COMMENT ON TABLE EMPLOYEES IS
cont> 'Main source of personal information about each employee';
SQL> SHOW TABLE EMPLOYEES
Information for table EMPLOYEES

Comment on table EMPLOYEES:
Main source of personal information about each employee
```

(continued on next page)

Example 3–7 (Cont.) Using the COMMENT ON Statement

```
Columns for table EMPLOYEES:
Column Name                     Data Type        Domain
-----------                     ---------        ------
EMPLOYEE_ID                     CHAR(5)          ID_DOM
 Primary Key constraint EMPLOYEES_PRIMARY_EMPLOYEE_ID
LAST_NAME                       CHAR(14)         LAST_NAME_DOM
FIRST_NAME                      CHAR(10)         FIRST_NAME_DOM
MIDDLE_INITIAL                  CHAR(1)          MIDDLE_INITIAL_DOM
ADDRESS_DATA_1                  CHAR(25)         ADDRESS_DATA_1_DOM
ADDRESS_DATA_2                  CHAR(20)         ADDRESS_DATA_2_DOM
CITY                            CHAR(20)         CITY_DOM
STATE                           CHAR(2)          STATE_DOM
POSTAL_CODE                     CHAR(5)          POSTAL_CODE_DOM
SEX                             CHAR(1)          SEX_DOM
BIRTHDAY                        DATE VMS         DATE_DOM
STATUS_CODE                     CHAR(1)          STATUS_CODE_DOM
   .
   .
   .
SQL> -- Create a comment for the BIRTHDAY column in the EMPLOYEES
SQL> -- table:
SQL> --
SQL> COMMENT ON COLUMN EMPLOYEES.BIRTHDAY IS
cont> 'Return format is "dd-Mmm-YYY"';
SQL> SHOW TABLE EMPLOYEES
Information for table EMPLOYEES

Comment on table EMPLOYEES:
Main source of personal information about each employee
```

(continued on next page)

Example 3–7 (Cont.) Using the COMMENT ON Statement

```
Columns for table EMPLOYEES:
Column Name                     Data Type        Domain
-----------                     ---------        ------
EMPLOYEE_ID                     CHAR(5)          ID_DOM
 Primary Key constraint EMPLOYEES_PRIMARY_EMPLOYEE_ID
LAST_NAME                       CHAR(14)         LAST_NAME_DOM
FIRST_NAME                      CHAR(10)         FIRST_NAME_DOM
MIDDLE_INITIAL                  CHAR(1)          MIDDLE_INITIAL_DOM
ADDRESS_DATA_1                  CHAR(25)         ADDRESS_DATA_1_DOM
ADDRESS_DATA_2                  CHAR(20)         ADDRESS_DATA_2_DOM
CITY                            CHAR(20)         CITY_DOM
STATE                           CHAR(2)          STATE_DOM
POSTAL_CODE                     CHAR(5)          POSTAL_CODE_DOM
SEX                             CHAR(1)          SEX_DOM
BIRTHDAY                        DATE VMS         DATE_DOM
 Comment:       Return format is "dd-Mmm-YYY"
STATUS_CODE                     CHAR(1)          STATUS_CODE_DOM
   .
   .
   .
SQL> --
SQL> -- The following statement demonstrates how to use the COMMENT
SQL> -- ON  statement when you want to use more than one string
SQL> -- literal:
SQL> --
SQL> COMMENT ON COLUMN EMPLOYEES.EMPLOYEE_ID IS
cont> '1: Used in SALARY_HISTORY table as Foreign Key constraint' /
cont> '2: Used in JOB_HISTORY table as Foreign Key constraint';
SQL> SHOW TABLE (COL) EMPLOYEES;
Information for table EMPLOYEES
```

(continued on next page)

Example 3–7 (Cont.) Using the COMMENT ON Statement

```
Columns for table EMPLOYEES:
Column Name                     Data Type        Domain
-----------                     ---------        ------
EMPLOYEE_ID                     CHAR(5)          ID_DOM
 Comment:       1: Used in SALARY_HISTORY table as Foreign Key constraint
                2: Used in JOB_HISTORY table as Foreign Key constraint
 Primary Key constraint EMPLOYEES_PRIMARY_EMPLOYEE_ID
LAST_NAME                       CHAR(14)         LAST_NAME_DOM
FIRST_NAME                      CHAR(10)         FIRST_NAME_DOM
MIDDLE_INITIAL                  CHAR(1)          MIDDLE_INITIAL_DOM
ADDRESS_DATA_1                  CHAR(25)         ADDRESS_DATA_1_DOM
ADDRESS_DATA_2                  CHAR(20)         ADDRESS_DATA_2_DOM
CITY                            CHAR(20)         CITY_DOM
STATE                           CHAR(2)          STATE_DOM
POSTAL_CODE                     CHAR(5)          POSTAL_CODE_DOM
SEX                             CHAR(1)          SEX_DOM
BIRTHDAY                        DATE VMS         DATE_DOM
STATUS_CODE                     CHAR(1)          STATUS_CODE_DOM
```

3.1.2 Commonly Used Show Statements

You may want to enter the HELP SHOW statement to see what other SHOW statements you can try to become more familiar with the mf_personnel sample database. Table 3–1 provides a partial list of SHOW statements for displaying database objects.

Table 3–1 Commonly Used SHOW Statements

To Display . . .	Use the SHOW Statement . . .
All tables and their attributes	SHOW TABLE *
A table and its attributes	SHOW TABLE table-name
Column names in a table	SHOW TABLE (COLUMNS) table-name
A list of tables and views	SHOW TABLE
The database name	SHOW DATABASE
All database indexes	SHOW INDEXES
All indexes defined on one table	SHOW INDEXES ON table-name
All database domains	SHOW DOMAINS
One domain	SHOW DOMAIN domain-name
All views	SHOW VIEWS
One view	SHOW VIEW view-name
All triggers	SHOW TRIGGERS
One trigger	SHOW TRIGGER trigger-name

Reference Reading

The chapter on SQL statements in the *Oracle Rdb7 SQL Reference Manual* contains more information about the SHOW statement.

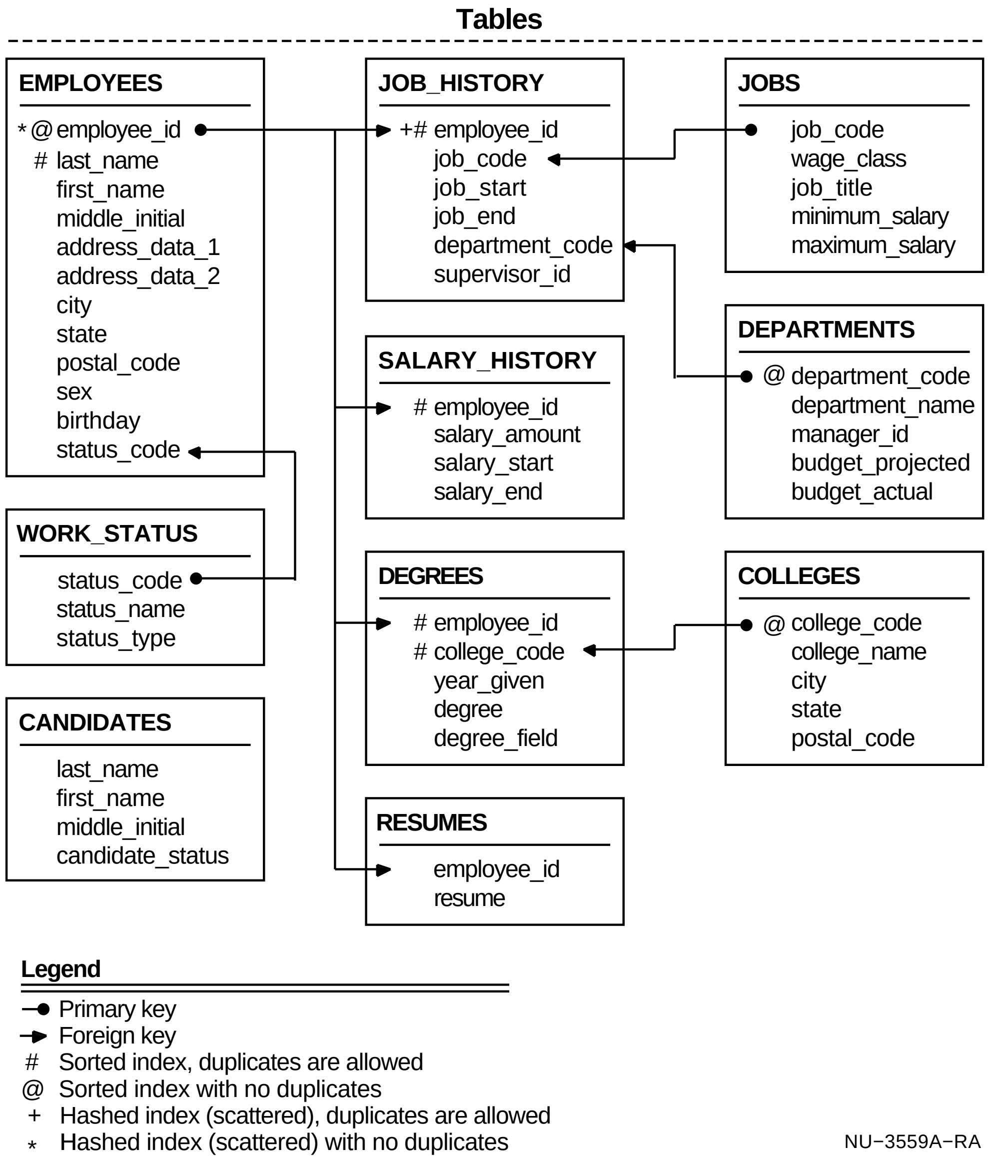
3.2 Summarizing Database Structures in a Diagram

After exploring the database structures you can construct a conceptual diagram of the database. Figure 3–1 provides a conceptual diagram for the multifile mf_personnel sample database. This diagram contains:

- Tables and their columns
- Views and their columns
- The primary key of each table
- The foreign keys in each table
- Sorted indexes
- Hashed indexes

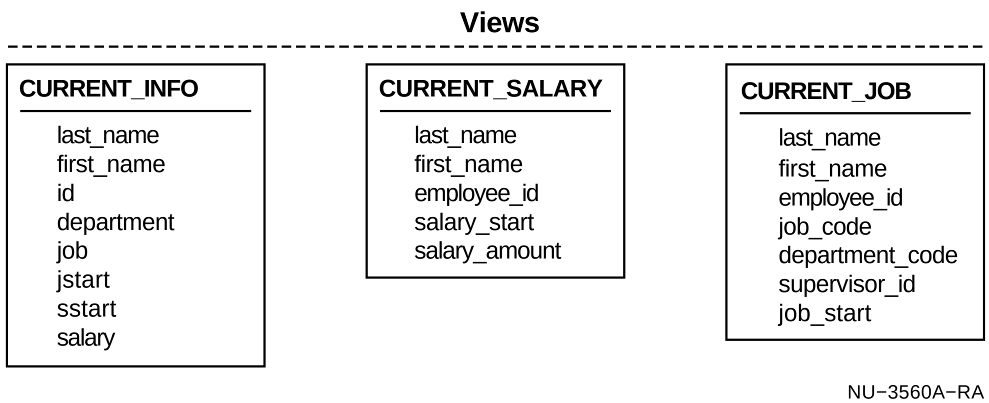
You may want to use this diagram as you go through this manual to help you visualize how the examples are being constructed. The diagram does not describe the domains that the columns are based on or the triggers and constraints defined in the database. You may want to add notations about those structures to the diagram.

Figure 3–1 Conceptual Structure of the mf_personnel Database



(continued on next page)

Figure 3–1 (Cont.) Conceptual Structure of the mf_personnel Database



4 Retrieving Data

The main SQL language statement for retrieving and displaying data is the SELECT statement.

The SELECT statement is used in both interactive SQL and in application programs that use SQL to access an Oracle Rdb database. Because the syntax is similar in both, you can use the SELECT statement interactively to test queries before including them in an application program.

This chapter explains how to write SQL queries using the SELECT statement.

Reference Reading

The *Oracle Rdb7 SQL Reference Manual* contains sections on the interactive SELECT statement and using the SELECT statement in programs.

4.1 Using Examples in This Chapter

To help you understand the examples in this chapter, use the conceptual diagram of the mf_personnel database shown in Figure 3–1.

When trying to duplicate the output of examples in this manual that do not use the ORDER BY clause, you may see displays on your terminal that differ from the displays shown in this manual. This can happen because the default display order for rows in a result table can vary from one execution of the query to the next. Section 4.8 discusses the importance of the ORDER BY clause.

4.2 Retrieving Data from a Table or View

To retrieve data from a table or a view, use the SELECT statement, the simplest form of which is:

Syntax SELECT select-list
FROM table-name;

The format of the simple SELECT statement contains:

- The keyword SELECT followed by a select list, which is a list of one or more columns that you want to retrieve
- The keyword FROM, followed by the name of the table or view that contains the columns in the select list

Example 4–1 shows how to use a simple SELECT statement to retrieve one or more columns from a table.

Example 4–1 Selecting One or More Columns from a Table

```
SQL> --
SQL> -- Get a list of job candidates' last names:
SQL> --
SQL> SELECT LAST_NAME FROM CANDIDATES;
 LAST_NAME
 Wilson
 Schwartz
 Boswick
3 rows selected
```

(continued on next page)

Example 4–1 (Cont.) Selecting One or More Columns from a Table

```
SQL> --
SQL> -- Get a list of employee names:
SQL> --
SQL> SELECT FIRST_NAME, LAST_NAME FROM EMPLOYEES;
 FIRST_NAME   LAST_NAME
 Terry        Smith
 Rick         O'Sullivan
 Stan         Lasch
 Susan        Gray
 Norman       Hastings
 Leslie       Gehr
 Karen        Pfeiffer
   .
   .
   .
 Alvin        Dement
 Peter        Blount
 James        Herbener
 Louie        Ames
100 rows selected
```

SQL creates a result table by retrieving the rows from the specified table or view. A result table contains the data that you requested (retrieved) from the database. It is a temporary table consisting of a set of rows and columns derived from one or more defined tables or views. The interactive display of the result table or view orders the columns from left to right as specified in the select list. SQL also provides the number of rows retrieved as the last line of output.

If you do not know the names of the columns in a table or a view, you can use an asterisk (*) wildcard to display all of the columns, as shown in Example 4–2.

Example 4–2 Selecting All Columns from a Table

```
SQL> --
SQL> -- Display all columns of WORK_STATUS:
SQL> --
SQL> SELECT * FROM WORK_STATUS;
STATUS_CODE STATUS_NAME STATUS_TYPE
0           INACTIVE    RECORD EXPIRED
1           ACTIVE      FULL TIME
2           ACTIVE      PART TIME

3 rows selected.
```

CAUTION

Using the asterisk (*) in an application program is not recommended because the result table produced by the SELECT statement will change if columns are added to or dropped from the defined table or view.

When column values are unknown the database system may insert a null value. When selecting rows that contain null values you will see the word NULL as the column value. Example 4–3 shows a null value for the JOB_END column in some rows. This indicates that the employee is still working in that job.

Example 4–3 Displaying Null Values

```
SQL> --
SQL> -- List employees' job histories:
SQL> --
SQL> SELECT * FROM JOB_HISTORY;
 EMPLOYEE_ID   JOB_CODE   JOB_START     JOB_END       DEPARTMENT_CODE   SUPERVISOR_ID
 00165          ASCK        1-Jul-1975    4-Sep-1977   PHRN              00201
 00165          ASCK        5-Sep-1977    7-Apr-1979   ELGS              00276
 00165          ASCK        8-Apr-1979    7-Mar-1981   MTEL              00248
 00165          ASCK        8-Mar-1981   NULL          MBMF              00227
 00190          MENG        5-Dec-1978    3-Mar-1980   ELMC              00369
   .
   .
   .
```

(continued on next page)

Example 4–3 (Cont.) Displaying Null Values

```
 00416         MENG       20-Mar-1981   NULL          SUNE              00201
 00416         MENG       21-Apr-1977   15-Feb-1980   SUSA              00435
 00416         PRGM       16-Feb-1980   19-Mar-1981   ELEL              00200
274 rows selected
```

4.3 Using Alternative Column Names

You can assign alternative names to any or all of the columns in the select list by following the column name with the keyword AS and another name.

The general syntax of the statement is:

Syntax

SELECT column-name AS name . . .
FROM table-name;

SQL uses the alternative names as column headers when it displays the data. For example, Example 4–4 shows the assignment of shorter alternative names to both of the columns in the select list.

Example 4–4 Assigning an Alternative Column Name

```
SQL> --
SQL> -- Assign shorter names to FIRST_NAME and
SQL> -- LAST_NAME columns:
SQL> --
SQL> SELECT FIRST_NAME AS FIRST, LAST_NAME AS LAST FROM EMPLOYEES;
 FIRST      LAST
 Terry        Smith
 Rick         O'Sullivan
 Stan         Lasch
 Susan        Gray
 Norman       Hastings
 Leslie       Gehr
 Karen        Pfeiffer
    .
    .
    .
100 rows selected
```

Using alternative column names is useful for columns that would otherwise have no name (described in Section 4.4), and alternative names can be used in queries that order output (described in Section 4.8).

4.4 Displaying Value Expressions and Literal Strings

A select list is not limited to a list of column names; it can be any valid value expression. Value expressions allow you to perform arithmetic operations on column values and display column values.

In addition, you can perform operations on character column values and date column values. See Section 4.5 and Section 4.13 for details on performing these types of operations.

The following arithmetic operations can be performed on numerical column values:

- Addition (+)
- Subtraction (–)
- Multiplication (*)
- Division (/)

For example, the select list in Example 4–5 uses a value expression and a literal string to display what each employee's current salary would be with a 10 percent increase.

SQL multiplies the SALARY column value from the CURRENT_INFO view by 1.1, and places the resulting number in the result table. The parentheses in the SELECT statement are optional and were added for clarity. A literal string is also added to each row to describe the output.

Example 4–5 Displaying Computed Values and Literal Strings

```
SQL> --
SQL> -- Compute new employee salaries with a 10% increase:
SQL> --
SQL> SELECT LAST_NAME, 'Salary with a 10% raise: ', (SALARY * 1.1)
cont> FROM CURRENT_INFO;
 LAST_NAME
 Lapointe         Salary with a 10% raise:                  11361.900
 Goldstone        Salary with a 10% raise:                  12663.200
 Gramby           Salary with a 10% raise:                  12241.900
 Reitchel         Salary with a 10% raise:                  19756.000
 Foote            Salary with a 10% raise:                  15260.300
 Mellace          Salary with a 10% raise:                  12260.600
   .
   .
   .
100 rows selected
```

When you include a literal string in a select list, every row in the result table contains the same character value. The literal string must be enclosed in single quotation marks ('). You can avoid the repetition by using an alternative column name, as Example 4–6 shows.

Example 4–6 Using an Alternative Column Name Instead of a Literal String

```
SQL> SELECT LAST_NAME, (SALARY * 1.1) AS TEN_PERCENT_RAISE
cont> FROM CURRENT_INFO;
 LAST_NAME                  TEN_PERCENT_RAISE
 Toliver                            56883.200
 Smith                              12843.600
 Dietrich                           20346.700
 Kilpatrick                         19261.000
 Nash                               57479.400
 Gray                               33968.000
   .
   .
   .
 MacDonald                          92561.700
 Herbener                           57200.000
100 rows selected
```

Performing a division operation results in scientific notation format, as shown in Example 4–7. Section 4.13.1 shows how to use the CAST function to produce a more readable output.

Example 4–7 Dividing Column Values

```
SQL> --
SQL> --  Compute the midpoint salary for each job:
SQL> --
SQL> SELECT JOB_TITLE,
cont> 'Midpoint salary:',
cont> (MINIMUM_SALARY + MAXIMUM_SALARY) / 2
cont> FROM JOBS;
 JOB_TITLE
 Associate Programmer   Midpoint salary:    1.950000000000000E+004
 Clerk                  Midpoint salary:    1.600000000000000E+004
 Assistant Clerk        Midpoint salary:    1.100000000000000E+004
 Department Manager     Midpoint salary:    7.500000000000000E+004
   .
   .
   .
 Systems Analyst        Midpoint salary:    5.000000000000000E+004
 Secretary              Midpoint salary:    1.750000000000000E+004
 Systems Programmer     Midpoint salary:    3.750000000000000E+004
 Vice President         Midpoint salary:    1.125000000000000E+005
15 rows selected
```

4.5 Displaying Concatenated Strings

You can use the string concatenation operator (| |) to link character column values together to provide specific output format. Spaces before or after the operator do not affect concatenation.

The general syntax of the statement is:

Syntax SELECT string1 | | string2 | | . . . string*n*
FROM table-name;

Example 4–8 shows how concatenation can be used to produce specific output.

Example 4–8 Concatenating Strings from Two Columns

```
SQL> --
SQL> -- Interoffice mail is sorted using a code
SQL> -- that combines employee ID and department code.
SQL> -- The two codes are separated with a hyphen.
SQL> -- Print the codes that will be used for each employee:
SQL> --
SQL> SELECT LAST_NAME, DEPARTMENT_CODE ||'-'|| EMPLOYEE_ID AS MAIL_CODE
cont> FROM CURRENT_JOB;
 LAST_NAME        MAIL_CODE
 Smith            MBMF-00165
 O'Sullivan       ELMC-00190
 Hastings         MNFG-00176
 Lasch            SUSO-00187
 Gehr             MBMN-00198
 Gray             SUNE-00169
   .
   .
   .
 Dement           MSCI-00405
 Blount           PRMG-00418
 Herbener         ENG -00471
 Ames             SUNE-00416
100 rows selected
```

4.6 Eliminating Duplicate Rows (DISTINCT)

Whenever a select list does not include a primary key, the default result table or unique index can contain duplicate rows.

To eliminate duplicate rows, use the DISTINCT keyword, which causes the SELECT statement to retrieve only unique rows.

The general syntax of the statement is:

Syntax SELECT DISTINCT select-list
FROM table-name;

The following query produces many duplicate rows:

```
SQL> --
SQL> -- List the state where each employee lives:
SQL> --
SQL> SELECT STATE FROM EMPLOYEES;
 STATE
 NH
 NH
 NH
 NH
   .
   .
   .
 NH
 MA
 NH
100 rows selected
```

Example 4–9 uses the DISTINCT keyword to eliminate duplicate rows.

Example 4–9 Using the DISTINCT Keyword to Eliminate Duplicates

```
SQL> --
SQL> -- List each state where employees live:
SQL> --
SQL> SELECT DISTINCT STATE FROM EMPLOYEES;
 STATE
 CT
 NH
 MA
3 rows selected.
SQL> --
SQL> -- List unique combinations of cities and states
SQL> -- where employees live:
SQL> --
SQL> SELECT DISTINCT CITY, STATE FROM EMPLOYEES;
 CITY                   STATE
 Acworth                NH
 Alstead                NH
 Alton                  NH
 Bennington             MA
 Boscawen               NH
   .
   .
   .
```

(continued on next page)

Example 4–9 (Cont.) Using the DISTINCT Keyword to Eliminate Duplicates

```
 Winnisquam           NH
 Wolfeboro            NH
 Wonalancet           NH
35 rows selected
```

4.7 Using the ALL Keyword to Include All Rows Explicitly

SQL includes an ALL keyword that explicitly requests that duplicate rows not be eliminated from the result table (the default behavior). Thus, the following queries have the same meaning:

```
SQL> SELECT STATE FROM EMPLOYEES;
```

```
SQL> SELECT ALL STATE FROM EMPLOYEES;
```

Use the ALL keyword if you prefer not to depend on the default behavior, which may be the case if you intend to port your application to other database systems.

4.8 Retrieving Rows in Sorted Order (ORDER BY)

To sort the rows of a result table in a particular way, use the ORDER BY clause in your query. SQL sorts the rows by the values of the columns listed in the ORDER BY clause.

The general syntax of the statement is:

Syntax

SELECT select-list
FROM table-name
ORDER BY column-name-or-number [ASC-or-DESC];

When using the ORDER BY clause you can:

- Order by one or more column values
- Specify the column's name or the ordinal position of the column in the select list
- Order by a computed value

- Use ascending (ASC) or descending (DESC) sort order
  - Ascending is the default

In Example 4–10 the rows are ordered by JOB_CODE in ascending order, which is the default. In the example, the JOB_CODE column contains character data. It will be ordered by ascending ASCII value.

Example 4–10 Using the ORDER BY Clause with the Default Setting

```
SQL> --
SQL> -- List job codes and wage classes of jobs.
SQL> -- Order output rows by the JOB_CODE column:
SQL> --
SQL> SELECT JOB_CODE, WAGE_CLASS
cont> FROM JOBS
cont> ORDER BY JOB_CODE;
 JOB_CODE   WAGE_CLASS
 ADMN       3
 APGM       4
 ASCK       2
 CLRK       2
 DMGR       4
 DSUP       4
 EENG       4
 JNTR       1
 MENG       4
 PRGM       4
 PRSD       4
 SANL       4
 SCTR       3
 SPGM       4
 VPSD       4
15 rows selected
```

You can use the optional keywords ASC to specify ascending (low-to-high) order, and DESC to specify descending (high-to-low) order. If the ordered column contains null values they will sort higher than other values. Example 4–11 shows the results of ordering the SALARY_AMOUNT column using the DESC keyword.

Example 4–11 Using the ORDER BY Clause with the DESC Keyword

```
SQL> --
SQL> -- List all salaries in the company from highest
SQL> -- to lowest:
SQL> --
SQL> SELECT SALARY_AMOUNT, LAST_NAME
cont> FROM CURRENT_SALARY
cont> ORDER BY SALARY_AMOUNT DESC;
 SALARY_AMOUNT   LAST_NAME
    $93,340.00   Crain
    $87,143.00   Myotte
    $86,124.00   Mistretta
    $85,150.00   Harrison
    $84,147.00   MacDonald
   .
   .
   .
    $10,664.00   Wood
    $10,661.00   Clarke
    $10,659.00   Dietrich
    $10,329.00   Lapointe
    $10,188.00   Johnson
     $8,951.00   Sarkisian
     $8,687.00   Jackson
100 rows selected
```

If you have a computed column in an ORDER BY clause, you can identify it by its ordinal position number or use the AS clause in the SELECT statement to give the computed column a name.

Example 4–12 shows two queries that retrieve the same data. The first one sorts the output by an alternative column name while the second uses the column's ordinal position.

Example 4–12 Using the ORDER BY Clause with a Computed Column

```
SQL> --
SQL> -- Order a computed column by an alternative column name:
SQL> --
SQL> SELECT LAST_NAME, SALARY_AMOUNT * 1.1 AS NEW_SALARY_AMOUNT
cont> FROM CURRENT_SALARY
cont> ORDER BY NEW_SALARY_AMOUNT DESC;
 LAST_NAME           NEW_SALARY_AMOUNT
 Crain                      102674.000
 Myotte                      95857.300
 Mistretta                   94736.400
 Harrison                    93665.000
 MacDonald                   92561.700
   .
   .
   .
 Clarke                      11727.100
 Dietrich                    11724.900
 Lapointe                    11361.900
 Johnson                     11206.800
 Sarkisian                    9846.100
 Jackson                      9555.700
100 rows selected
SQL> --
SQL> -- Order a computed column by its ordinal position number:
SQL> --
SQL> SELECT LAST_NAME, SALARY_AMOUNT * 1.1 AS NEW_SALARY_AMOUNT
cont> FROM CURRENT_SALARY
cont> ORDER BY 2 DESC;
 LAST_NAME           NEW_SALARY_AMOUNT
 Crain                      102674.000
 Myotte                      95857.300
 Mistretta                   94736.400
 Harrison                    93665.000
 MacDonald                   92561.700
   .
   .
   .
 Clarke                      11727.100
 Dietrich                    11724.900
 Lapointe                    11361.900
 Johnson                     11206.800
 Sarkisian                    9846.100
 Jackson                      9555.700
100 rows selected
```

Whether you identify columns in an ORDER BY clause using a name or a number, the columns are called sort keys. When you use multiple sort keys, SQL treats the first column as the major sort key and successive columns as minor sort keys. That is, it first sorts the rows into groups based on the first value expression. Then, it uses the second value expression to sort the rows within each group and so on.

Example 4–13 shows how to use two sort keys.

Example 4–13 Using the ORDER BY Clause with Two Sort Keys

```
SQL> --
SQL> -- List wage classes and job codes,
SQL> -- order by wage class from highest code to lowest,
SQL> -- then by job codes in ascending order:
SQL> --
SQL> SELECT WAGE_CLASS, JOB_CODE
cont> FROM JOBS
cont> ORDER BY 1 DESC, 2 ASC;
 WAGE_CLASS   JOB_CODE
 4            APGM
 4            DMGR
 4            DSUP
 4            EENG
 4            MENG
 4            PRGM
 4            PRSD
 4            SANL
 4            SPGM
 4            VPSD
 3            ADMN
 3            SCTR
 2            ASCK
 2            CLRK
 1            JNTR
15 rows selected
```

If you use minor (second or subsequent) sort keys you should specify the sort order by explicitly using the ASC or DESC keywords. If you do not specify ASC or DESC for the second or subsequent sort keys, SQL issues a warning message and uses the order that you specified for the preceding sort key. If you do not specify the sort order with the first sort key, the default order is ascending for the first sort key and any subsequent sort keys.

4.9 Retrieving a Limited Number of Rows (LIMIT TO)

If you want to limit your result table to a specific number of rows, use the LIMIT TO clause.

The general syntax of the statement is:

Syntax

```
SELECT    select-list
FROM    table-name
[ORDER BY column-name-or-number]
LIMIT TO    row-limit    ROWS;
```

Example 4–14 shows how to select just the first five rows from the CURRENT_SALARY view.

Example 4–14 Using the LIMIT TO Clause to Control Output

```
SQL> --
SQL> -- List the 5 highest salaries in the company:
SQL> --
SQL> SELECT SALARY_AMOUNT, LAST_NAME
cont> FROM CURRENT_SALARY
cont> ORDER BY SALARY_AMOUNT DESC
cont> LIMIT TO 5 ROWS;
 SALARY_AMOUNT   LAST_NAME
    $93,340.00   Crain
    $87,143.00   Myotte
    $86,124.00   Mistretta
    $85,150.00   Harrison
    $84,147.00   MacDonald
5 rows selected
```

4.10 Retrieving a Subset of Rows (WHERE)

Use the WHERE clause in a SELECT statement to retrieve data from only those rows in a table or view that satisfy certain criteria. The WHERE clause follows the FROM clause in a SELECT statement. It begins with the keyword WHERE followed by a WHERE predicate.

A WHERE predicate is a group of one or more conditions that SQL evaluates as either true, false, or unknown. Using the WHERE clause causes SQL to test rows with the condition specified in the predicate before including them in the result table.

The general syntax of the statement is:

Syntax	SELECT select-list FROM table-name WHERE condition;

In Example 4–15, the WHERE clause specifies a search condition consisting of a single predicate that requires the value of the FIRST_NAME column to be equal to the literal string 'Norman'.

Example 4–15 Using the WHERE Clause

```
SQL> --
SQL> -- List all employees named Norman:
SQL> --
SQL> SELECT FIRST_NAME, LAST_NAME
cont> FROM EMPLOYEES
cont> WHERE FIRST_NAME = 'Norman';
 FIRST_NAME LAST_NAME
 Norman     Hastings
 Norman     Nash
 Norman     Lasch
 Norman     Roberts
4 rows selected.
```

For each row in the specified table or view, SQL evaluates the search condition as having one of three possible values:

- True. If a row in the table or view being searched satisfies the condition, SQL evaluates the search condition as true and includes that row in the result table.
- False. If a row in the table or view being searched does not satisfy the condition, SQL evaluates the search condition as false and does not include that row in the result table.
- Unknown. If the search condition attempts to compare a data value to a null value, then SQL evaluates the search condition as unknown and does not include the row in the result table.

In other words, the result table contains only those rows for which the search condition is true.

4.10.1 Understanding Predicates

SQL provides several types of predicates. The ones that you can use in a simple query are listed in this section. There are others that are used in an advanced query structure called a subquery that is explained in Chapter 6.

- The **comparison** predicates (=, <>, <, <=, >, >=) compare two value expressions. For details, see Section 4.10.2.
- The **range test** predicate (BETWEEN) tests whether a value expression falls within a specified range of values. For details, see Section 4.10.3.
- The **set membership** predicate (IN) tests whether a value expression matches one of a set of values. For details, see Section 4.10.4.
- The **string comparison** predicates (STARTING WITH and CONTAINING) test whether a character column value matches a specified string. For details, see Section 4.10.5.
- The **pattern matching** predicate (LIKE) tests whether a character column value matches a specified pattern. For details, see Section 4.10.6.
- The **null value** predicate (IS NULL) tests whether a column has a null value. For details, see Section 4.10.7.

See the *Oracle Rdb7 SQL Reference Manual* for more detailed information about using predicates.

4.10.2 Using Comparison Predicates

Comparison predicates use comparison operators (called relational operators in most high-level programming languages) to compare two value expressions according to the comparison rules specified in the *Oracle Rdb7 SQL Reference Manual*. The comparison operators are:

=	equal to
<>	not equal to
>	greater than
>=	greater than or equal to
<	less than
<=	less than or equal to

You can use numeric, text, and date-time values in a comparison predicate.

Example 4–16 shows the use of several comparison operators.

Example 4–16 Using Comparison Operators

```
SQL> --
SQL> -- Which jobs have a minimum salary of at least $20,000?
SQL> --
SQL> SELECT JOB_TITLE, MINIMUM_SALARY
cont> FROM JOBS
cont> WHERE MINIMUM_SALARY >= 20000;
 JOB_TITLE              MINIMUM_SALARY
 Department Manager         $50,000.00
 Dept. Supervisor           $36,000.00
 Electrical Engineer        $20,000.00
 Mechanical Engineer        $20,000.00
 Programmer                 $20,000.00
 Company President         $100,000.00
 Systems Analyst            $40,000.00
 Systems Programmer         $25,000.00
 Vice President             $75,000.00
9 rows selected
SQL> --
SQL> -- Which jobs have a wage class greater than 2?
SQL> --
SQL> SELECT * FROM JOBS WHERE WAGE_CLASS > '2';
 JOB_CODE   WAGE_CLASS   JOB_TITLE              MINIMUM_SALARY   MAXIMUM_SALARY
 APGM       4            Associate Programmer       $15,000.00       $24,000.00
 DMGR       4            Department Manager         $50,000.00      $100,000.00
 DSUP       4            Dept. Supervisor           $36,000.00       $60,000.00
 EENG       4            Electrical Engineer        $20,000.00       $40,000.00
 ADMN       3            Admin. Assistant           $10,000.00       $17,000.00
 MENG       4            Mechanical Engineer        $20,000.00       $35,000.00
 PRGM       4            Programmer                 $20,000.00       $35,000.00
 PRSD       4            Company President         $100,000.00      $200,000.00
 SANL       4            Systems Analyst            $40,000.00       $60,000.00
 SCTR       3            Secretary                  $10,000.00       $25,000.00
 SPGM       4            Systems Programmer         $25,000.00       $50,000.00
 VPSD       4            Vice President             $75,000.00      $150,000.00
12 rows selected
SQL> --
SQL> -- List last names of employees from A to Babbin (inclusive):
SQL> --
SQL> SELECT EMPLOYEE_ID, LAST_NAME
cont> FROM EMPLOYEES
cont> WHERE LAST_NAME <= 'Babbin';
 EMPLOYEE_ID   LAST_NAME
 00416         Ames
 00374         Andriola
 00207         Babbin
3 rows selected
```

(continued on next page)

Example 4–16 (Cont.) Using Comparison Operators

```
SQL> --
SQL> -- Which employees started their current job before January 1, 1982?
SQL> --
SQL> SELECT LAST_NAME, JSTART
cont> FROM CURRENT_INFO
cont> WHERE JSTART < '1-JAN-1982'
cont> ORDER BY JSTART;
 LAST_NAME        JSTART
 Kinmonth         12-Feb-1979
 Roberts          19-Mar-1979
 Reitchel          3-Apr-1979
 Goldstone        28-May-1979
   .
   .
   .
 Andriola         15-Oct-1981
 Connolly         23-Nov-1981
 Johnston         25-Nov-1981
 Dement           10-Dec-1981
85 rows selected
SQL> --
SQL> -- Who had their salary changed last when they changed jobs?
SQL> --
SQL> SELECT LAST_NAME
cont> FROM CURRENT_INFO
cont> WHERE JSTART = SSTART
cont> ORDER BY LAST_NAME;
 LAST_NAME
 Jackson
 Johnston
 Keisling
 Silver
 Ulrich
5 rows selected
```

Like most high-level programming languages, the meaning of the comparison depends on the data types of the value expressions.

- When you compare numeric values the comparison is based on arithmetic; `a > b` means a is greater than b.
- When you compare character strings the comparison is based on collating order; `a > b` means a collates after b. Shorter strings will be padded with trailing spaces.
- When you compare date-time values, as shown in Chapter 8, the comparison is based on chronological order; `a > b` means a is more recent than b (for example, June 1 1995 > January 1 1995) or a is further in the future than b (for example, July 1 2000 > January 1 2000).

In a search condition, comparing a data value against a column that contains a null value causes the search condition to be evaluated as unknown; SQL does not include the row in the result table.

To find rows in which a particular column contains null values, use the IS NULL predicate, as explained in Section 4.10.7.

4.10.3 Using the Range Test Predicate ([NOT] BETWEEN)

The BETWEEN predicate retrieves rows that are greater than or equal to the first value and less than or equal to a second value. In other words, `x BETWEEN y AND z` is equivalent to `x >= y AND x <= z`.

The general syntax of the statement is:

Syntax

```
SELECT   select-list
FROM   table-name
WHERE   column-name
[NOT]BETWEEN   lower-value AND upper-value;
```

Be sure to specify the lower value first. If you specify the higher value first, SQL returns no rows. Example 4–17 shows the use of BETWEEN to perform a range test.

Example 4–17 Using the BETWEEN Predicate

```
SQL> --
SQL> -- Find jobs with a minimum salary between $10,000 and $20,000:
SQL> --
SQL> SELECT JOB_TITLE, MINIMUM_SALARY
cont> FROM JOBS
cont> WHERE MINIMUM_SALARY BETWEEN 10000 AND 20000;
 JOB_TITLE              MINIMUM_SALARY
 Associate Programmer       $15,000.00
 Clerk                      $12,000.00
 Electrical Engineer        $20,000.00
 Admin. Assistant           $10,000.00
 Janitor                    $10,000.00
 Mechanical Engineer        $20,000.00
 Programmer                 $20,000.00
 Secretary                  $10,000.00
8 rows selected
```

You might also want to use the BETWEEN predicate to retrieve a list of character data.

To include all last names starting with B or C, for example, type a multicharacter string to extend the range through all possible character combinations that names starting with B or C can have. Example 4–18 shows how to do this.

Example 4–18 Using the BETWEEN Predicate with Character Data

```
SQL> --
SQL> -- Find employees with last names beginning with B or C:
SQL> --
SQL> SELECT LAST_NAME FROM EMPLOYEES WHERE LAST_NAME BETWEEN 'B' AND 'Czzzz';
 LAST_NAME
 Babbin
 Bartlett
 Bartlett
 Belliveau
 Blount
 Boyd
 Boyd
 Brown
 Burton
 Canonica
 Clairmont
 Clarke
 Clarke
 Clarke
 Clinton
 Clinton
 Connolly
 Crain
18 rows selected
```

The NOT BETWEEN predicate is the negated form of the BETWEEN predicate. In other words, `x NOT BETWEEN y AND z` is equivalent to `x < y AND x > z`. Example 4–19 shows how to use this form of the BETWEEN predicate.

Example 4–19 Using the NOT BETWEEN Predicate

```
SQL> --
SQL> -- Find all salaries less than $20,000 and more
SQL> -- than $30,000:
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME, SALARY
cont> FROM CURRENT_INFO
cont> WHERE SALARY NOT BETWEEN 20000 AND 30000
cont> ORDER BY SALARY DESC;
 LAST_NAME        FIRST_NAME         SALARY
 Crain            Jesse          $93,340.00
 Myotte           Charles        $87,143.00
 Mistretta        Kathleen       $86,124.00
 Harrison         Lisa           $85,150.00
 MacDonald        Johanna        $84,147.00
 .
 .
 .
 Clarke           Mary           $10,661.00
 Dietrich         Alan           $10,659.00
 Lapointe         Jo Ann         $10,329.00
 Johnson          Bill           $10,188.00
 Sarkisian        Dean            $8,951.00
 Jackson          Mary Lou        $8,687.00
75 rows selected
```

4.10.4 Using the Set Membership Predicate ([NOT] IN)

You can use the IN predicate to retrieve rows in which a column value matches any value in a value list. Enclose the value list in parentheses. The IN predicate allows you to make both numeric and text comparisons. In text comparisons, the IN predicate is case sensitive and ignores any trailing space characters stored in a column.

The general syntax of the statement is:

Syntax	SELECT select-list FROM table-name WHERE column-name [NOT] IN (value1, value2, . . . value*n*);

Example 4–20 shows how to use the IN predicate.

Example 4–20 Using the IN Predicate

```
SQL> --
SQL> -- Who works as a programmer or system analyst?
SQL> -- Codes of those jobs:
SQL> -- APGM - Associate Programmer
SQL> -- PRGM - Programmer
SQL> -- SANL - System Analyst
SQL> -- SPGM - System Programmer
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME, JOB_CODE
cont> FROM CURRENT_JOB
cont> WHERE JOB_CODE IN ('APGM','PRGM','SANL','SPGM')
cont> ORDER BY LAST_NAME;
 LAST_NAME        FIRST_NAME   JOB_CODE
 Brown            Nancy        SANL
 Burton           Frederick    PRGM
 Canonica         Rick         APGM
 Clinton          Kathleen     PRGM
 D'Amico          Aruwa        PRGM
 Dallas           Meg          SANL
   .
   .
   .
 Stornelli        Marty        SPGM
 Sullivan         Len          PRGM
 Ulrich           Christine    APGM
 Villari          Christine    SANL
 Vormelker        Daniel       PRGM
34 rows selected
```

(continued on next page)

Example 4–20 (Cont.) Using the IN Predicate

```
SQL> --
SQL> -- List which job titles receive the lowest salaries:
SQL> --
SQL> SELECT JOB_TITLE, MINIMUM_SALARY
cont> FROM JOBS
cont> WHERE MINIMUM_SALARY IN (10000,15000,20000)
cont> ORDER BY MINIMUM_SALARY;
 JOB_TITLE              MINIMUM_SALARY
 Secretary                  $10,000.00
 Admin. Assistant           $10,000.00
 Janitor                    $10,000.00
 Associate Programmer       $15,000.00
 Programmer                 $20,000.00
 Mechanical Engineer        $20,000.00
 Electrical Engineer        $20,000.00
7 rows selected
```

The NOT IN predicate is the negated form of the IN predicate. It retrieves rows in which a column value does not match a specified value or values, as shown in Example 4–21.

Example 4–21 Using the NOT IN Predicate

```
SQL> --
SQL> -- List job codes and titles not in wage class 4:
SQL> --
SQL> SELECT JOB_CODE, WAGE_CLASS, JOB_TITLE
cont> FROM JOBS
cont> WHERE WAGE_CLASS NOT IN '4';
 JOB_CODE   WAGE_CLASS   JOB_TITLE
 CLRK       2            Clerk
 ASCK       2            Assistant Clerk
 ADMN       3            Admin. Assistant
 JNTR       1            Janitor
 SCTR       3            Secretary
5 rows selected
```

Another way to use the IN predicate is with subqueries. This is discussed in Chapter 6.

4.10.5 Using String Comparison Predicates

The string comparison predicates are:

- CONTAINING
- STARTING WITH

They are used to find specific text strings.

The general syntax of the statements are:

Syntax

```
SELECT   select-list
FROM   table-name
WHERE   column-name
string-comparison-predicate   'text-string';
```

The CONTAINING predicate retrieves rows where the data value in a column contains a specified substring. The CONTAINING predicate is not case sensitive. For example:

```
SQL> SELECT DISTINCT LAST_NAME
cont> FROM EMPLOYEES
cont> WHERE LAST_NAME CONTAINING 'RO';
 LAST_NAME
 Brown
 McElroy
 Roberts
 Robinson
 Rodrigo
5 rows selected
```

Although 'RO' is typed in all uppercase letters, SQL still returns all combinations of 'RO' in uppercase and lowercase letters.

The STARTING WITH predicate is similar to CONTAINING except that the comparison is done against a specific string of characters.

The STARTING WITH predicate is case sensitive. The following query does not return any rows because it is searching for an uppercase 'O'.

```
SQL> SELECT DISTINCT LAST_NAME
cont> FROM EMPLOYEES
cont> WHERE LAST_NAME STARTING WITH 'RO';
0 rows selected
```

Example 4–22 shows the use of the STARTING WITH and CONTAINING predicates.

Example 4–22 Using the STARTING WITH and CONTAINING Predicates

```
SQL> --
SQL> -- Find all employees with last names starting with ’Ro’:
SQL> --
SQL> SELECT DISTINCT LAST_NAME
cont> FROM EMPLOYEES
cont> WHERE LAST_NAME STARTING WITH ’Ro’;
 LAST_NAME
 Roberts
 Robinson
 Rodrigo
3 rows selected
SQL> --
SQL> -- List all Engineering departments:
SQL> --
SQL> SELECT DEPARTMENT_NAME, DEPARTMENT_CODE
cont> FROM DEPARTMENTS
cont> WHERE DEPARTMENT_NAME CONTAINING ’ENGINEERING’;
 DEPARTMENT_NAME                  DEPARTMENT_CODE
 Electronics Engineering          ELEL
 Large Systems Engineering        ELGS
 Mechanical Engineering           ELMC
 Engineering                      ENG
4 rows selected
```

4.10.6 Using the Pattern Matching Predicate ([NOT] LIKE)

The LIKE predicate retrieves rows where the character value in a column matches a specified pattern. (You can use the LIKE predicate for text comparisons only).

The general syntax of the statement is:

Syntax

```
SELECT   select-list
FROM   table-name
WHERE   column-name
[NOT] LIKE   ’text-string’
[IGNORE CASE]
[ESCAPE ’character’];
```

To represent in a pattern any additional characters in a column value that are not significant to your search, include the following wildcard characters at the beginning, at the end, or in the middle of your character string:

- The percent sign (%) character matches zero or more characters.
- The underscore (_) character matches exactly one character.

By default, the LIKE predicate is case sensitive. To make it case insensitive, use the IGNORE CASE keyword. Example 4–23 shows the use of the LIKE predicate.

Example 4–23 Using the LIKE Predicate

```
SQL> --
SQL> -- Find any last name that starts with 'Harri' and ends with 'on':
SQL> -- (Looking for Ms. Harrison, or does she spell it 'Harrisson'?)
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME
cont> FROM EMPLOYEES
cont> WHERE LAST_NAME LIKE 'Harri%on%';
 LAST_NAME        FIRST_NAME
 Harrington       Margaret
 Harrison         Lisa
2 rows selected
SQL> --
SQL> -- Using the underscore (_)
SQL> -- will find only last names with one letter missing.
SQL> -- IGNORE CASE is used because LIKE is case sensitive:
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME
cont> FROM EMPLOYEES
cont> WHERE LAST_NAME LIKE 'HARRI_ON%'
cont> IGNORE CASE;
 LAST_NAME        FIRST_NAME
 Harrison         Lisa
1 row selected
```

The LIKE predicate does not ignore trailing spaces in character data values. If you do not terminate the pattern with a specific number of spaces or a wildcard character, the query fails to match data values with trailing spaces. For example:

```
SQL> SELECT LAST_NAME
cont> FROM EMPLOYEES
cont> WHERE LAST_NAME LIKE '%la' IGNORE CASE;
0 rows selected
```

To search for patterns containing percent sign or underscore characters, use the ESCAPE keyword to specify an escape character, which is a special character that causes SQL to temporarily treat a wildcard character as an ordinary character. This example finds values containing the string AAA_BBB:

```
SQL> SELECT   . . .
cont> FROM     . . .
cont> WHERE    . . .   LIKE '%AAA\_BBB%' ESCAPE '\';
```

The ESCAPE keyword specifies that backslash (\ ) is the escape character. The combination _ causes SQL to treat the underscore as an ordinary character, rather than as a wildcard. Place the character that you designate as the escape character before the wildcard character that you are searching for.

When choosing an escape character, try to find a character that does not exist in the pattern that you are searching for. For example, suppose that you intend to use the backslash character as an escape character. You can use the LIKE predicate to see if any of the rows of data contain a backslash character:

```
SQL> SELECT LAST_NAME
cont> FROM EMPLOYEES
cont> WHERE LAST_NAME LIKE '%\%';
```

Table 4–1 summarizes the common patterns that you can search for using the LIKE predicate.

Table 4–1 Summary of LIKE Pattern Matching

LIKE Patterns	Explanation
`WHERE LAST_NAME LIKE '_er%'`	Finds values containing the string "er" when preceded by one character and followed by zero or multiple characters. Would find the names Vers or Bernard, but not Oliver, Erquist, or Averly.
`WHERE LAST_NAME LIKE '%er_'`	Finds values containing the string "er" when preceded by zero or multiple characters and followed by one character. Would find Vers, but only if Vers were stored in a 4-character column or in a column defined as varying character.
`WHERE LAST_NAME LIKE '%er%' IGNORE CASE`	Finds values containing the string "er", in uppercase or lowercase, when preceded and/or followed by zero or multiple characters. Would find the names Oliver, Erquist, Vers, Bernard, and Averly.
`WHERE LAST_NAME LIKE 'Er%'`	Finds values starting with the string "Er" followed by zero or multiple characters. Would find Erquist, but not Oliver, Bernard, Averly, or Vers.
`WHERE LAST_NAME LIKE '%er'`	Finds values ending with or matching the string "er" with no spaces following it. Would find "er" only in a 2-character or varying character column, and Oliver only in a 6-character or varying character column.
`WHERE LAST_NAME LIKE 'er'`	Finds values matching the string "er" but only in a 2-character column.
`WHERE COLLEGE_CODE LIKE '%+_%' ESCAPE '+';`	Finds values containing the character "_" when preceded and/or followed by zero or multiple characters. The character "+" is the escape character.

The NOT LIKE predicate is the negated form of the LIKE predicate. You can use the NOT LIKE predicate to perform an "everything but . . . " kind of a search. The NOT LIKE predicate adheres to the same rules as LIKE where it is case sensitive by default and does not ignore trailing spaces. Example 4–24 shows how to use the NOT LIKE predicate.

Example 4–24 Using the NOT LIKE Predicate

```
SQL> --
SQL> -- Find all employees with no 'a'
SQL> -- in their last name:
SQL> --
SQL> SELECT LAST_NAME
cont> FROM EMPLOYEES
cont> WHERE LAST_NAME NOT LIKE '%a%' IGNORE CASE;
 LAST_NAME
 Blount
 Boyd
 Boyd
 Brown
 Burton
    .
    .
    .
 Stornelli
 Toliver
 Ulrich
 Vormelker
 Wood
 Ziemke
50 rows selected
```

4.10.7 Using the Null Value Predicate (IS [NOT] NULL)

As explained in Section 4.10.2, comparing a data value against a column that contains a null value causes a search condition to be evaluated as unknown; SQL does not include the row in the result table. To find rows in which a particular column contains a null value, use the IS NULL predicate.

The general syntax of the statement is:

Syntax

```
SELECT   select-list
FROM   table-name
WHERE   column-name   IS [NOT] NULL;
```

Example 4–25 shows how to search for null values.

Example 4–25 Checking for Null Values

```
SQL> --
SQL> -- List current job codes of all employees:
SQL> --
SQL> SELECT EMPLOYEE_ID, JOB_CODE, JOB_START, JOB_END
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NULL
cont> ORDER BY EMPLOYEE_ID;
 EMPLOYEE_ID   JOB_CODE   JOB_START     JOB_END
 00164         DMGR       21-Sep-1981   NULL
 00165         ASCK        8-Mar-1981   NULL
 00166         DMGR       12-Aug-1981   NULL
 00167         APGM       26-Aug-1981   NULL
    .
    .
    .
 00416         MENG       20-Mar-1981   NULL
 00418         DMGR       16-Sep-1980   NULL
 00435         VPSD       17-Nov-1980   NULL
 00471         DMGR       26-Jun-1980   NULL
100 rows selected
SQL> --
SQL> -- Who does not have a middle initial?
SQL> --
SQL> SELECT LAST_NAME, MIDDLE_INITIAL, FIRST_NAME
cont> FROM EMPLOYEES
cont> WHERE MIDDLE_INITIAL IS NULL
cont> ORDER BY LAST_NAME;
 LAST_NAME        MIDDLE_INITIAL   FIRST_NAME
 Bartlett         NULL             Wes
 Belliveau        NULL             Paul
 Blount           NULL             Peter
 Brown            NULL             Nancy
 Clairmont        NULL             Rick
    .
    .
    .
 Siciliano        NULL             George
 Tarbassian       NULL             Louis
 Villari          NULL             Christine
 Watters          NULL             Cora
 Wood             NULL             Brian
36 rows selected
```

To select rows in which a particular column contains missing values and stored values, use a search condition with an IS NULL predicate and another predicate. Example 4–26 shows how to use the IS NULL predicate with another predicate.

Example 4–26 Using the IS NULL Predicate with Another Predicate

```
SQL> --
SQL> -- Find all employees who were active on or since 1-Jan-1981:
SQL> --
SQL> SELECT EMPLOYEE_ID, JOB_CODE, JOB_END
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NULL
cont> OR JOB_END >= '01-Jan-1981'
ORDER BY EMPLOYEE_ID;
EMPLOYEE_ID   JOB_CODE   JOB_END
 00164         SPGM       20-Sep-1981
 00164         DMGR       NULL
 00165         ASCK        7-Mar-1981
 00165         ASCK       NULL
 00166         APGM       11-Aug-1981
 00166         DMGR       NULL
 00167         APGM       25-Aug-1981
   .
   .
   .
 00415         VPSD       NULL
 00416         MENG       NULL
 00416         PRGM       19-Mar-1981
 00418         DMGR       NULL
 00435         VPSD       NULL
 00471         DMGR       NULL
149 rows selected
```

To use the IS NULL predicate effectively, you must understand the logical design of the database. A null value may mean only that the column value was omitted when the row was last updated, or it may have some special significance. For example, if the value of a column represents the end of a period of time, a null value typically indicates that the period of time has not yet ended, thus the row contains current information. For example:

```
SQL> --
SQL> -- Find how many different jobs employee 00164 has had:
SQL> --
SQL> SELECT EMPLOYEE_ID, JOB_CODE, JOB_END
cont> FROM JOB_HISTORY
cont> WHERE EMPLOYEE_ID = '00164';
 EMPLOYEE_ID   JOB_CODE   JOB_END
 00164         SPGM       20-Sep-1981
 00164         DMGR       NULL
2 rows selected
```

In the JOB_HISTORY table, the row with information about the current job of an employee has a null value stored in the JOB_END column. A value is stored in the JOB_END column when the employee starts a new job or leaves the company. The employee with the ID 00164 has held two jobs in the company. To find the employee's current job (or jobs):

```
SQL> SELECT EMPLOYEE_ID, JOB_CODE, JOB_END
cont> FROM JOB_HISTORY
cont> WHERE EMPLOYEE_ID = '00164'
cont> AND JOB_END IS NULL;
 EMPLOYEE_ID   JOB_CODE   JOB_END
 00164         DMGR       NULL
1 row selected
```

To find rows that have a value stored in a particular column, use the IS NOT NULL predicate. Example 4–27 shows how to use the IS NOT NULL predicate to list all the previous jobs of each employee.

Example 4–27 Using the IS NOT NULL Predicate

```
SQL> --
SQL> -- List previous jobs of employees:
SQL> --
SQL> SELECT EMPLOYEE_ID, JOB_CODE
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NOT NULL;
cont> ORDER BY EMPLOYEE_ID;
 EMPLOYEE_ID   JOB_CODE
 00164         SPGM
 00165         ASCK
 00165         ASCK
 00165         ASCK
 00166         APGM
   .
   .
   .
 00435         VPSD
 00471         DMGR
 00471         DMGR
174 rows selected
```

The IS NOT NULL predicate was used in Example 4–27 to find all rows in the JOB_HISTORY table where the JOB_END column held a date to indicate that the job had ended for that employee.

4.11 Using Conditional and Boolean Operators

A **conditional operator** is a keyword that specifies how you want to compare value expressions in a predicate. In a few cases, more than one SQL keyword or character represents one operator (not equal (<>) or = ANY, for example).

Boolean operators (NOT, AND, and OR) are keywords that operate on the conditions rather than the values. Boolean operators allow you to negate, combine, or list alternative conditions when you specify the criteria used to search tables and select data. Table 4–2 summarizes how these operators are used.

Table 4–2 Boolean Operators

Operator	Use to Select Rows That . . .
AND	Satisfy both simple conditions.
OR	Satisfy either one or both conditions.
NOT	Do not satisfy the simple condition.

The predicate in a WHERE clause may include one simple condition or a negated condition (a condition preceded by NOT), or it may include multiple conditions affected by one or more Boolean operators.

Example 4–28 shows how to use complex predicates with conditions.

Example 4–28 Combining Conditions in Predicates

```
SQL> --
SQL> -- Find all employees who work as Electrical Engineers
SQL> -- in the Electronics Engineering Department:
SQL> --
SQL> SELECT EMPLOYEE_ID, LAST_NAME, JOB_CODE, DEPARTMENT_CODE
cont> FROM CURRENT_JOB
cont> WHERE JOB_CODE = 'EENG'
cont> AND DEPARTMENT_CODE = 'ELEL';
 EMPLOYEE_ID   LAST_NAME        JOB_CODE   DEPARTMENT_CODE
 00238         Flynn            EENG       ELEL
1 row selected
```

(continued on next page)

Example 4–28 (Cont.) Combining Conditions in Predicates

```
SQL> --
SQL> -- Find all employees who work either in the Electronics
SQL> -- Engineering Department or work as Electrical Engineers
SQL> -- or both:
SQL> --
SQL> SELECT EMPLOYEE_ID, LAST_NAME, JOB_CODE, DEPARTMENT_CODE
cont> FROM CURRENT_JOB
cont> WHERE JOB_CODE = 'EENG'
cont> OR DEPARTMENT_CODE = 'ELEL';
cont> ORDER BY EMPLOYEE_ID;
 EMPLOYEE_ID   LAST_NAME        JOB_CODE   DEPARTMENT_CODE
 00172         Peters           SANL       ELEL
 00188         Clarke           DMGR       ELEL
 00197         Danzig           EENG       MKTG
 00198         Gehr             EENG       MBMN
 00206         Stornelli        SPGM       ELEL
 00211         Gutierrez        SANL       ELEL
 00222         Lasch            DSUP       ELEL
 00226         Boyd             EENG       PERL
 00231         Clairmont        MENG       ELEL
 00238         Flynn            EENG       ELEL
 00240         Johnson          ADMN       ELEL
11 rows selected
SQL> --
SQL> -- Find Electrical Engineers who work in departments
SQL> -- other than the Electronics Engineering Department:
SQL> --
SQL> SELECT EMPLOYEE_ID, LAST_NAME, JOB_CODE, DEPARTMENT_CODE
cont> FROM CURRENT_JOB
cont> WHERE JOB_CODE = 'EENG'
cont> AND NOT DEPARTMENT_CODE = 'ELEL'
cont> ORDER BY EMPLOYEE_ID;
 EMPLOYEE_ID   LAST_NAME        JOB_CODE   DEPARTMENT_CODE
 00197         Danzig           EENG       MKTG
 00198         Gehr             EENG       MBMN
 00226         Boyd             EENG       PERL
3 rows selected
```

(continued on next page)

Example 4–28 (Cont.) Combining Conditions in Predicates

```
SQL> --
SQL> -- An alternate way of finding all Electrical Engineers who
SQL> -- work in departments other than the Electrical Engineering
SQL> -- Department:
SQL> --
SQL> SELECT EMPLOYEE_ID, LAST_NAME, JOB_CODE, DEPARTMENT_CODE
cont> FROM CURRENT_JOB
cont> WHERE JOB_CODE = 'EENG'
cont> AND DEPARTMENT_CODE <> 'ELEL'
cont> ORDER BY EMPLOYEE_ID;
 EMPLOYEE_ID   LAST_NAME        JOB_CODE   DEPARTMENT_CODE
 00197         Danzig           EENG       MKTG
 00198         Gehr             EENG       MBMN
 00226         Boyd             EENG       PERL
3 rows selected
```

Reference Reading

The *Oracle Rdb7 SQL Reference Manual* has a section on complex predicates in the chapter on language and syntax elements. Included in the section are truth tables, which are tables that show how complex condition evaluation works. There is a truth table for each Boolean operator. Checking a truth table is the surest way to determine if a row will be selected when a complex condition is evaluated.

If you use a non-English collating sequence, see the section on predicates in the *Oracle Rdb7 SQL Reference Manual* for notes on the behavior of certain operators with specific languages.

4.11.1 Evaluating Search Conditions

SQL evaluates search conditions using the following descending order of precedence:

1. parentheses
2. predicates
3. NOT operator
4. AND operator
5. OR operator

Because the AND operator has higher precedence than the OR operator, you must use parentheses to group all the predicates linked by the OR operator if ANDs are also present. When you mix complex conditions in a WHERE clause, you often must use parentheses to ensure that SQL returns the results that you expect. Example 4–29 shows the use of parentheses to group predicates linked by the OR operator.

Example 4–29 Using Parentheses to Group Predicates

```
SQL> --
SQL> -- Who works as a Mechanical Engineer
SQL> -- in either the Electronics or
SQL> -- the Mechanical Engineering Department?
SQL> --
SQL> SELECT EMPLOYEE_ID, LAST_NAME, JOB_CODE, DEPARTMENT_CODE
cont> FROM CURRENT_JOB
cont> WHERE JOB_CODE = 'MENG'
cont> AND (DEPARTMENT_CODE = 'ELEL' OR DEPARTMENT_CODE = 'ELMC');
 EMPLOYEE_ID   LAST_NAME        JOB_CODE   DEPARTMENT_CODE
 00192         Connolly         MENG       ELMC
 00231         Clairmont        MENG       ELEL
2 rows selected
```

In some cases parentheses are optional, but they make queries more structured and easier to read. For example, these WHERE clauses are equivalent:

```
WHERE LAST_NAME = 'Toliver' AND FIRST_NAME = 'Alvin'

WHERE (LAST_NAME = 'Toliver') AND (FIRST_NAME = 'Alvin')
```

4.12 Summary Queries

In previous sections each row was examined independently, but sometimes it is important to receive summary information from many rows of the same column. This type of query can answer questions like: What is the average starting salary? What is the maximum salary anyone can ever obtain in this company? To answer such questions you can apply functions to values of one column. This section describes set (aggregate) functions.

4.12.1 Performing Calculations on Columns

You can use aggregate functions in the select list of a query to perform calculations on an entire column of data values at once. Specifying aggregate functions consists of using a keyword, followed by an expression (in parentheses) that usually includes a column name.

Table 4–3 shows the aggregate functions that are covered in this section.

Table 4–3 Aggregate Functions

Function	Syntax	Returns
SUM	SUM ([DISTINCT] column-name)	Total amount of numeric column values
AVG	AVG ([DISTINCT] column-name)	Average of numeric column values
MIN	MIN ([DISTINCT] column-name)	Lowest value in the column
MAX	MAX ([DISTINCT] column-name)	Highest value in the column
COUNT	COUNT (*)	Number of rows in the result table
	COUNT (DISTINCT column-name)	Number of unique values in the column

Null values are not included in the computation of the function AVG, SUM, MAX, MIN, and COUNT (DISTINCT column-name). Because COUNT (*) counts how many rows are in a result table without looking at specific column values, this form is not affected by null values. If you specify the DISTINCT keyword with these functions, redundant rows are not included in the computation.

4.12.2 Computing a Total (SUM)

The SUM function returns the arithmetic sum of the data values in a column. The data type of the value returned by the SUM function depends on the data type of the column, which must be of a numeric or date-time type. Example 4–30 shows how to use the SUM function.

Example 4–30 Using the SUM Function

```
SQL> --
SQL> -- What is the company paying for salaries of all employees?
SQL> --
SQL> SELECT SUM(SALARY_AMOUNT) FROM CURRENT_SALARY;

             3192279.00
1 row selected
```

4.12.3 Computing an Average (AVG)

The AVG function returns the average (arithmetic mean) of the data values in a column. The data type of the value returned by the AVG function depends on the data type of the column, which must be of a numeric or date-time type. The AVG function used by itself will return a result in scientific notation format. Section 4.13.1 shows how the CAST function can be combined with the AVG function to reformat this output. Example 4–31 shows how to use the AVG function.

Example 4–31 Using the AVG Function

```
SQL> --
SQL> -- What is the average of all minimum salaries for all jobs?
SQL> --
SQL> SELECT AVG(MINIMUM_SALARY) FROM JOBS;

  3.000000000000000E+004
1 row selected
SQL> --
SQL> -- What would the average salary in the company be if all
SQL> -- employees received a 10% raise?
SQL> --
SQL> SELECT AVG(SALARY_AMOUNT * 1.1) FROM CURRENT_SALARY;

  3.511506899999999E+004
1 row selected
```

4.12.4 Finding Minimum and Maximum Values (MIN and MAX)

The MIN and MAX functions return the minimum and maximum data values, respectively, in a column. Example 4–32 shows how to use the MAX and MIN functions.

Example 4–32 Using the MAX and MIN Functions

```
SQL> --
SQL> -- When was the youngest employee in the company born?
SQL> --
SQL> SELECT  MAX(BIRTHDAY)
cont> FROM EMPLOYEES;

 10-JAN-1960 00:00:00.00
1 row selected
SQL> --
SQL> -- What is the smallest salary amount
SQL> -- anyone ever had in the company?
SQL> --
SQL> SELECT MIN(SALARY_AMOUNT) FROM SALARY_HISTORY;

       7000.00
1 row selected
```

4.12.5 Counting Rows (COUNT)

The COUNT function returns an integer representing the number of data values in a column or the number of rows in a result table depending on the format that you use. Table 4–4 shows the two formats of the COUNT function.

Table 4–4 Two Formats of the COUNT Function

Format	Example	Returns
COUNT (*)	SELECT COUNT (*) FROM EMPLOYEES;	Number of rows in the EMPLOYEES table
COUNT (DISTINCT column-name)	SELECT COUNT (DISTINCT CITY) FROM EMPLOYEES;	Number of unique city names in the EMPLOYEES table

Example 4–33 shows how to use the COUNT function.

Example 4–33 Using the COUNT Function

```
SQL> --
SQL> -- How many rows are in the JOB_HISTORY table?
SQL> --
SQL> SELECT COUNT (*) FROM JOB_HISTORY;

         274
1 row selected
SQL> --
SQL> --  How many different employees are described
SQL> --  in the JOB_HISTORY table?
SQL> --
SQL> SELECT COUNT (DISTINCT EMPLOYEE_ID) FROM JOB_HISTORY;

         100
1 row selected
SQL> --
SQL> -- Find out how many employees are supervisors of other employees:
SQL> --
SQL> SELECT COUNT (DISTINCT SUPERVISOR_ID)
cont> FROM CURRENT_JOB;

          35
1 row selected
SQL> --
SQL> -- or:
SQL> --
SQL> SELECT COUNT (DISTINCT SUPERVISOR_ID)
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NULL;

          35
1 row selected
```

4.12.6 When Functions Return Empty Rows

When you use functions to provide summary information and the query returns a stream that contains no rows, the results returned by SQL differ depending upon the function that you use:

- SUM, MIN, MAX, AVG

  When the result table from a SUM, MIN, MAX, or AVG function contains no rows, SQL returns a null value. For example:

  ```
  SQL> SELECT SUM (MINIMUM_SALARY) FROM JOBS WHERE WAGE_CLASS > '5';

            NULL
  1 row selected
  ```

- COUNT

  When you retrieve the COUNT of an empty stream, SQL returns a zero (0). For example:

```
SQL> SELECT COUNT (*) FROM JOBS WHERE WAGE_CLASS > '5';

           0
1 row selected
```

4.13 Built-In Functions

SQL provides several built-in functions that can be used to convert or reformat column values or the contents of result tables. Table 4–5 lists the functions that are discussed in this section.

Table 4–5 Built-In Functions

Function	Syntax	Output
CAST	CAST (column-name AS target_datatype)	Converts one data type to another
CHARACTER_LENGTH	CHARACTER_LENGTH (column-name)	Gives the character length of a column value as an integer
OCTET_LENGTH	OCTET_LENGTH (column-name)	Gives the octet length of a column value as an integer
SUBSTRING	SUBSTRING (column-name FROM start-position [FOR string-length])	Displays part of a character column value
TRIM	TRIM ([LEADING or TRAILING or BOTH] char-value-expr FROM char-val-expr)	Returns a character string minus a specified leading or trailing character (or both) of a value expression.
POSITION	POSITION (char-value-expr IN char-value-expr [FROM numeric-value-expr])	Returns a numeric value that indicates the position of the search string in a source string.
UPPER	UPPER (column-name)	Converts lowercase characters to uppercase
LOWER	LOWER (column-name)	Converts uppercase characters to lowercase
TRANSLATE	TRANSLATE (column-name target-language)	Translates a character value expression from one character set to another compatible character set

4.13.1 Converting Data Types (CAST)

The CAST function allows you to explicitly convert one Oracle Rdb data type to another within a value expression. CAST works with any valid Oracle Rdb data type except the LIST OF BYTE VARYING data type. See the *Oracle Rdb7 SQL Reference Manual* for a full listing of Oracle Rdb data types.

Example 4–34 shows how to use the CAST function to convert the output of operations that would ordinarily return scientific notation format. Notice the nesting of parentheses required to perform these operations.

Example 4–34 Using the CAST Function

```
SQL> --
SQL> -- What is the average of all minimum salaries for all jobs?
SQL> --
SQL> SELECT CAST(AVG(MINIMUM_SALARY) AS INTEGER(2)) FROM JOBS;

  30000.00
1 row selected
SQL> --
SQL> --  Compute the midpoint salary for each job:
SQL> --
SQL> SELECT JOB_TITLE,
cont> 'Midpoint salary:',
cont> CAST(((MINIMUM_SALARY + MAXIMUM_SALARY) / 2) AS INTEGER(2))
cont> FROM JOBS;
 JOB_TITLE
 Associate Programmer   Midpoint salary:     19500.00
 Clerk                  Midpoint salary:     16000.00
 Assistant Clerk        Midpoint salary:     11000.00
 Department Manager     Midpoint salary:     75000.00
   .
   .
   .
 Systems Analyst        Midpoint salary:     50000.00
 Secretary              Midpoint salary:     17500.00
 Systems Programmer     Midpoint salary:     37500.00
 Vice President         Midpoint salary:    112500.00
15 rows selected
```

4.13.2 Returning String Length (CHARACTER_LENGTH and OCTET_LENGTH)

The CHARACTER_LENGTH and OCTET_LENGTH functions return the length, in characters or octets, of a character string. The length of a character can be one or more octets depending on the character set that you use. In the sample database a character equals one octet, so the output is the same for either function. See the *Oracle Rdb7 SQL Reference Manual* for more information on using these functions with different character sets.

Example 4–35 shows how to use the CHARACTER_LENGTH function. In the sample database, the FIRST_NAME column is defined as a fixed-length CHAR data type of ten characters. The CANDIDATE_STATUS column is defined as a variable-length VARCHAR data type. CHARACTER_LENGTH can be shortened to CHAR_LENGTH.

Example 4–35 Using the CHARACTER_LENGTH Function

```
SQL> --
SQL> -- Determine the length of the FIRST_NAME column:
SQL> --
SQL> SELECT CHARACTER_LENGTH(FIRST_NAME)
cont> FROM EMPLOYEES;
          10
          10
   .
   .
   .
          10
          10
100 rows selected
SQL> --
SQL> -- Determine the length of the CANDIDATE_STATUS column:
SQL> --
SQL> SELECT CHAR_LENGTH(CANDIDATE_STATUS)
cont> FROM CANDIDATES;
          63
          69
          46
3 rows selected
SQL> --
SQL> -- Determine how many lines you would need to allocate when
SQL> -- formatting a report that is set up to have 60 characters per line:
SQL> --
SQL> SELECT CAST(CHAR_LENGTH(CANDIDATE_STATUS)/60
cont> AS INTEGER(2))
cont> FROM CANDIDATES;
          1.05
          1.15
          0.77
3 rows selected
```

4.13.3 Displaying a Substring (SUBSTRING)

Use the SUBSTRING function to display a portion of a character column value. When displaying a substring you must specify a starting position within the literal string and, optionally, a length for the output.

Example 4–36 shows how to display EMPLOYEE_ID from the third position of its five-character length.

Example 4–36 Using the SUBSTRING Function

```
SQL> --
SQL> -- Currently, only the last three characters of EMPLOYEE_ID are used.
SQL> -- Display EMPLOYEE_ID without the leading zeros:
SQL> --
SQL> SELECT LAST_NAME, 'Employee ID number:', SUBSTRING(EMPLOYEE_ID FROM 3)
cont> FROM EMPLOYEES
cont> ORDER BY EMPLOYEE_ID;
 LAST_NAME
 Toliver          Employee ID number:   164
 Smith            Employee ID number:   165
 Dietrich         Employee ID number:   166
 Kilpatrick       Employee ID number:   167
 Nash             Employee ID number:   168
 Gray             Employee ID number:   169
    .
    .
    .
 Ames             Employee ID number:   416
 Blount           Employee ID number:   418
 MacDonald        Employee ID number:   435
 Herbener         Employee ID number:   471
100 rows selected
```

4.13.4 Removing Leading or Trailing Characters (TRIM)

The TRIM function removes leading or trailing characters, or both, from any character value expression. Although you only specify a single character, the TRIM function removes all leading or trailing spaces, numbers, and characters that match the specified character.

SQL returns the specified string without the specified leading or trailing characters (or both).

The BOTH option is the default if none is specified. The space character is the default if a string is not specified.

The character value expression that you trim must be defined as data type CHAR, VARCHAR, NCHAR, or NCHAR VARYING. Use the CAST function to convert other data types before using the TRIM function.

SQL returns a run-time error when the trim character is not exactly one character in length.

Example 4–37 shows how to use the TRIM function.

Example 4–37 Using the TRIM Function

```
SQL> --
SQL> -- Because all the current employee IDs in the mf_personnel
SQL> -- database begin with leading zeros, you can use the TRIM function
SQL> -- to display only the unique portions of the employee IDs:
SQL> --
SQL> SELECT EMPLOYEE_ID,
cont> TRIM (LEADING '0' FROM EMPLOYEE_ID)
cont> FROM EMPLOYEES;
 EMPLOYEE_ID
 00164         164
 00165         165
 00166         166
 00167         167
 00168         168
SQL> --
SQL> -- The next query, though not a likely scenario, shows the
SQL> -- use of the TRIM function to remove the first character
SQL> -- in a last name:
SQL> --
SQL> SELECT LAST_NAME,
cont> TRIM (LEADING 'H' FROM LAST_NAME)
cont> FROM EMPLOYEES
cont> WHERE LAST_NAME LIKE 'H%';
 LAST_NAME
 Hall             all
 Harrington       arrington
 Harrison         arrison
 Hastings         astings
 Herbener         erbener
5 rows selected
SQL> -- The following INSERT statement inserts a LAST_NAME
SQL> -- that contains leading spaces:
SQL> --
SQL> INSERT INTO EMPLOYEES (LAST_NAME,FIRST_NAME,EMPLOYEE_ID) VALUES
cont> ('  Hillson','Ann','99999');
1 row inserted
SQL> --
SQL> -- If you select columns without specifying the
SQL> -- TRIM function on the WHERE clause, SQL returns only those
SQL> -- last names that start with 'H' and have no leading spaces.
SQL> -- Thus, the column just added is not displayed:
SQL> --
```

(continued on next page)

Example 4–37 (Cont.) Using the TRIM Function

```
SQL> SELECT LAST_NAME || ', ' || FIRST_NAME
cont> FROM EMPLOYEES
cont> WHERE LAST_NAME LIKE 'H%';
 Hall          , Lawrence
 Harrington    , Margaret
 Harrison      , Lisa
 Hastings      , Norman
 Herbener      , James
5 rows selected
SQL> --
SQL> -- Add the TRIM function to the WHERE clause to get a complete
SQL> -- list of last names beginning with 'H' including the one
SQL> -- just added (which includes leading spaces).
SQL> --
SQL> SELECT LAST_NAME || ', ' || FIRST_NAME
cont> FROM EMPLOYEES
cont> WHERE TRIM (LEADING ' ' FROM LAST_NAME) LIKE 'H%';
 Hastings      , Norman
 Harrington    , Margaret
 Hall          , Lawrence
 Harrison      , Lisa
   Hillson     , Ann
 Herbener      , James
6 rows selected
SQL> -- Add the TRIM function to the SELECT portion of the query
SQL> -- to trim the leading spaces from the display of 'Hillson'.
SQL> -- Note that the LEADING option has been changed to the BOTH
SQL> -- option to trim leading and trailing spaces from the
SQL> -- LAST_NAME column.
SQL> --
SQL> SELECT TRIM (BOTH ' ' FROM LAST_NAME) || ', ' || FIRST_NAME
cont> FROM EMPLOYEES
cont> WHERE TRIM (LEADING ' ' FROM LAST_NAME) LIKE 'H%';
 Hastings, Norman
 Harrington, Margaret
 Hall, Lawrence
 Harrison, Lisa
 Hillson, Ann
 Herbener, James
6 rows selected
```

4.13.5 Locating a Substring (POSITION)

The POSITION function returns a numeric value that indicates the position of the first character value expression (the search string) within the second character value expression (the source string).

The returned numeric value is the absolute position of the search string in the source string starting with 1. The match between the search string and the source string is case sensitive.

If the search string is not found in the source string, the POSITION function returns a zero (0) value. If any of the strings are NULL, the result is NULL.

The FROM clause of the POSITION function is an extension to the ANSI/ISO SQL standard and allows searching to begin from any location.

Example 4–38 Using the POSITION Function

```
SQL> --
SQL> -- Determine the location of 'Engineering' within all the
SQL> -- departments' names:
SQL> --
SQL> SELECT DEPARTMENT_NAME,
cont> POSITION ('Engineering' in DEPARTMENT_NAME)
cont> FROM DEPARTMENTS;
 DEPARTMENT_NAME
 Corporate Administration                0
 Electronics Engineering                13
 Large Systems Engineering              15
 Mechanical Engineering                 12
 Engineering                             1
 Board Manufacturing                     0
 Board Manufacturing North               0
 Board Manufacturing South               0
 Cabinet & Frame Manufacturing           0
 Commercial & Business Mktg.             0
 Gov't & Defense Industries              0
 Corporate Marketing                     0
 Manufacturing                           0
 Scientific & Laboratory Mktg.           0
 Systems Integration & Test              0
 Telecommunications Industries           0
 Employee Relations                      0
 Corporate Personnel                     0
 Personnel Hiring                        0
 Resource Management                     0
 Corporate Sales                         0
 European Sales                          0
 Northeastern US Sales                   0
 United States Sales                     0
 Southern U.S. Sales                     0
 Western U.S. Sales                      0
26 rows selected
```

(continued on next page)

Example 4–38 (Cont.) Using the POSITION Function

```
SQL> --
SQL> -- Return only those department names that contain the
SQL> -- string 'Engineering':
SQL> SELECT DEPARTMENT_NAME,
cont> POSITION ('Engineering' in DEPARTMENT_NAME)
cont> FROM DEPARTMENTS
cont> WHERE DEPARTMENT_NAME LIKE '_%Engineering%';
 DEPARTMENT_NAME
 Electronics Engineering                  13
 Large Systems Engineering                15
 Mechanical Engineering                   12
3 rows selected
SQL> --
SQL> -- Use the POSITION function to find only those
SQL> -- department names that contain the string 'Engineering'.
SQL> -- Use the SUBSTRING function to display the type of
SQL> -- Engineering department:
SQL> --
SQL> SELECT SUBSTRING (DEPARTMENT_NAME FROM 1
cont> FOR POSITION ('Engineering' IN DEPARTMENT_NAME) -1)
cont> FROM DEPARTMENTS
cont> WHERE DEPARTMENT_NAME LIKE '_%Engineering%';
 Electronics
 Large Systems
 Mechanical
3 rows selected
```

4.13.6 Changing Character Case (UPPER and LOWER)

The LOWER function converts all selected uppercase characters in a column to lowercase, while the UPPER function converts all selected lowercase characters in a column to uppercase. When executing these functions, SQL follows the rules of the character set being used. For example, if the character set being converted is Hanzi (Japanese) and ASCII, SQL converts only the ASCII characters. For more information on character sets, see the *Oracle Rdb7 SQL Reference Manual*. If the result of a query is a null value, these functions return a null value.

Example 4–39 shows how to use the UPPER and LOWER functions.

Example 4–39 Using the LOWER and UPPER Functions

```
SQL> --
SQL> -- Print employees' last names in all uppercase:
SQL> --
SQL> SELECT UPPER(LAST_NAME), FIRST_NAME, MIDDLE_INITIAL ❶
cont> FROM EMPLOYEES
cont> ORDER BY LAST_NAME
cont> LIMIT TO 5 ROWS;

                  FIRST_NAME   MIDDLE_INITIAL
 AMES             Louie        A
 ANDRIOLA         Leslie       Q
 BABBIN           Joseph       Y
 BARTLETT         Dean         G
 BARTLETT         Wes          NULL
5 rows selected
SQL> --
SQL> -- Print employees' last names correctly because you
SQL> -- are not sure how they were entered:
SQL> --
SQL> SELECT UPPER(SUBSTRING(LAST_NAME FROM 1 FOR 1 ))
cont> ||LOWER(SUBSTRING(LAST_NAME FROM 2)) ❷
cont> FROM EMPLOYEES
cont> LIMIT TO 5 ROWS;
 Ames
 Andriola
 Babbin
 Bartlett
 Bartlett
5 rows selected
```

The following callouts are keyed to Example 4–39:

❶ An entire column value is converted to uppercase.

❷ A column is concatenated with itself to ensure consistent output.

4.13.7 Translating Character Strings (TRANSLATE)

The TRANSLATE function translates a character value expression from one character set to another compatible character set.

The characters in the value expression are translated, character by character, to the character set specified. If a direct translation exists for a character, it is replaced by the equivalent character in the translation character set. If there is no direct translation for a character, it is replaced by the space character in the translation character set.

See the *Oracle Rdb7 SQL Reference Manual* for more information on using this function.

4.14 Using Column Functions on Groups of Rows (GROUP BY)

When you name columns in your SELECT statement and include a function, SQL requires a clause to determine a value by which rows are grouped before the function is applied. The GROUP BY clause organizes a table into groups of rows that have something in common to apply a function to each group of rows.

The GROUP BY clause follows the WHERE clause and specifies one or more columns on which to group rows with equal values and rows with null values.

The general syntax of the statement is:

Syntax

```
SELECT    select-list,   function()
FROM    table-name
GROUP BY    column-name;
```

Example 4–40 shows how the GROUP BY clause could be used to organize tables.

Example 4–40 Organizing Tables Using the GROUP BY Clause

```
SQL> --
SQL> -- How many different positions did each
SQL> -- employee have in the company?
SQL> --
SQL> SELECT EMPLOYEE_ID, 'held', COUNT(*), 'job(s)'
cont> FROM JOB_HISTORY
cont> GROUP BY EMPLOYEE_ID; ❶
 EMPLOYEE_ID
 00164         held            2   job(s)
 00165         held            4   job(s)
 00166         held            3   job(s)
   .
   .
   .
 00471         held            3   job(s)
100 rows selected
```

(continued on next page)

Example 4–40 (Cont.) Organizing Tables Using the GROUP BY Clause

```
SQL> --
SQL> -- What is the smallest salary amount
SQL> -- in the history of each employee?
SQL> --
SQL> SELECT EMPLOYEE_ID, MIN(SALARY_AMOUNT)
cont> FROM SALARY_HISTORY
cont> GROUP BY EMPLOYEE_ID; ❷
 EMPLOYEE_ID
 00164             26291.00
 00165              7089.00
 00166             15188.00
 00167             15000.00
    .
    .
    .
 00471             51430.00
100 rows selected
```

The following callouts are keyed to Example 4–40:

❶ The GROUP BY clause is used to organize the JOB_HISTORY table by EMPLOYEE_ID, and the COUNT function gives the number of rows for each employee in the table. Each row represents a job the employee has held.

❷ The GROUP BY clause is used to organize the SALARY_HISTORY table by EMPLOYEE_ID, and the MIN function is used to find the smallest salary amount.

All null values for a column name in the GROUP BY clause are grouped together.

Each group is treated as the source for the values of a single row of the result table.

Because there is no single value for columns not specified in the GROUP BY clause, references to column names not specified in that clause must be within an aggregate function as the following example shows:

```
SQL> SELECT LAST_NAME, FIRST_NAME
cont> FROM EMPLOYEES
cont> GROUP BY LAST_NAME;
%SQL-F-NOTGROFLD, Column FIRST_NAME cannot be referred to in the select list,
ORDER BY, or HAVING clause because it is not in the GROUP BY clause
```

When you mix columns and functions, you must always include a GROUP BY clause; otherwise, you will receive an error message as the following example shows:

```
SQL> SELECT DEPARTMENT_CODE, COUNT(DISTINCT EMPLOYEE_ID)
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NULL;
%SQL-F-INVSELLIS, Select list cannot mix columns and functions
   without GROUP BY
```

Also, if you use a function in the SELECT statement, you cannot include any other column name unless it is included in the GROUP BY clause. In the following example, SQL groups the rows in the SALARY_HISTORY table by the EMPLOYEE_ID column. It then applies the function MIN to each group, to determine the minimum amount for each employee. Listing the SALARY_START column at this point is meaningless, because the statistical figure of minimum amount does not belong to any specific salary row.

```
SQL> SELECT EMPLOYEE_ID, SALARY_START, MIN(SALARY_AMOUNT)
cont> FROM SALARY_HISTORY
cont> GROUP BY EMPLOYEE_ID;
%SQL-F-NOTGROFLD, Column SALARY_START cannot be referred to in the
select list or HAVING clause because it is not in the GROUP BY clause
```

If you specify more than one grouping column, SQL groups the rows that have the same value in all of the grouping columns and applies the column function to each group. Example 4–41 shows how to do this.

Example 4–41 Using the GROUP BY Clause with Two Columns

```
SQL> --
SQL> -- Find how many employees of each sex live in each state:
SQL> --
SQL> SELECT STATE, SEX, COUNT(DISTINCT EMPLOYEE_ID) AS POPULATION
cont> FROM EMPLOYEES
cont> GROUP BY STATE, SEX;
 STATE   SEX     POPULATION
 CT      M                1
 MA      F                6
 MA      M                3
 NH      F               29
 NH      M               61
5 rows selected.
```

If the grouping column contains rows with null values, SQL treats those rows as a group and applies the column function to that group. For example, the following query finds the frequency distribution of middle initials:

```
SQL> SELECT MIDDLE_INITIAL, COUNT(DISTINCT EMPLOYEE_ID) AS NUMBER
cont> FROM EMPLOYEES
cont> GROUP BY MIDDLE_INITIAL
cont> ORDER BY NUMBER DESC, MIDDLE_INITIAL ASC
cont> LIMIT TO 5 ROWS;
 MIDDLE_INITIAL       NUMBER
 NULL                     36
 G                         5
 Q                         5
 V                         5
 A                         4
5 rows selected
```

The result table contains a row representing the group in which the MIDDLE_INITIAL value is null. To eliminate the row, use the IS NOT NULL predicate. For example:

```
SQL> SELECT MIDDLE_INITIAL, COUNT(DISTINCT EMPLOYEE_ID) AS NUMBER
cont> FROM EMPLOYEES
cont> WHERE MIDDLE_INITIAL IS NOT NULL
cont> GROUP BY MIDDLE_INITIAL
cont> ORDER BY NUMBER DESC, MIDDLE_INITIAL ASC
cont> LIMIT TO 5 ROWS;
 MIDDLE_INITIAL       NUMBER
 G                         5
 Q                         5
 V                         5
 A                         4
 B                         4
5 rows selected.
```

4.14.1 Using a Search Condition to Limit Groups (HAVING)

You can use the HAVING clause to limit the rows that SQL includes in a grouped result table. The HAVING clause is similar to the WHERE clause because it specifies a search condition that produces a result of TRUE, FALSE, or UNKNOWN. The result table contains only groups for which the search condition is TRUE. However, the HAVING clause applies the search condition after the grouping and column functions have been applied.

The general syntax of the statement is:

Syntax

```
SELECT    column-name, function()
FROM    table-name
GROUP BY    column-name, . . .
HAVING    condition;
```

Example 4–42 shows how to obtain a list of employees for whom the current job is not their first one in the company.

Example 4–42 Using the HAVING Clause

```
SQL> --
SQL> -- For employees who changed jobs at least once,
SQL> -- how many previous jobs did they have?
SQL> --
SQL> SELECT EMPLOYEE_ID, 'held', COUNT(*) - 1, 'previous jobs'
cont> FROM JOB_HISTORY
cont> GROUP BY EMPLOYEE_ID
cont> HAVING COUNT(*) > 1; ❶
 EMPLOYEE_ID
 00164        held                         1   previous jobs
 00165        held                         3   previous jobs
 00166        held                         2   previous jobs
 00167        held                         2   previous jobs
 00168        held                         3   previous jobs
   .
   .
   .
80 rows selected
SQL> --
SQL> -- Count the number of jobs employees had,
SQL> -- but only for those who worked in a different type of job:
SQL> --
SQL> SELECT EMPLOYEE_ID, 'held', COUNT(*), 'job(s)'
cont> FROM JOB_HISTORY
cont> GROUP BY EMPLOYEE_ID
cont> HAVING COUNT(DISTINCT JOB_CODE) > 1; ❷
 EMPLOYEE_ID
 00164        held              2   job(s)
 00166        held              3   job(s)
 00168        held              4   job(s)
 00169        held              4   job(s)
 00171        held              2   job(s)
   .
   .
   .
 00416        held              4   job(s)
 00418        held              4   job(s)
 00435        held              3   job(s)
66 rows selected
```

The following callouts are keyed to Example 4–42:

❶ SQL groups the rows of the JOB_HISTORY table by employees, counts how many rows of jobs belong to each employee, and excludes from the result table those who do not have more than one row.

❷ This query shows employees who worked in different types of jobs. Note that employee 165 does not appear on this list. This employee has four rows in the JOB_HISTORY table but they are of the same job code (ASCK). This person moved from one Assistant Clerk job to another in different departments, as shown in the following example:

```
SQL> SELECT EMPLOYEE_ID, JOB_CODE, JOB_END, DEPARTMENT_CODE
cont> FROM JOB_HISTORY
cont> WHERE EMPLOYEE_ID = '00165';
 EMPLOYEE_ID   JOB_CODE   JOB_END       DEPARTMENT_CODE
 00165         ASCK        4-Sep-1977   PHRN
 00165         ASCK        7-Apr-1979   ELGS
 00165         ASCK        7-Mar-1981   MTEL
 00165         ASCK       NULL          MBMF
4 rows selected
```

Always include a column function in the search condition of a HAVING clause. Although omitting it is syntactically valid, a search condition without a column function belongs in the WHERE clause.

Always include a GROUP BY clause with a HAVING clause. If you omit the GROUP BY clause, SQL considers all of the rows in the result table to be a single group, applies the column functions in the HAVING clause to that group, and either includes or discards the group.

4.15 Retrieving Data from Multiple Tables (JOINS)

Until now all SQL operations in this manual have been discussed using one table. Working with only one table is limiting but easy to learn. Now you will see how SQL operations can be used with multiple tables.

Retrieving data from different tables in one query is done by joining tables using the relational join operation. SQL includes support for implicit as well as explicit join syntax.

4.15.1 Crossing Two Tables

A cross is a **Cartesian product** set operation. The Cartesian product, which is also considered a multiplication operation, appends each and every row from one table to each and every row of another table. The result is a very large table that contains all the columns from both tables.

If one table has n number of rows and the other has m, the result table contains $n * m$ rows.

To obtain a Cartesian product in SQL, you cross two tables. Crossing two tables is done implicitly by listing the table names in the FROM clause separated with commas. Explicitly, the same results can be obtained by specifying the CROSS JOIN keyword in your statement.

The general syntax for crossing two tables is:

Syntax

```
SELECT   column(s)
FROM   table1, table2 ;
```

or

```
SELECT   column(s)
FROM   table1   CROSS JOIN   table2 ;
```

When crossing the EMPLOYEES table with the DEPARTMENTS table, each EMPLOYEES table row is combined with each DEPARTMENTS table row. The 100 rows of the EMPLOYEES table crossed with 26 rows of the DEPARTMENTS table results in 2,600 rows.

Crossing two tables usually produces a very large result table, which may be of limited value. For example, there is no meaning to a row of data that combines an EMPLOYEES table row with every DEPARTMENTS table row, as shown in Example 4–43.

Example 4–43 Crossing Two Tables

```
SQL> --
SQL> -- Crossing EMPLOYEES table with DEPARTMENTS table:
SQL> --
SQL> SELECT EMPLOYEE_ID, LAST_NAME, DEPARTMENT_NAME
cont> FROM EMPLOYEES, DEPARTMENTS;
 EMPLOYEES.EMPLOYEE_ID   EMPLOYEES.LAST_NAME   DEPARTMENTS.DEPARTMENT_NAME
 00164                   Toliver               Corporate Administration
 00165                   Smith                 Corporate Administration
 00166                   Dietrich              Corporate Administration
 00167                   Kilpatrick            Corporate Administration
 00168                   Nash                  Corporate Administration
 00169                   Gray                  Corporate Administration
 00170                   Wood                  Corporate Administration
 00171                   D'Amico               Corporate Administration
 00172                   Peters                Corporate Administration
 00173                   Bartlett              Corporate Administration
 00174                   Myotte                Corporate Administration
 00175                   Siciliano             Corporate Administration
   .
   .
   .
 00415                   Mistretta             Western U.S. Sales
 00416                   Ames                  Western U.S. Sales
 00418                   Blount                Western U.S. Sales
 00435                   MacDonald             Western U.S. Sales
 00471                   Herbener              Western U.S. Sales
2600 rows selected
```

4.15.2 Joining Two Tables

A **join** is a Cartesian product followed by a selection. Out of the resulting large table produced by the product, only rows that satisfy some condition are included in the result table of the join. That condition compares two columns, one from each of the original tables, using one of the comparison operators (=, =>, <, . . .).

This operation eliminates some of the rows from the result of the cross by checking for a condition called the join condition.

Table 4–6 shows the two types of joins.

Table 4–6 Types of Joins

Type	Description
Equijoin	An equijoin checks if the two columns are equal. The problem with the equijoin is that its result table contains the common column from both source tables. The data in those columns is exactly the same, thus one of the columns is redundant. The equijoin checks for the equality (=) of the join column values.
Natural join	The natural join eliminates one of those duplicated columns. The resulting table is a combination of data from two tables, where only data that is relevant to the original entities is included (with no unnecessary columns). The natural join is the most commonly used join and the default type of join used by Oracle Rdb.

Joining two tables is done by listing table names in the FROM clause separated with commas, and then specifying the join condition in the WHERE clause.

The general syntax of a join statement is:

Syntax

```
SELECT   column(s)
FROM   table1, table2
WHERE   join-condition ;
```

Example 4–44 shows the joining of two tables.

Example 4–44 Joining Two Tables

```
SQL> --
SQL> -- Which employees are department managers?
SQL> --
SQL> --  Join EMPLOYEES and DEPARTMENTS over ID number.
SQL> --  Select only rows that have the same number
SQL> --  for EMPLOYEE_ID in EMPLOYEES
SQL> --  and MANAGER_ID in DEPARTMENTS:
SQL> --
SQL> SELECT EMPLOYEE_ID, LAST_NAME, DEPARTMENT_NAME
cont> FROM EMPLOYEES, DEPARTMENTS
cont> WHERE EMPLOYEE_ID = MANAGER_ID; ❶
EMPLOYEES.EMPLOYEE_ID   EMPLOYEES.LAST_NAME   DEPARTMENTS.DEPARTMENT_NAME ❷
 00225                   Jackson               Corporate Administration
 00188                   Clarke                Electronics Engineering
 00369                   Lapointe              Large Systems Engineering
 00190                   O'Sullivan            Mechanical Engineering
   .
   .
   .
 00201                   Clinton               Northeastern US Sales
 00186                   Watters               United States Sales
 00173                   Bartlett              Southern U.S. Sales
 00230                   Tarbassian            Western U.S. Sales
26 rows selected
SQL> --
SQL> -- Join EMPLOYEES and DEGREES
SQL> -- to get degrees of each employee:
SQL> --
SQL> SELECT LAST_NAME, DEGREE
cont> FROM EMPLOYEES, DEGREES
cont> WHERE EMPLOYEES.EMPLOYEE_ID = DEGREES.EMPLOYEE_ID; ❸
 EMPLOYEES.LAST_NAME   DEGREES.DEGREE
 Toliver               MA
 Toliver               PhD
 Smith                 BA
 Dietrich              BA
 Dietrich              PhD
   .
   .
   .
```

```
 MacDonald            MA
 MacDonald            PhD
 Herbener             BA
 Herbener             MA
165 rows selected
```

The following callouts are keyed to Example 4–44:

❶ The join condition limits the results to those rows from the EMPLOYEES table that belong to managers of each department. Had you not specified the join condition, the result table would contain 2,600 rows as in Example 4–43.

Note that the tables are joined over two columns that are based on the same domain but are not related as a primary key and foreign key.

❷ SQL precedes the column name with the source table name.

❸ SQL requires qualifying of the column name with the table name when the column names in the source tables are the same. Do so by preceding each column name with the source table name. Separate the table name from the column name with a period (.).

4.15.3 Using Correlation Names

You may use a shortened or different name for a table when qualifying a column name with the table name. This is called a **correlation name**.

It is a common practice to use the first letter of the table name, or the initials of the words that make up the table name, for a correlation name. SQL requires a unique name for every table that you include in one SELECT statement.

You may decide to use table names or correlation names for all columns in the query, even though they are not required.

If you include a common column name in the select list, its table name or correlation name is required in the select list.

The correlation name appears as part of the column heading in the output.

The correlation name used for a table name is known to SQL during the execution of that SELECT statement only. Once you start another SELECT statement, you need to declare the correlation name again. This also means that you can use the letter D in one query for the DEGREES table, and for the DEPARTMENTS table in another.

Example 4–45 shows the use of correlation names.

Example 4–45 Using Correlation Names

```
SQL> --
SQL> --  List employees and their degrees:
SQL> --
SQL> SELECT E.EMPLOYEE_ID, LAST_NAME, DEGREE
cont> FROM EMPLOYEES AS E, DEGREES AS D
cont> WHERE E.EMPLOYEE_ID = D.EMPLOYEE_ID;
 E.EMPLOYEE_ID   E.LAST_NAME      D.DEGREE
 00164           Toliver          MA
 00164           Toliver          PhD
 00165           Smith            BA
 00166           Dietrich         BA
 00166           Dietrich         PhD
   .
   .
   .
 00435           MacDonald        MA
 00435           MacDonald        PhD
 00471           Herbener         BA
 00471           Herbener         MA
165 rows selected
```

4.15.4 Using Explicit Join Syntax

You can use explicit or implicit join syntax to perform join operations. Table 4–7 lists the keywords used with explicit syntax.

Table 4–7 Explicit Join Syntax

Keyword	Description
NATURAL JOIN	Automatically performs a join operation on the matching named columns of the specified tables. You do not have to specify the matching columns in the join statement.
INNER JOIN	Combines all rows of the left-specified table reference to matching rows in the right-specified table reference. The keyword NATURAL can be used with INNER JOIN as well.

Example 4–46 shows the use of explicit join syntax for natural and inner joins. There is also explicit join syntax for outer joins. To learn more about outer joins see Chapter 6. For more information on joins, see the *Oracle Rdb7 SQL Reference Manual*.

Example 4–46 Using Explicit Join Syntax

```
SQL> --
SQL> -- Use NATURAL JOIN syntax to list employees and degrees:
SQL> --
SQL> SELECT EMPLOYEE_ID, LAST_NAME, DEGREE ❶
cont> FROM EMPLOYEES NATURAL JOIN DEGREES; ❷
 EMPLOYEE_ID   EMPLOYEES.LAST_NAME   DEGREES.DEGREE
 00164         Toliver               MA
 00164         Toliver               PhD
 00165         Smith                 BA
 00166         Dietrich              BA
 00166         Dietrich              PhD
   .
   .
   .
 00435         MacDonald             MA
 00435         MacDonald             PhD
 00471         Herbener              BA
 00471         Herbener              MA
165 rows selected
SQL> --
SQL> -- Use INNER JOIN syntax to list employee ID and degree:
SQL> --
SQL> SELECT LAST_NAME, DEGREE
cont> FROM EMPLOYEES INNER JOIN DEGREES ❸
cont> ON EMPLOYEES.EMPLOYEE_ID = DEGREES.EMPLOYEE_ID; ❹
 EMPLOYEES.LAST_NAME   DEGREES.DEGREE
 Toliver               MA
 Toliver               PhD
 Smith                 BA
 Dietrich              BA
   .
   .
   .
 Blount                PhD
 MacDonald             MA
 MacDonald             PhD
 Herbener              BA
 Herbener              MA
165 rows selected
```

The following callouts are keyed to Example 4–46:

❶ Correlation names are not necessary because the explicit syntax instructs SQL to join the tables based on their common column, which is EMPLOYEES.

❷ The NATURAL JOIN syntax replaces the implicit syntax and no WHERE clause is required.

❸ The INNER JOIN syntax can be used to obtain similar information.

❹ The ON clause is required to state the condition.

4.15.5 Combining a Join Condition with a Regular Condition

You can specify multiple join conditions in the WHERE clause by using the AND operator, as shown in Example 4–47.

Example 4–47 Combining a Join Condition with a Regular Condition

```
SQL> --
SQL> -- Who has a degree from a college in California?
SQL> --
SQL> SELECT EMPLOYEE_ID, COLLEGE_NAME,
cont> C.COLLEGE_CODE, STATE
cont> FROM DEGREES AS D, COLLEGES AS C
cont> WHERE D.COLLEGE_CODE = C.COLLEGE_CODE ❶
cont> AND STATE = 'CA'; ❷
 D.EMPLOYEE_ID        C.COLLEGE_NAME             C.COLLEGE_CODE   C.STATE
 00167                Cal. Institute of Tech.    CALT             CA
 00168                Cal. Institute of Tech.    CALT             CA
 00168                Cal. Institute of Tech.    CALT             CA
   .
   .
   .
 00354                Cal. Institute of Tech.    CALT             CA
 00418                Cal. Institute of Tech.    CALT             CA
 00166                Stanford University        STAN             CA
 00167                Stanford University        STAN             CA
   .
   .
   .
 00374                Stanford University        STAN             CA
 00435                Stanford University        STAN             CA
 00176                U. of Southern California  USCA             CA
 00198                U. of Southern California  USCA             CA
 00217                U. of Southern California  USCA             CA
34 rows selected
```

The following callouts are keyed to Example 4–47:

❶ You must specify a join condition in the WHERE clause to obtain the rows of related data from two tables.

❷ In addition, you may specify another condition to test the rows in the result table as was done with one table.

Combine the two conditions with an AND operator.

4.15.6 Joining More Than Two Tables

You must join more than two tables when:

- The data you want is in more than two tables.
- The data you want is in two tables, but those two tables have no columns in common. If a third table has a common column with both, you join the three tables by using one of the tables as a bridge between the other two.

Example 4–48 illustrates the first condition.

Example 4–48 Joining EMPLOYEES, DEGREES, and COLLEGES

```
SQL> --
SQL> -- Display employee names, their degree field,
SQL> -- and college where they received their degree:
SQL> --
SQL> SELECT LAST_NAME, DEGREE_FIELD, COLLEGE_NAME
cont> FROM EMPLOYEES AS E, DEGREES AS D, COLLEGES AS C ❶
cont> WHERE E.EMPLOYEE_ID = D.EMPLOYEE_ID ❷
cont> AND  D.COLLEGE_CODE = C.COLLEGE_CODE ❸
cont> ORDER BY LAST_NAME;
 E.LAST_NAME              D.DEGREE_FIELD         C.COLLEGE_NAME
 Ames                     Elect. Engrg.          Purdue University
 Ames                     Elect. Engrg.          Quinnipiac College
 Andriola                 Applied Math           Stanford University
 Andriola                 Statistics             Stanford University
 Babbin                   Applied Math           Harvard University
 Babbin                   Elect. Engrg.          Harvard University
 Bartlett                 Statistics             Harvard University
 Bartlett                 Elect. Engrg.          Harvard University
 Bartlett                 Arts                   Quinnipiac College
 Belliveau                Arts                   Purdue University
   .
   .
   .
```

```
 Ziemke                   Business Admin          Purdue University
 Ziemke                   Elect. Engrg.           Purdue University
165 rows selected
```

The following callouts are keyed to Example 4–48:

❶ Joining multiple tables is usually required when the data is related with a many-to-many relationship. An employee may have attended many colleges, and many employees may have attended the same college.

Join multiple tables by listing table names in the FROM clause.

❷ Join condition for EMPLOYEES-DEGREES.

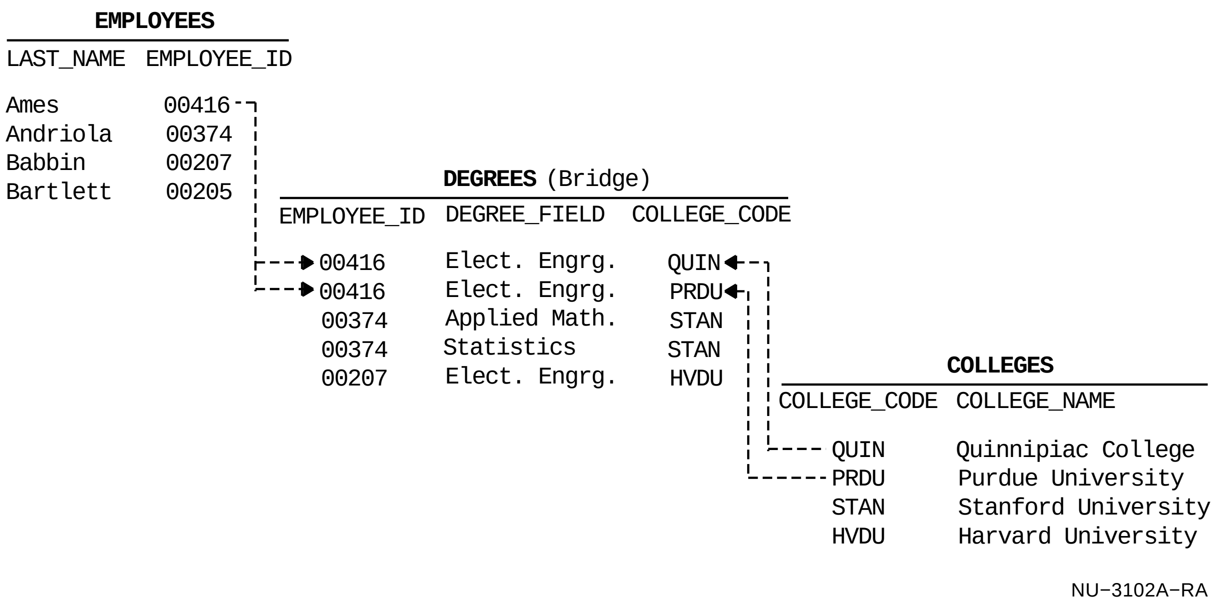
❸ Join condition for DEGREES-COLLEGES.

You must specify a join condition for every pair of tables. When joining *n* tables you should have at least *n–1* join conditions. In this example, three tables are joined so two join conditions are needed.

4.15.7 Using a Table as a Bridge Between Two Other Tables

Building on Example 4–48, you can use a table as a bridge between two others. Figure 4–1 shows that if you want to list employee names and the colleges they have degrees from, you must use the DEGREES table as a bridge between the EMPLOYEES table and the COLLEGES table.

Figure 4–1 Using a Table as a Bridge Between Two Other Tables



Example 4–49 shows the SQL statement used to perform this operation.

Example 4–49 Using the DEGREES Table as a Bridge

```
SQL> --
SQL> -- Display employee name and the colleges from
SQL> -- which he or she received degrees:
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME, COLLEGE_NAME
cont> FROM EMPLOYEES AS E, DEGREES AS D, COLLEGES AS C ❶
cont> WHERE E.EMPLOYEE_ID = D.EMPLOYEE_ID
cont> AND D.COLLEGE_CODE = C.COLLEGE_CODE
cont> ORDER BY LAST_NAME;
 E.LAST_NAME      E.FIRST_NAME   C.COLLEGE_NAME
 Ames             Louie          Purdue University
 Ames             Louie          Quinnipiac College
 Andriola         Leslie         Stanford University
 Andriola         Leslie         Stanford University
 Babbin           Joseph         Harvard University
 Babbin           Joseph         Harvard University
 Bartlett         Dean           Quinnipiac College
 Bartlett         Wes            Harvard University
 Bartlett         Wes            Harvard University
 Belliveau        Paul           Purdue University
 Belliveau        Paul           Cal. Institute of Tech.
   .
   .
   .
 Ziemke           Al             Purdue University
 Ziemke           Al             Purdue University
165 rows selected
```

The following callout is keyed to Example 4–49:

❶ An employee's name is in the EMPLOYEES table, and the college name is in the COLLEGES table. These tables have common data values with columns in the DEGREES table.

4.15.8 Joining a Table with Itself to Answer Reflexive Questions

To compare data in different rows of the same table, you can join a table with itself as if it was two different tables.

In Example 4–50, to find out for which employees the current salary amount is the same as the previous salary amount, you need to compare two rows of salary amounts from the SALARY_HISTORY table.

Example 4–50 Joining SALARY_HISTORY with Itself

```
SQL> --
SQL> -- Who has the same salary amount in their current salary row
SQL> -- as their previous salary row?
SQL> --
SQL> SELECT SH_CUR.EMPLOYEE_ID,
cont> SH_CUR.SALARY_AMOUNT,
cont> SH_PREV.SALARY_START,
cont> SH_CUR.SALARY_START
cont> FROM SALARY_HISTORY AS SH_CUR, ❶
cont> SALARY_HISTORY AS SH_PREV ❶
cont> WHERE SH_CUR.EMPLOYEE_ID = SH_PREV.EMPLOYEE_ID ❷
cont> AND SH_CUR.SALARY_START = SH_PREV.SALARY_END ❸
cont> AND SH_CUR.SALARY_END IS NULL ❹
cont> AND SH_CUR.SALARY_AMOUNT = SH_PREV.SALARY_AMOUNT; ❺
 SH_CUR.EMPLOYEE_ID   SH_CUR.SALARY_AMOUNT   SH_PREV.SALARY_START   SH_CUR.SALARY_START
 00165                $11,676.00             3-Nov-1981             1-Jul-1982
   .
   .
   .
 00232                $22,933.00             11-Sep-1981            9-May-1982
 00233                $21,160.00             1-Mar-1982             27-Oct-1982
   .
   .
   .
 00267                $80,812.00             28-Feb-1982            25-Dec-1982
 00358                $10,329.00             21-Jul-1981            18-Mar-1982
 00374                $50,424.00             15-Oct-1981            10-Oct-1982
 00418                $63,080.00             10-Nov-1981            6-Sep-1982
 00435                $84,147.00             17-Nov-1980            12-Mar-1982
27 rows selected
```

The following callouts are keyed to Example 4–50:

❶ Two copies of the SALARY_HISTORY table with different correlation names:

- SH_CUR is for the current row
- SH_PREV is for the previous row

  Crossing the two copies of the table gives all combinations of every row with all other rows of the same table.

❷ Compare rows on the same employee.

❸ SH_PREV is the last salary before current salary.

❹ SH_CUR is the current salary.

❺ Both salary amounts are the same.

Out of all the rows, it is important to determine the rows that satisfy the condition that the salary amount of the current salary is the same as the salary amount of the previous salary.

4.16 Testing SQL Statements Before Accessing the Database

SQL provides a set of statements that allows you to turn execution mode ON and OFF to test statements without accessing the database. This can be useful for debugging SQL queries without interrupting other users. Table 4–8 describes the statements that you can use to turn execution mode ON and OFF.

Table 4–8 SET EXECUTE and Associated Statements

Statement	Description
SHOW EXECUTION MODE	Use this statement to see if you are accessing the database or not. ON is the default mode and means that statements you issue will access the database.
SET NOEXECUTE	This statement turns execution mode OFF. You can test SQL statements for syntax errors without accessing the database.
SET EXECUTE	Use this statement to turn execution mode ON, thus accessing the database.

Example 4–51 shows how to use this feature.

Example 4–51 Testing SQL Queries

```
SQL> --
SQL> -- Execution mode is 'ON' by default:
SQL> --
SQL> SHOW EXECUTION MODE ❶
The EXECUTION MODE is ON
```

(continued on next page)

Example 4–51 (Cont.) Testing SQL Queries

```
SQL> --
SQL> -- Turn execution mode off:
SQL> --
SQL> SET NOEXECUTE ❷
SQL> --
SQL> -- Test SQL statement:
SQL> --
SQL> SELECT LAST_NAME, J_START FROM CURRENT_INFO WHERE JSTART < '1-JAN-1982';
%SQL-F-FLDNOTCRS, Column J_START was not found in the tables in current scope ❸
SQL> --
SQL> -- Correct query and retest:
SQL> --
SQL> SELECT LAST_NAME, JSTART FROM CURRENT_INFO WHERE JSTART < '1-JAN-1982';
0 rows selected ❹
SQL> --
SQL> -- Turn execute mode on again:
SQL> --
SQL> SET EXECUTE ❺
SQL> SHOW EXECUTION MODE
The EXECUTION MODE is ON
SQL> SELECT LAST_NAME, JSTART FROM CURRENT_INFO WHERE JSTART < '1-JAN-1982'
cont> ORDER BY JSTART;
 LAST_NAME       JSTART
 Kinmonth        12-Feb-1979
 Roberts         19-Mar-1979
 Reitchel         3-Apr-1979
 Goldstone       28-May-1979
 Sarkisian       28-Jul-1979
 Lasch            7-Aug-1979
   .
   .
   .
85 rows selected
```

The following callouts are keyed to Example 4–51:

❶ Use the SHOW EXECUTION MODE statement to see if you are accessing the database or not.

❷ SET NOEXECUTE turns off database access for your SQL statements so that you can test your queries.

❸ SQL generates the same error messages that it would in normal operating mode.

❹ Fix and retest your statements to ensure that the syntax is correct without accessing the actual data.

❺ SET EXECUTE turns on execution mode again and statements entered now will access the database.

5

Inserting, Updating, and Deleting Data

The sections in this chapter describe how to insert, update, and delete data in an Oracle Rdb database.

5.1 Transactions

All access to data in an Oracle Rdb database is done in the context of a transaction. When you include one or more related SQL commands in a transaction, those commands are treated as one unit. They must complete or be canceled as a unit for a transaction to be considered successful. This applies to operations that just read data as well as operations that add or modify data in any way. In previous sections all the operations discussed were used to read data, so it has not been critical to understand the concept of a transaction. But in the context of adding and modifying data in the database, it is important to understand that you have control over making those changes to the database contents permanent or not.

If you make changes to the data in the database by inserting new data, updating existing data, or deleting data, you must indicate to the system if the changes are to be permanent or not. All changes made in one transaction are either made permanent or disregarded as a unit, depending on the commands that you issue.

5.1.1 Starting a Transaction

Transactions can be started implicitly or explicitly.

An implicit transaction starts automatically when you issue your first SQL statement in the session. By default, this is a read/write transaction. A read/write transaction allows you to retrieve, insert, update, or delete data, as well as to create and change data structure definitions.

An explicit transaction starts when you use the SET TRANSACTION statement. This statement allows you to select specific transaction characteristics and options.

Reference Reading

The SET TRANSACTION statement is discussed in detail in the *Oracle Rdb7 SQL Reference Manual* and the *Oracle Rdb7 Guide to SQL Programming*.

5.1.2 Ending a Transaction

When you make changes to the database, you need to inform SQL as to whether you want to make the changes permanent or not. Table 5–1 describes the statements that you use to do this.

Table 5–1 Ending a Transaction

Statement	Effect
COMMIT or COMMIT WORK[1]	Makes the changes to the database permanent
ROLLBACK or ROLLBACK WORK[1]	Disregards the changes

[1]Adding WORK to the COMMIT or ROLLBACK statements can be done to make the statements comply with SQL standards, but has no effect on how the statements work.

Table 5–2 describes what happens when you exit the interactive SQL session and have made changes to the data or data definitions, but did not end the last transaction with a ROLLBACK or a COMMIT statement.

Table 5–2 Ending a Transaction When Exiting the Interactive Session

If You Exit Using . . .	SQL Automatically . . .
`QUIT`	Rolls back and exits the session.
`EXIT` or `Ctrl/Z` on OpenVMS or `Ctrl/d` on Digital UNIX	Allows you a chance to roll back. If you do not want to roll back, the changes are committed.

Detaching from a database using the DISCONNECT statement rolls back any active transaction.

If all you do in a transaction is data retrieval, there is no difference between committing and rolling back.

Note

Committed changes to the database can be reversed only by issuing the opposite write operation. If you practice with the examples in this chapter, you may want to issue the reversing operation after finishing to bring the data in the personnel database back to its previous state.

5.2 Inserting New Rows

SQL provides the INSERT statement for storing rows of data in an Oracle Rdb database. Use the INSERT statement to insert a new row into a table or view.

The general syntax of the statement is:

Syntax

```
INSERT   INTO   table-name
( column-name1, . . . , column-namen)
VALUES   ( value1, . . . ,valuen);
```

In the VALUES clause you can enter many different values and keywords. Table 5–3 lists some of them.

Table 5–3 VALUES Clause Entries

Value	Description
Literals	Constant value such as a number or character string
Parameters	Variable data from a host program
Column Select Statement	Column that specifies a one-column result table
Value Expression	Computed value or function result
NULL	Used to specify a null or empty value
Keywords	Special SQL literals (see Section 5.7 for details)

Example 5–1 and Example 5–2 show how to use the INSERT statement to add a new row to a database.

Example 5–1 Inserting a New Row (Part 1 of 2)

```
SQL> --
SQL> -- Insert a new department row:
SQL> --
SQL> INSERT INTO DEPARTMENTS
cont>    (DEPARTMENT_CODE, ❶
cont>    DEPARTMENT_NAME,
cont>    MANAGER_ID,
cont>    BUDGET_PROJECTED,
cont>    BUDGET_ACTUAL)
cont>  VALUES ❷
cont>    ('CREL', ❸
cont>    'Customer Relations', ❹
cont>    '00212',
cont>    27569, ❺
cont>    NULL ) ; ❻
1 row inserted
SQL> --
SQL> -- Check that the new row is inserted:
SQL> --
SQL> SELECT * FROM DEPARTMENTS WHERE DEPARTMENT_CODE = 'CREL' ;
 DEPARTMENT_CODE   DEPARTMENT_NAME                  MANAGER_ID ❼
   BUDGET_PROJECTED   BUDGET_ACTUAL
 CREL              Customer Relations               00212
           $27,569            NULL

1 row selected
SQL> --
SQL> -- Roll back the transaction:
SQL> --
SQL> ROLLBACK; ❽
SQL> --
SQL> -- The row you inserted is gone now:
SQL> --
SQL> SELECT * FROM DEPARTMENTS WHERE DEPARTMENT_CODE = 'CREL' ;
0 rows selected
SQL> ROLLBACK;
```

The following callouts are keyed to Example 5–1:

❶ Separate column names, as well as values, with commas.

❷ Values listed must appear in the same order as the column names list.

❸ Values should be of the same data type as the corresponding columns. Oracle Rdb converts into the column's data type if it is compatible.

❹ A character data type column requires single quotation marks around its value and is case sensitive.

❺ An integer data type column is inserted without quotes.

❻ The literal value NULL is inserted without quotes.

❼ The output in this example and following examples may be difficult to interpret because the lines have wrapped around due to their size.

❽ The row is inserted tentatively and is only visible to your transaction. If you roll back the transaction, the row is removed. If you commit the transaction, the row is inserted into the database and becomes visible to any transactions started after your transaction committed.

Example 5–2 Inserting a New Row (Part 2 of 2)

```
SQL> --
SQL> -- Insert the row again,
SQL> -- this time without listing column names
SQL> -- (List values in the order the columns
SQL> --  are defined in the table):
SQL> --
SQL> INSERT INTO DEPARTMENTS ❶
cont> VALUES
cont> ('CREL',
cont>    'Customer Relations',
cont>    '00212',
cont>    27569,
cont>    NULL ) ;
1 row inserted
SQL> --
SQL> -- Check that the new row is inserted:
SQL> --
SQL> SELECT * FROM DEPARTMENTS WHERE DEPARTMENT_CODE = 'CREL' ;
 DEPARTMENT_CODE   DEPARTMENT_NAME                  MANAGER_ID
   BUDGET_PROJECTED   BUDGET_ACTUAL
 CREL              Customer Relations               00212
            $27,569            NULL

1 row selected
```

(continued on next page)

Example 5–2 (Cont.) Inserting a New Row (Part 2 of 2)

```
SQL> --
SQL> -- Commit the change this time:
SQL> --
SQL> COMMIT; ❷
SQL> SELECT * FROM DEPARTMENTS WHERE DEPARTMENT_CODE = 'CREL' ;
 DEPARTMENT_CODE   DEPARTMENT_NAME                  MANAGER_ID
   BUDGET_PROJECTED   BUDGET_ACTUAL
 CREL              Customer Relations               00212
           $27,569            NULL
1 row selected
SQL> COMMIT;
```

The following callouts are keyed to Example 5–2:

❶ Listing column names is optional if you provide values for all columns and list them in the order that they are defined in the table. The following are disadvantages of omitting column names:

- You must know the defined order of the columns in the table.
- The order of columns may change between the time you compile a program in which you omit column names, and the time the program runs.
- The statement is less readable without the explicit specification of column names to correspond to the values listed.

It is recommended that you omit column names in the interactive session only. When using programs to change data in the database, list column names explicitly.

❷ If you commit changes, instead of rolling back, you need to perform the opposite operation to bring the sample database back to its previous state. For example, if you commit a transaction in which you have inserted a row, you have to delete the row and commit the deletion to reverse the change. See Section 5.6 for more details on deleting rows.

Reference Reading

To become familiar with how to load large amounts of data in batch processing mode, see the chapter on loading data in the *Oracle Rdb7 Guide to Database Design and Definition*.

5.2.1 Default Column Values

If you do not specify values for all the columns when inserting a row, SQL automatically inserts values to fill in the columns that you did not specify in the following way:

1. SQL checks if a default value was assigned for the column.
2. If no default value was defined for the column or for the domain that it is based on, SQL assigns the null value to the column.
3. If no default value was defined, and null values are not allowed in the column, you receive an error message, and you cannot insert the row.

When defining the database, default values can be:

- Defined directly for the column or for the domain on which the column is based
- A string, such as "NA", "?", "Unknown", or a blank for character columns
- Defined as NULL keyword, user name, the current date, the current time, or the current timestamp.

Example 5–3 shows how to determine which columns in the EMPLOYEES table have default values.

Example 5–3 Listing Default Values for the EMPLOYEES Table

```
SQL> SHOW TABLE (COLUMNS) EMPLOYEES
Information for table EMPLOYEES

Columns for table EMPLOYEES:
Column Name                     Data Type        Domain
-----------                     ---------        ------
EMPLOYEE_ID                     CHAR(5)          ID_DOM
 Primary Key constraint EMPLOYEES_PRIMARY_EMPLOYEE_ID
LAST_NAME                       CHAR(14)         LAST_NAME_DOM
FIRST_NAME                      CHAR(10)         FIRST_NAME_DOM
MIDDLE_INITIAL                  CHAR(1)          MIDDLE_INITIAL_DOM
ADDRESS_DATA_1                  CHAR(25)         ADDRESS_DATA_1_DOM
ADDRESS_DATA_2                  CHAR(20)         ADDRESS_DATA_2_DOM
CITY                            CHAR(20)         CITY_DOM
STATE                           CHAR(2)          STATE_DOM
POSTAL_CODE                     CHAR(5)          POSTAL_CODE_DOM
SEX                             CHAR(1)          SEX_DOM
BIRTHDAY                        DATE VMS         DATE_DOM
STATUS_CODE                     CHAR(1)          STATUS_CODE_DOM
```

(continued on next page)

Example 5–3 (Cont.) Listing Default Values for the EMPLOYEES Table

```
SQL> SHOW DOMAIN STATUS_CODE_DOM
STATUS_CODE_DOM                 CHAR(1)
 Comment:       standard definition of employment status codes
 Oracle Rdb default: N ❶
SQL> SHOW DOMAIN ADDRESS_DATA_1_DOM
ADDRESS_DATA_1_DOM              CHAR(25)
 Comment:       standard definition for street addresses
 Oracle Rdb default:   ❷
SQL> SHOW DOMAIN FIRST_NAME_DOM
FIRST_NAME_DOM                  CHAR(10) ❸
 Comment:       standard definition of first name
SQL> SHOW DOMAIN SEX_DOM
SEX_DOM                         CHAR(1)
 Comment:       standard definition for sex
 Oracle Rdb default: ?
```

The following callouts are keyed to Example 5–3:

❶ This is where you see the default value defined for the domain. In this case, the value is the letter "N".

❷ If the "Oracle Rdb default:" has no value in it, it actually has a blank as a default value.

❸ If the domain definition does not have the line stating "Oracle Rdb default", there is no default value defined for the domain.

Example 5–4 shows how default values are inserted automatically when you insert an employee row without specifying values for all columns.

The columns MIDDLE_INITIAL, ADDRESS_DATA_1, ADDRESS_DATA_2, CITY, STATE, and POSTAL_CODE have a blank as a default value. The default value for STATUS_CODE is "N" and for SEX is "?".

BIRTHDAY has no default value so NULL is inserted.

Example 5–4 Inserting an Incomplete Row

```
SQL> --
SQL> -- Insert an employee row
SQL> -- specifying only EMPLOYEE_ID, LAST_NAME, and FIRST_NAME:
SQL> --
SQL> INSERT INTO EMPLOYEES
cont>    (EMPLOYEE_ID, LAST_NAME, FIRST_NAME)
cont>    VALUES
cont>    ('00500', 'Hermit', 'Herman') ;
1 row inserted
SQL> --
SQL> -- Display the default values for that employee:
SQL> --
SQL> SELECT MIDDLE_INITIAL, ADDRESS_DATA_1,
cont> POSTAL_CODE, STATUS_CODE, SEX
cont> FROM EMPLOYEES
cont> WHERE EMPLOYEE_ID = '00500';
 MIDDLE_INITIAL   ADDRESS_DATA_1             POSTAL_CODE   STATUS_CODE   SEX
                                                           N             ?
1 row selected
```

5.2.2 Using the INSERT Statement to Copy Data from Another Table

Use the SELECT expression to select the applicable rows and columns from the source table. Those rows are then inserted into the target table specified in the INSERT statement.

To add constant values to the ones that you copy from the source table, include those values in the SELECT expression.

The general syntax of the statement is:

Syntax INSERT INTO table-name [(column-name1, . . . ,column-name*n*)]
SELECT expression ;

Example 5–5 shows how to copy the data of a new employee from the CANDIDATES table into the EMPLOYEES table. Because not all of the data needed in the EMPLOYEES table is available in the CANDIDATES table, some constant values are added in the SELECT expression.

Example 5–5 Copying a Row from One Table to Another

```
SQL> --
SQL> -- We hired Schwartz.
SQL> -- Copy her personal data from the candidates table.
SQL> -- (Add SEX and EMPLOYEE_ID column values):
SQL> --
SQL> INSERT INTO EMPLOYEES
cont>    (EMPLOYEE_ID, ❶
cont>    LAST_NAME,
cont>    FIRST_NAME,
cont>    MIDDLE_INITIAL,
cont>    SEX)
cont>  SELECT '00501', ❷
cont>    LAST_NAME, ❸
cont>     FIRST_NAME,
cont>     MIDDLE_INITIAL,
cont>     'F' ❷
cont> FROM CANDIDATES
cont> WHERE LAST_NAME = 'Schwartz' ;
1 row inserted
SQL> --
SQL> -- Display the employee's information:
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME, MIDDLE_INITIAL, SEX
cont> FROM EMPLOYEES
cont> WHERE EMPLOYEE_ID = '00501';
 LAST_NAME        FIRST_NAME   MIDDLE_INITIAL   SEX
 Schwartz         Trixie       R                F
1 row selected
SQL> COMMIT;
```

The following callouts are keyed to Example 5–5:

❶ Listing column names is optional. If you do not list column names, values created by the SELECT expression must correspond to the columns in the target table.

❷ EMPLOYEE_ID and SEX are added as literal values in the SELECT expression to complete the data needed in the row of the target table.

❸ Because it is a sample database, only three columns from the CANDIDATES table are applicable to the EMPLOYEES table. In real applications there would probably be more columns in the CANDIDATES table to justify copying from one table to another.

5.2.3 Inserting the Results of a Calculated Column Expression

A retrieved or calculated value can be inserted into a row, as shown in Example 5–6.

Example 5–6 Inserting a Calculated Value into a Row

```
SQL> -- Insert a new department row for
SQL> -- Customer Services
SQL> -- with a projected budget
SQL> -- 10% higher than that of Customer Relations:
SQL> --
SQL> INSERT INTO DEPARTMENTS
cont> VALUES
cont> ('CRSR',
cont> 'Customer Services',
cont> '00213',
cont>  (SELECT BUDGET_PROJECTED * 1.1 FROM ➊
cont> DEPARTMENTS WHERE DEPARTMENT_CODE = 'CREL'),
cont> NULL);
1 row inserted
SQL> --
SQL> SELECT BUDGET_PROJECTED FROM DEPARTMENTS
cont> WHERE DEPARTMENT_CODE = 'CRSR';
 BUDGET_PROJECTED
          $30,326
1 row selected
SQL> COMMIT;
```

The following callout is keyed to Example 5–6:

➊ A SELECT statement used to retrieve or calculate an inserted value must specify a one-value result table. SQL functions such as AVG, CAST, COUNT, SUM, MAX, MIN, UPPER, LOWER, and others may also be used to calculate, convert, or reformat inserted values.

5.3 Updating Rows

To modify values in existing rows, use the UPDATE statement. Unlike inserting rows, updating rows is a more complex operation that involves selecting the row (or set of rows) that you want to modify.

The general syntax of the statement is:

Syntax UPDATE table-name
SET column-name1 = value, . . . , column-name*n* = value
[WHERE condition] ;

When using the UPDATE statement:

- Specify which table is to be updated in the UPDATE statement.
- In the SET clause, specify which column to change, and the new value to use for that column.
  - The new value can be any of the values that are valid for the INSERT statement (see Table 5–3).
- The WHERE clause is optional. If you specify a condition with this clause, only those rows that satisfy the condition will be updated to contain the new value. If you omit this clause, all rows of the table will be updated.

Example 5–7 shows how to update values using a new value, a value from another column, and a computed value.

Example 5–7 Updating Rows

```
SQL> --
SQL> -- D’Amico is replacing Herbener
SQL> -- as the manager of the Engineering Department:
SQL> --
SQL> UPDATE DEPARTMENTS
cont> SET MANAGER_ID = ’00171’
cont> WHERE DEPARTMENT_NAME = ’Engineering’;
1 row updated
SQL> --
SQL> SELECT DEPARTMENT_CODE, MANAGER_ID
cont> FROM DEPARTMENTS
cont> WHERE DEPARTMENT_NAME = ’Engineering’;
 DEPARTMENT_CODE   MANAGER_ID
 ENG               00171
1 row selected
SQL> COMMIT;
```

(continued on next page)

Example 5–7 (Cont.) Updating Rows

```
SQL> --
SQL> -- Make the value of minimum salaries of each job
SQL> -- the same amount as its current maximum salary:
SQL> --
SQL> UPDATE JOBS
cont> SET MINIMUM_SALARY = MAXIMUM_SALARY ;
15 rows updated
SQL> SELECT * FROM JOBS;
 JOB_CODE   WAGE_CLASS   JOB_TITLE              MINIMUM_SALARY   MAXIMUM_SALARY
 APGM       4            Associate Programmer       $24,000.00       $24,000.00
 CLRK       2            Clerk                      $20,000.00       $20,000.00
 ASCK       2            Assistant Clerk            $15,000.00       $15,000.00
 DMGR       4            Department Manager        $100,000.00      $100,000.00
    .
    .
    .
 SANL       4            Systems Analyst            $60,000.00       $60,000.00
 SCTR       3            Secretary                  $25,000.00       $25,000.00
 SPGM       4            Systems Programmer         $50,000.00       $50,000.00
 VPSD       4            Vice President            $150,000.00      $150,000.00
15 rows selected
SQL> --
SQL> --  Raise the maximum salary by 50%:
SQL> --
SQL> UPDATE JOBS
cont> SET MAXIMUM_SALARY = MAXIMUM_SALARY * 1.5 ;
15 rows updated
SQL> SELECT * FROM JOBS;
 JOB_CODE   WAGE_CLASS   JOB_TITLE              MINIMUM_SALARY   MAXIMUM_SALARY
 APGM       4            Associate Programmer       $24,000.00       $36,000.00
 CLRK       2            Clerk                      $20,000.00       $30,000.00
 ASCK       2            Assistant Clerk            $15,000.00       $22,500.00
 DMGR       4            Department Manager        $100,000.00      $150,000.00
    .
    .
    .
 SANL       4            Systems Analyst            $60,000.00       $90,000.00
 SCTR       3            Secretary                  $25,000.00       $37,500.00
 SPGM       4            Systems Programmer         $50,000.00       $75,000.00
 VPSD       4            Vice President            $150,000.00      $225,000.00
15 rows selected
SQL> ROLLBACK;
```

5.4 Changing Data Using Views

If views are used as a security mechanism that allows groups of users to access the view, but not the underlying tables, your application may have to allow those groups of users to update data only through the views and not directly in the underlying tables.

There are two types of views that can be created:

- Simple view
- Read-only view

A simple view can be updated, and when it is, the underlying table is automatically updated. If each output row of the view is based on just one row of one table, then the view is generally considered to be updatable.

Views that contain the criteria in the following list are generally considered read-only views or complex views by SQL. Because it is impossible for SQL to associate an update with a row from the original table on which the view is based, this type of view cannot be updated.

- The view is defined using columns from more than one table.
- The view contains a function, such as COUNT or AVG, in its definition.
- The view contains one or more of the following clauses or keywords:
  - DISTINCT
  - GROUP BY
  - HAVING

Example 5–8 shows a read-only view. It is considered read-only because the definition of the view is based on more than one table.

Example 5–8 Displaying a Read-Only View

```
SQL> SHOW VIEW CURRENT_JOB
Information for table CURRENT_JOB
```

(continued on next page)

Example 5–8 (Cont.) Displaying a Read-Only View

```
Columns for view CURRENT_JOB:
Column Name                     Data Type        Domain
-----------                     ---------        ------
LAST_NAME                       CHAR(14)
   .
   .
   .
 Source:
        SELECT  E.LAST_NAME,
                E.FIRST_NAME,
                E.EMPLOYEE_ID,
               JH.JOB_CODE,
               JH.DEPARTMENT_CODE,
               JH.SUPERVISOR_ID,
               JH.JOB_START
          FROM JOB_HISTORY JH,
               EMPLOYEES E
         WHERE JH.EMPLOYEE_ID = E.EMPLOYEE_ID
               AND JH.JOB_END IS NULL
```

5.5 Conversion of Data Type in INSERT and UPDATE Statements

The data inserted or modified in a column should match the data type of the column. Oracle Rdb attempts to convert the data into another data type if the types do not match. If it is impossible to convert the data, Oracle Rdb displays an error message and does not insert the row, as shown in Example 5–9. Remember, however, that for best performance, use compatible data types. The CAST function can be used to explicitly convert data types.

Example 5–9 Inserting an Unmatched Data Type

```
SQL> --
SQL> -- First, insert a new employee into EMPLOYEES:
SQL> --
SQL> INSERT INTO EMPLOYEES
cont> (EMPLOYEE_ID) VALUES ('00500');
1 row inserted
```

(continued on next page)

Example 5–9 (Cont.) Inserting an Unmatched Data Type

```
SQL> --
SQL> -- Insert a SALARY_HISTORY row for the new employee
SQL> -- with a salary amount as a string, instead of an integer:
SQL> --
SQL> INSERT INTO SALARY_HISTORY
cont> (EMPLOYEE_ID, SALARY_AMOUNT)
cont> VALUES
cont> ('00500', '20000');
%SQL-I-STRCVTNUM, String literal will be converted to numeric ➊
1 row inserted
SQL> SELECT * FROM SALARY_HISTORY
cont> WHERE EMPLOYEE_ID = '00500';
 EMPLOYEE_ID   SALARY_AMOUNT   SALARY_START   SALARY_END
 00500            $20,000.00   NULL           NULL
1 row selected
SQL> --
SQL> -- UPDATE THE SALARY_HISTORY row with SALARY_AMOUNT
SQL> -- as a string that cannot be turned into a number:
SQL> --
SQL> UPDATE SALARY_HISTORY
cont> SET SALARY_AMOUNT = 'XXXX'
cont> WHERE EMPLOYEE_ID = '00500';
%SQL-I-STRCVTNUM, String literal will be converted to numeric
%RDB-E-ARITH_EXCEPT, truncation of a numeric value at runtime
-OTS-F-INPCONERR, input conversion error ➋
SQL> SELECT * FROM SALARY_HISTORY
cont> WHERE EMPLOYEE_ID = '00500';
 EMPLOYEE_ID   SALARY_AMOUNT   SALARY_START   SALARY_END
 00500            $20,000.00   NULL           NULL
1 row selected
SQL> ROLLBACK;
```

The following callouts are keyed to Example 5–9:

➊ SQL was able to successfully convert the text string entered to a numeric.

➋ SQL could not convert this entry and SALARY_AMOUNT was unchanged.

5.6 Deleting Rows

The DELETE statement is very powerful. If you do not specify a condition for the deletion, all the rows of the table are deleted. Remember to specify a condition with the WHERE clause to limit the deletion to the rows that satisfy that condition.

Note

It is recommended that you first issue a SELECT statement with the same condition as you intend to use in your WHERE clause for the DELETE statement. Doing so allows you to check that you are going to delete the intended set of rows.

The general syntax of the statement is:

Syntax

```
DELETE FROM table-name
[ WHERE condition ] ;
```

Example 5–10 shows the use of the DELETE statement.

Example 5–10 Deleting Rows

```
SQL> --
SQL> -- List the WORK_STATUS table contents:
SQL> --
SQL> SELECT * FROM WORK_STATUS WHERE STATUS_NAME='INACTIVE'; ❶
 STATUS_CODE   STATUS_NAME   STATUS_TYPE
 0             INACTIVE      RECORD EXPIRED
1 rows selected
SQL> --
SQL> -- Delete the inactive work status:
SQL> --
SQL> DELETE FROM WORK_STATUS
cont> WHERE STATUS_NAME = 'INACTIVE'; ❷
1 row deleted
SQL> SELECT * FROM WORK_STATUS;
 STATUS_CODE   STATUS_NAME   STATUS_TYPE
 1             ACTIVE        FULL TIME
 2             ACTIVE        PART TIME
2 rows selected
SQL> --
SQL> -- Delete all rows of WORK_STATUS table:
SQL> --
SQL> DELETE FROM WORK_STATUS; ❸
2 rows deleted
SQL> --
SQL> SELECT * FROM WORK_STATUS ;
0 rows selected
SQL> ROLLBACK; ❹
```

The following callouts are keyed to Example 5–10:

❶ Use the WHERE clause you intend to use in the DELETE statement to make certain you will delete the intended records.

❷ Use the same WHERE clause in your DELETE statement.

❸ This statement deletes all rows in the table.

❹ The ROLLBACK statement restores all rows deleted during the transaction.

5.7 Using Special SQL Keywords

The keywords in Table 5–4 produce literals with special meaning for SQL.

Table 5–4 SQL Keywords

Keyword	Description
USER[1]	Specifies the user name of the process that invokes interactive SQL or runs a program.
CURRENT_USER	Specifies the current active user name for a request.
SESSION_USER[2]	Specifies the current active session user name.
SYSTEM_USER	Specifies the user name of the login process at the time of the database attach.
CURRENT_DATE	Specifies the current year, month, and day when the statement is executed.
CURRENT_TIME	Specifies the current hour, minute, and second when the statement is executed.
CURRENT_TIMESTAMP	Specifies the current date and time when the statement is executed.

[1]If you have specified SQL92 dialect, USER is a synonym for CURRENT_USER. For other dialects, USER is a synonym for SYSTEM_USER. To become familiar with SQL dialects, see the SET DIALECT statement description in the *Oracle Rdb7 SQL Reference Manual*.

[2]If no session user name exists, the SYSTEM_USER name is inserted.

You can use the keywords when inserting or retrieving data. You can also use them to compare to existing values in a column, to insert new rows into a table, or to update values in a column. This section discusses the CURRENT_USER and CURRENT_TIMESTAMP keywords.

For more details on these and other keywords, see the *Oracle Rdb7 SQL Reference Manual*.

5.7.1 Using the CURRENT_USER Keyword

Assigning the CURRENT_USER keyword to a column enters the system user name from the user's process as follows:

- In an interactive session, the system user name is the name of the process running the session.
- In a program, the system user name is the name of the process in which the program runs or it is the authorization ID.
- On OpenVMS, the system user name is entered in the column in uppercase.

• On Digital UNIX, the system user name is entered in the column in lowercase.

The examples in this chapter display the Digital UNIX convention.

Using CURRENT_USER is convenient when your application needs to keep information about the user who is running the program; for example, if you need to track the identity of a salesperson who made a sale that was entered into the database. You can also select a row based on the value of the CURRENT_USER.

Example 5–11 shows the use of the CURRENT_USER keyword.

Example 5–11 Inserting and Retrieving the CURRENT_USER Value

```
SQL> INSERT INTO EMPLOYEES
cont>   (EMPLOYEE_ID,
cont>    LAST_NAME,
cont>    FIRST_NAME,
cont>    MIDDLE_INITIAL,
cont>    ADDRESS_DATA_1,
cont>    ADDRESS_DATA_2,
cont>    CITY,
cont>    STATE,
cont>    POSTAL_CODE,
cont>    SEX,
cont>    BIRTHDAY,
cont>    STATUS_CODE)
cont>  VALUES
cont>   ('00500',
cont>    CURRENT_USER, ❶
cont>    'WHO?',
cont>    'Y',
cont>    'Over the Rainbow',
cont>    '',
cont>    'Somewhere',
cont>    'KN',
cont>    '99999',
cont>    'M',
cont>    '01-JAN-1960',
cont>    '0');
%SQL-W-LENMISMAT, Truncating right hand side string for assignment to
 column LAST_NAME ❷
1 row inserted
```

(continued on next page)

Example 5–11 (Cont.) Inserting and Retrieving the CURRENT_USER Value

```
SQL> SELECT LAST_NAME FROM EMPLOYEES WHERE LAST_NAME = CURRENT_USER;
 LAST_NAME
 smith ❸
1 row selected
SQL> ROLLBACK;
```

The following callouts are keyed to Example 5–11:

❶ Insert CURRENT_USER for LAST_NAME.

❷ Because the system user identifier data type is greater than the LAST_NAME data type, the value for CURRENT_USER is truncated. This is not an issue if the user identifier is a short name with several trailing blanks. If the user identifier is longer than 14 characters, the truncation will be noticeable.

❸ The name is inserted.

5.7.2 Using the CURRENT_TIMESTAMP Keyword

The CURRENT_TIMESTAMP keyword can be used in place of any date expression or literal. It generates the current date and time when you issue an interactive statement, or the current date and time that the statement is executed when your program runs.

The date and time is formatted according to the format specified for the session.

The column may contain more information than is displayed when you select the column that stores the CURRENT_TIMESTAMP value. For instance, if you insert the CURRENT_TIMESTAMP value into a JOB_END column, the time as well as the date is stored in the database. However, only the date is displayed by the column, as specified by the edit string definition of DATE_DOM on which the column is based.

Example 5–12 shows the use of the CURRENT_TIMESTAMP keyword.

Example 5–12 Using the CURRENT_TIMESTAMP Keyword

```
SQL> -- In December 1993, employee number 165 is taking a leave of absence.
SQL> -- End his current job description
SQL> -- without opening a new one:
SQL> --
SQL> SELECT * FROM JOB_HISTORY
cont> WHERE EMPLOYEE_ID = '00165'
cont> AND JOB_END IS NULL;
 EMPLOYEE_ID   JOB_CODE   JOB_START     JOB_END       DEPARTMENT_CODE
   SUPERVISOR_ID
 00165         ASCK        8-Mar-1981   NULL          MBMF
   00227

1 row selected
SQL> UPDATE JOB_HISTORY
cont> SET JOB_END = CURRENT_TIMESTAMP ❶
cont> WHERE EMPLOYEE_ID = '00165'
cont> AND JOB_END IS NULL;
1 row updated
SQL> SELECT * FROM JOB_HISTORY
cont> WHERE EMPLOYEE_ID = '00165';
 EMPLOYEE_ID   JOB_CODE   JOB_START     JOB_END       DEPARTMENT_CODE
   SUPERVISOR_ID
 00165         ASCK        1-Jul-1975    4-Sep-1977   PHRN
   00201

 00165         ASCK        5-Sep-1977    7-Apr-1979   ELGS
   00276

 00165         ASCK        8-Apr-1979    7-Mar-1981   MTEL
   00248

 00165         ASCK        8-Mar-1981    1-Mar-1995❷ MBMF
   00227

4 rows selected
SQL> COMMIT;
```

The following callouts are keyed to Example 5–12:

❶ Update the JOB_END column with the CURRENT_TIMESTAMP in the most recent JOB_HISTORY row.

❷ The output shows that the row has been updated with the current date.

5.8 How Constraints Affect Write Operations

INSERT, UPDATE, and DELETE operations are collectively referred to as write operations.

When you insert new data, or modify or delete existing data, Oracle Rdb checks if the data violates any constraint defined on the column or on the table.

When tables and columns are created, constraints are defined as either:

Deferrable	Evaluation time can be deferred until a COMMIT statement is executed. You may perform many operations in one transaction, but only when you try to commit will you know if any one of them is invalid.
Not Deferrable	Evaluated when the INSERT, UPDATE, or DELETE statement is executed. You will receive an error message immediately after attempting to insert, update, or delete if you are using invalid data values.

When you define a constraint in the database, the default evaluation time is set to be when an SQL statement is executed. You may change the constraint evaluation time for the interactive session, for a transaction, or for a program that you are compiling.

The constraints in Table 5–5 can be defined as table constraints or as column constraints. Using table constraints enables you to define a constraint on a combination of columns, rather than on a single column.

For example, a primary key constraint for a multicolumn primary key must be defined as a table constraint, whereas a single-column primary key constraint can be defined at either the column or the table level.

Table 5–5 Constraints on Tables and Columns

Constraint	Requires Values to . . .
CHECK condition	Satisfy the condition
UNIQUE column-name, . . .	Be unique
NOT NULL	Have a value other than NULL (column constraint only)
PRIMARY KEY column-name, . . .	Be unique and not NULL
REFERENCES table-name	Use an existing value in another table (column constraint only)
FOREIGN KEY column-name REFERENCES table-name	Use an existing primary key value in another table (table constraint only)

Reference Reading

The *Oracle Rdb7 SQL Reference Manual* and the *Oracle Rdb7 Guide to SQL Programming* have detailed discussions on constraint definition and evaluation.

The SHOW TABLE statement displays all constraints defined on the table, as well as all constraints in other tables that are referencing this table. A foreign key constraint, for example, is described in its own table, and in the table of the primary key that it references.

Example 5–13 shows the constraints defined on the DEPARTMENTS table.

Example 5–13 Looking at Primary and Foreign Key Constraints

```
SQL> SHOW TABLE (CONSTRAINTS) DEPARTMENTS
Information for table DEPARTMENTS

Table constraints for DEPARTMENTS:
DEPARTMENTS_PRIMARY1 ❶
 Primary Key constraint
 Column constraint for DEPARTMENTS.DEPARTMENT_CODE
 Evaluated on COMMIT ❷
 Source:
        DEPARTMENTS.DEPARTMENT_CODE PRIMARY KEY

Constraints referencing table DEPARTMENTS:
JOB_HISTORY_FOREIGN3 ❸
 Foreign Key constraint
 Column constraint for JOB_HISTORY.DEPARTMENT_CODE
 Evaluated on COMMIT ❹
 Source:
        JOB_HISTORY.DEPARTMENT_CODE REFERENCES DEPARTMENTS (DEPARTMENT_CODE)
```

The following callouts are keyed to Example 5–13:

❶ DEPARTMENTS_PRIMARY1 is a primary key constraint on the DEPARTMENT_CODE column of the DEPARTMENTS table. Values must be unique and not null.

❷ It will be evaluated when the transaction is committed.

❸ JOB_HISTORY_FOREIGN3 is a foreign key constraint on the DEPARTMENT_CODE column of the JOB_HISTORY table. It references the DEPARTMENT_CODE column of the DEPARTMENTS table and is used to ensure that no department code is entered in the JOB_HISTORY table that does not already exist in the DEPARTMENTS table.

❹ It will also be evaluated when the transaction is committed.

When a constraint is evaluated, the violating change is not rolled back automatically. You must roll back the transaction manually. If you do not roll back the transaction, you will not be able to commit succeeding changes made to the database. Example 5–14 demonstrates this.

Example 5–14 Violation of a Primary Key Constraint

```
SQL> --
SQL> -- Insert a new department row that uses
SQL> -- a department code that already exists in the database:
SQL> --
SQL> INSERT INTO DEPARTMENTS
cont> (DEPARTMENT_CODE, DEPARTMENT_NAME)
cont> VALUES
cont> ('ELEL', 'Elevator Maintenance');
%RDB-E-NO_DUP, index field value already exists; duplicates not allowed for DEPA
RTMENTS_INDEX ➊
SQL> SELECT * FROM DEPARTMENTS WHERE DEPARTMENT_CODE = 'ELEL';
 DEPARTMENT_CODE   DEPARTMENT_NAME                  MANAGER_ID
   BUDGET_PROJECTED   BUDGET_ACTUAL
 ELEL              Electronics Engineering          00188
               NULL            NULL

1 row selected
SQL> EXIT
There are uncommitted changes to this database.
Would you like a chance to ROLLBACK these changes (No)? YES ➋
SQL> ROLLBACK;
```

The following callouts are keyed to Example 5–14:

➊ Because this operation failed the primary key constraint on the DEPARTMENTS table, an error message is displayed.

➋ You must manually roll back the transaction even though it failed.

5.9 Write Operations That Activate Triggers

Triggers are used to specify one or more automatic write operations that will take place before or after a write operation changes the data in a database. They are used to help maintain the integrity of the data. It is important to be aware of what triggers have been defined on the database because:

- As an application programmer, you need to be aware of existing triggers so that you will know which operations are going to take place automatically when you update or delete data.

  You may sometimes want, for example, to save data from a row that is going to be deleted as a result of a trigger.

- A well-designed trigger saves work for the application programmer and helps to maintain the integrity of the data by taking care of operations that are always required when certain SQL statements take place.

The triggers that are defined on a table are included in the output for the SHOW TABLE and SHOW TRIGGERS statements. The output from these SQL statements shows the definition of the action that the trigger causes.

Example 5–15 shows the triggers that are defined on the mf_personnel database and details of the EMPLOYEE_ID_CASCADE_DELETE trigger.

Example 5–15 Using the SHOW TRIGGERS Statement

```
SQL> SHOW TRIGGERS
User triggers in database with filename mf_personnel
     COLLEGE_CODE_CASCADE_UPDATE
     EMPLOYEE_ID_CASCADE_DELETE
     STATUS_CODE_CASCADE_UPDATE
SQL> --
SQL> SHOW TRIGGER EMPLOYEE_ID_CASCADE_DELETE
     EMPLOYEE_ID_CASCADE_DELETE
 Source:
 EMPLOYEE_ID_CASCADE_DELETE
                       BEFORE DELETE ON EMPLOYEES
                       (DELETE FROM DEGREES D WHERE D.EMPLOYEE_ID =
                        EMPLOYEES.EMPLOYEE_ID)
                          FOR EACH ROW
                       (DELETE FROM JOB_HISTORY JH WHERE JH.EMPLOYEE_ID =
                        EMPLOYEES.EMPLOYEE_ID)
                          FOR EACH ROW
                       (DELETE FROM SALARY_HISTORY SH WHERE SH.EMPLOYEE_ID =
                        EMPLOYEES.EMPLOYEE_ID)
                          FOR EACH ROW
                     ! Also, if an employee is terminated and that employee
                     ! is the manager of a department, set the manager_id
                     ! null for that department.
                       (UPDATE DEPARTMENTS D  SET D.MANAGER_ID = NULL
                        WHERE D.MANAGER_ID = EMPLOYEES.EMPLOYEE_ID)
                          FOR EACH ROW
```

The EMPLOYEE_ID_CASCADE_DELETE trigger is defined on the EMPLOYEES table and specifies that before the employee is deleted from the EMPLOYEES table, all rows for that employee are deleted from the DEGREES, JOB_HISTORY, and SALARY_HISTORY tables. Also, if the employee is a department manager, the MANAGER_ID is set to a null value in the DEPARTMENTS table.

This trigger is an example of a trigger that enhances the integrity of the database and saves the programmer time by automatically deleting rows of data from other tables that are referenced in a foreign key relationship.

Example 5–16 shows the data in the affected tables before the data is deleted, and that the JOB_HISTORY and SALARY_HISTORY tables are automatically changed after the employee's data is deleted from the EMPLOYEES table.

Example 5–16 Values of EMPLOYEES and JOB_HISTORY Before the Update

```
SQL> --
SQL> -- Display the content of the EMPLOYEES table for employee 00170:
SQL> --
SQL> SELECT * FROM EMPLOYEES WHERE EMPLOYEE_ID = '00170';
 EMPLOYEE_ID   LAST_NAME        FIRST_NAME   MIDDLE_INITIAL
   ADDRESS_DATA_1              ADDRESS_DATA_2         CITY
      STATE   POSTAL_CODE   SEX    BIRTHDAY      STATUS_CODE
 00170         Wood             Brian        NULL
   140 Searles Rd.                                    Jefferson
      NH      03583         M       3-Jun-1957   1

1 row selected
SQL> --
SQL> -- Display the JOB_HISTORY for employee 00170:
SQL> --
SQL> SELECT * FROM JOB_HISTORY
cont> WHERE EMPLOYEE_ID = '00170';
 EMPLOYEE_ID   JOB_CODE   JOB_START     JOB_END       DEPARTMENT_CODE
   SUPERVISOR_ID
 00170         SCTR       26-Nov-1980   NULL          MCBM
   00195

1 row selected
SQL> --
SQL> -- Employee 00170 leaves the company:
SQL> --
SQL> DELETE FROM EMPLOYEES
cont> WHERE EMPLOYEE_ID = '00170';
1 row deleted
SQL> --
SQL> -- Look at the modified EMPLOYEES table:
SQL> --
SQL> SELECT * FROM EMPLOYEES
cont> WHERE EMPLOYEE_ID = '00170';
0 rows selected
SQL> --
SQL> -- The employee's JOB_HISTORY entries
SQL> -- are automatically deleted:
SQL> --
SQL> SELECT * FROM JOB_HISTORY
cont> WHERE EMPLOYEE_ID = '00170';
0 rows selected
```

(continued on next page)

Example 5–16 (Cont.) Values of EMPLOYEES and JOB_HISTORY Before the Update

```
SQL> --
SQL> -- The employee's SALARY_HISTORY entries
SQL> -- are automatically deleted as well:
SQL> --
SQL> SELECT * FROM SALARY_HISTORY
cont> WHERE EMPLOYEE_ID = '00170';
0 rows selected
SQL> --
SQL> ROLLBACK;
```

6
Advanced Data Manipulation

Because the SELECT statement is the only SQL statement for retrieving data, its syntax allows for the construction of complex queries. Queries can be combined in structures of nested subqueries, or they can be combined with a UNION operation or explicit and implicit JOIN operators to produce combinations of result tables.

This chapter demonstrates the use of these complex queries and covers other advanced retrieval subjects, such as retrieving data from system tables.

Reference Reading

The *Oracle Rdb7 SQL Reference Manual* contains more information on the topics discussed in this chapter.

6.1 Using Subqueries to Answer Complex Questions

By using a subquery structure you can:

- Substitute a constant value with another query when testing column values.
- Obtain data from more than one table (an alternative to join).
- Answer complex questions for which you cannot use a simple join.

6.1.1 Developing Subqueries

When developing subqueries, make sure the subquery:

- Evaluates to a single row when used with operands that accept a single value; for example, when the subquery is used with comparison operators.
- Is of the same domain as the column to which it is compared. You do not receive an error message if you compare birthday with city, for example, but it does not make sense.

Example 6–1 shows how to build and use a basic subquery in place of a single constant value. The first part of this example shows two queries; the first query finds the city where Walter Nash lives, the second query finds out who else lives in the same city as Walter Nash. The second part of this example combines the previous two queries. This is achieved by equating the CITY column name with a select expression, instead of a string constant. In this example, the city name is substituted with a query that finds the city where employee number 183 (Walter Nash) lives.

Example 6–1 Substituting a Subquery for a Constant Value

```
SQL> --
SQL> -- What city does employee number 00183 (Walter Nash) live in?
SQL> --
SQL> SELECT CITY
cont> FROM EMPLOYEES
cont> WHERE EMPLOYEE_ID = ’00183’;
 CITY
 Fremont
1 row selected
SQL> --
SQL> -- Who else lives in that city?
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME
cont> FROM EMPLOYEES
cont> WHERE CITY = ’Fremont’;
 LAST_NAME        FIRST_NAME
 O’Sullivan       Rick
 Nash             Walter
 Clarke           Mary
 Myotte           Charles
 Gaudet           Johanna
 Harrington       Margaret
 Robinson         Tom
7 rows selected
```

(continued on next page)

Example 6–1 (Cont.) Substituting a Subquery for a Constant Value

```
SQL> --
SQL> -- Combining the two queries
SQL> -- into one structure
SQL> -- of a main (outer) query and a nested (inner) query:
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME
cont> FROM EMPLOYEES
cont> WHERE CITY =
cont>       (SELECT CITY
cont>        FROM EMPLOYEES
cont>        WHERE EMPLOYEE_ID = '00183');
 LAST_NAME        FIRST_NAME
 O'Sullivan       Rick
 Nash             Walter
 Clarke           Mary
 Myotte           Charles
 Gaudet           Johanna
 Harrington       Margaret
 Robinson         Tom
7 rows selected
```

6.1.2 Subqueries and Joins

You can use different types of queries to produce the same result table. For example, often you can obtain the same result table by using a subquery or by joining multiple tables. It is also possible to construct many equivalent queries using subqueries combined with different operators.

The following are examples of cases when it is more difficult or impossible to construct the query by using a join:

- Queries that use the NOT EXISTS predicate cannot be constructed with a join (see Example 6–4).
- Queries to create bill of materials reports can be difficult to produce with a join if the report must list all parts and subparts of an item.
- Queries that include functions that must specify columns that are not allowed in the select-list because of the restrictions imposed by the GROUP BY clause (see Section 4.14) are not possible.

6.1.3 General Format for Using Subqueries

You may use subqueries with both the WHERE and the HAVING clauses.

The general syntax for using a subquery is:

Syntax

```
SELECT . . .
FROM . . .
WHERE     value-or-column-name     operator     (subquery) ;
```

The WHERE clause is constructed from the following elements:

- The value or column name can be:
  - Constant value, for example, 00164
  - Column name, for example, EMPLOYEE_ID
- Any of the following operators (predicates):
  - IN
  - EXISTS
  - SINGLE
  - CONTAINING
  - STARTING WITH
  - BETWEEN
  - Comparison operators, such as equal (=) or greater than (>)
  - A quantified predicate, which is a condition that combines a comparison operator with one of the following keywords:

    ALL
    ANY
    SOME

The form of the SELECT statement that is used for a subquery is called a **column select expression**. A column select expression is a SELECT statement whose result is one column of data. It may contain one or more rows, but is always one column.

The reason for this restriction is that the result of the subquery is compared to either a constant value or to values of one column in the outer query. In Example 6–1, the result of the subquery was compared to the column CITY in the EMPLOYEES table. The CITY values cannot be compared to values from multiple columns.

For the same reason, the column selected as a result of the subquery should be of the same data type as the column or constant in the outer query.

If a column select expression returns zero rows, SQL evaluates the expression as null and the entire query (the query containing the column select expression) evaluates to null.

6.1.4 Building a Subquery Structure

When building a subquery, perform the following steps:

1. Form the inner query.
2. Surround the inner query with parentheses. It now becomes the subquery.
3. Substitute the subquery for the values to which the outer query is compared.

The steps for building the subquery structure are similar to the way Oracle Rdb processes the query; first, it evaluates the subquery, then it passes its result to the outer query.

Example 6–2 shows how a subquery can be used to obtain data from multiple tables. The IN predicate is used to compare a column's value with a set of values. The subquery obtains several rows from the JOB_CODE column.

Example 6–2 Using a Subquery to Obtain Data from Multiple Tables

```
SQL> --
SQL> -- Who works in any programming job?
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME, JOB_CODE ❶
cont> FROM CURRENT_JOB
cont> WHERE JOB_CODE IN
cont>          (SELECT JOB_CODE ❷
cont>           FROM JOBS
cont>           WHERE JOB_TITLE CONTAINING ’Programmer’
cont>            OR JOB_TITLE CONTAINING    ’System’ )
cont> ORDER BY LAST_NAME;
 LAST_NAME       FIRST_NAME   JOB_CODE
 Brown           Nancy        SANL
 Burton          Frederick    PRGM
 Canonica        Rick         APGM
 Clinton         Kathleen     PRGM
 D’Amico         Aruwa        PRGM
   .
   .
   .
 Sullivan        Len          PRGM
 Ulrich          Christine    APGM
 Villari         Christine    SANL
 Vormelker       Daniel       PRGM
34 rows selected
SQL> --
SQL> -- The preceding query is the same as:
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME, JOB_CODE
cont> FROM CURRENT_JOB
cont> WHERE JOB_CODE IN (’APGM’,’PRGM’,’SANL’,’SPGM’)
cont> ORDER BY LAST_NAME;
 LAST_NAME       FIRST_NAME   JOB_CODE
 Brown           Nancy        SANL
 Burton          Frederick    PRGM
 Canonica        Rick         APGM
 Clinton         Kathleen     PRGM
 D’Amico         Aruwa        PRGM
   .
   .
   .
 Sullivan        Len          PRGM
 Ulrich          Christine    APGM
 Villari         Christine    SANL
 Vormelker       Daniel       PRGM
34 rows selected
```

The following callouts are keyed to Example 6–2:

❶ The outer query is used to obtain the employees' names and job codes.

❷ The subquery is used to determine if the employee's job code matches the job codes with specific associated titles in the JOBS table.

6.1.5 Using Different Values with Each Evaluation of the Outer Query

In Example 6–2, subqueries were used to obtain one value or a finite set of values to compare with rows of the outer query. When the job codes for programmers were unknown, a subquery was used to find the set of job codes, and then every row of the outer query was compared to this set.

You may want to compare a different set or a different single value for each row of the outer query. For example, to compare the date when every employee started their current job with the date of their last salary change, you need to use a different value in the subquery for every employee found in the outer query.

Because the start date in the subquery is different for every employee, the subquery must include a reference to the row in the outer query to which the comparison is being made.

Example 6–3 shows how to construct this type of subquery.

Example 6–3 Referring to the Outer Query

```
SQL> --
SQL> -- Who had a raise (or any other salary change)
SQL> -- since they started their current job?
SQL> --
SQL> SELECT EMPLOYEE_ID, JOB_START
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NULL
cont> AND JOB_START <
cont>        (SELECT SALARY_START
cont>        FROM SALARY_HISTORY
cont>        WHERE EMPLOYEE_ID = JOB_HISTORY.EMPLOYEE_ID ➊
cont>        AND SALARY_END IS NULL )
cont> ORDER BY EMPLOYEE_ID;
 EMPLOYEE_ID   JOB_START
 00164         21-Sep-1981
 00165          8-Mar-1981
 00166         12-Aug-1981
 00167         26-Aug-1981
   .
   .
   .
95 rows selected
SQL> --
SQL> -- Who had a change in salary on the day they started their
SQL> -- current job?
SQL> --
SQL> SELECT EMPLOYEE_ID, JOB_START
cont> FROM JOB_HISTORY AS JH
cont> WHERE JOB_END IS NULL
cont> AND JOB_START =
cont>       ( SELECT SALARY_START
cont>        FROM SALARY_HISTORY AS SH
cont>        WHERE SH.EMPLOYEE_ID = JH.EMPLOYEE_ID ➋
cont>        AND SALARY_END IS NULL )
cont> ORDER BY EMPLOYEE_ID;
 EMPLOYEE_ID   JOB_START
 00225          3-Jan-1983
 00227         25-Nov-1981
 00241          3-Jan-1983
 00247         19-Jan-1982
 00319          7-Aug-1982
5 rows selected
```

The following callouts are keyed to Example 6–3:

➊ To refer to the outer query, precede the column name in the subquery with the table name used in the outer query.

❷ As with joins, you can either use the full table name or a correlation name to refer to a table.

6.1.6 Checking for the Existence of Rows

The EXISTS and SINGLE predicates can be applied to a subquery to check whether the subquery resulted in zero, one, or more than one row. These predicates do the following:

- EXISTS checks whether any rows satisfy a condition specified by a subquery.
- The NOT EXISTS predicate evaluates to true only if no rows match the condition in the subquery.
- The SINGLE predicate checks for the existence of exactly one row in the subquery.
- The NOT SINGLE predicate evaluates to true if no rows are found, or if the subquery results in more than one row.

Example 6–4 shows how to construct a subquery using the EXISTS predicate.

Example 6–4 Using the EXISTS Predicate

```
SQL> --
SQL> -- To find out which work status values are used in the EMPLOYEES table,
SQL> -- you can issue a query on the EMPLOYEES table:
SQL> --
SQL> SELECT DISTINCT STATUS_CODE FROM EMPLOYEES;
 STATUS_CODE
 1
 2
2 rows selected
```

(continued on next page)

Example 6–4 (Cont.) Using the EXISTS Predicate

```
SQL> --
SQL> -- If you want to include other columns of the WORK_STATUS table
SQL> -- you need to issue the query on the WORK_STATUS table
SQL> -- using the EXISTS predicate
SQL> -- to make sure that you select only work status values
SQL> -- that are used in the EMPLOYEES table:
SQL> --
SQL> SELECT *
cont> FROM WORK_STATUS
cont> WHERE EXISTS
cont>      (SELECT * ➊
cont>         FROM EMPLOYEES AS E
cont>         WHERE E.STATUS_CODE = WORK_STATUS.STATUS_CODE); ➋
 STATUS_CODE   STATUS_NAME   STATUS_TYPE
 1             ACTIVE        FULL TIME
 2             ACTIVE        PART TIME
2 rows selected
SQL> --
SQL> -- To list status codes that are NOT used by any employee,
SQL> -- use the NOT EXISTS predicate:
SQL> --
SQL> SELECT *
cont> FROM WORK_STATUS
cont> WHERE NOT EXISTS
cont>            (SELECT *
cont>            FROM EMPLOYEES AS E
cont>            WHERE E.STATUS_CODE = WORK_STATUS.STATUS_CODE);
 STATUS_CODE   STATUS_NAME   STATUS_TYPE
 0             INACTIVE      RECORD EXPIRED
1 row selected
```

The following callouts are keyed to Example 6–4:

➊ Because the result of the subquery is either true or false rather than a column value, EXISTS and SINGLE do not require the subquery to be a column select expression. You can use the asterisk (*) in the SELECT statement of the subquery.

The subquery is checking for a row from the EMPLOYEES table that uses the STATUS_CODE value in the outer query.

➋ Qualify column names with a correlation name or with the full table name to indicate that you are referring to the table in the outer query.

Example 6–5 shows how to construct a subquery using the SINGLE predicate.

Example 6–5 Using the SINGLE Predicate

```
SQL> --
SQL> -- Find how many employees have just one degree:
SQL> --
SQL> SELECT E.LAST_NAME, E.EMPLOYEE_ID
cont> FROM EMPLOYEES AS E
cont> WHERE SINGLE
cont>     (SELECT * FROM DEGREES AS D
cont>     WHERE D.EMPLOYEE_ID =
cont>     E.EMPLOYEE_ID)
cont> ORDER BY EMPLOYEE_ID;
 LAST_NAME        EMPLOYEE_ID
 Smith            00165
 Wood             00170
 Peters           00172
 Bartlett         00173
   .
   .
   .
 Johnson          00240
 Roberts          00245
 Rodrigo          00249
 Watters          00276
 Silver           00319
 Lapointe         00358
 Blount           00418
33 rows selected
```

6.1.7 Using Several Levels of Subqueries

You can use several levels of subqueries to answer complex business questions.

When processing this type of query SQL evaluates the innermost subquery first, passes its result to the next level, and then evaluates the next level of query. When constructing such a compound query, it is easier to start with the innermost subquery first, and then build to the outer one.

Example 6–6 shows this nested type of subquery.

Example 6–6 Nested Subqueries

```
SQL> --
SQL> -- Get the name of Toliver’s supervisor:
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME ❶
cont> FROM EMPLOYEES
cont> WHERE EMPLOYEE_ID =
cont>      (SELECT SUPERVISOR_ID ❷
cont>      FROM JOB_HISTORY
cont>      WHERE JOB_END IS NULL
cont>      AND EMPLOYEE_ID =
cont>           (SELECT EMPLOYEE_ID ❸
cont>           FROM EMPLOYEES
cont>           WHERE LAST_NAME = ’Toliver’
cont>           AND FIRST_NAME = ’Alvin’));
 LAST_NAME        FIRST_NAME
 Harrison         Lisa
1 row selected
SQL> --
SQL> -- Which employees
SQL> -- work for Toliver’s supervisor?
SQL> --
SQL> SELECT EMPLOYEE_ID ❹
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NULL
cont> AND SUPERVISOR_ID =
cont>      (SELECT SUPERVISOR_ID ❺
cont>      FROM JOB_HISTORY
cont>      WHERE JOB_END IS NULL
cont>      AND EMPLOYEE_ID =
cont>            (SELECT EMPLOYEE_ID ❻
cont>            FROM EMPLOYEES
cont>            WHERE LAST_NAME = ’Toliver’
cont>            AND FIRST_NAME = ’Alvin’));
 EMPLOYEE_ID
 00164
 00166
 00195
 00227
 00246
5 rows selected
```

(continued on next page)

Example 6–6 (Cont.) Nested Subqueries

```
SQL> --
SQL> -- Get the name of Toliver’s supervisor’s supervisor:
SQL> --
SQL> SELECT SUPERVISOR_ID ❼
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NULL
cont> AND EMPLOYEE_ID =
cont>      (SELECT SUPERVISOR_ID ❽
cont>      FROM JOB_HISTORY
cont>      WHERE JOB_END IS NULL
cont>      AND EMPLOYEE_ID =
cont>           (SELECT EMPLOYEE_ID ❾
cont>           FROM EMPLOYEES
cont>           WHERE LAST_NAME = ’Toliver’
cont>           AND FIRST_NAME = ’Alvin’));
 SUPERVISOR_ID
 00225
1 row selected
```

The following callouts are keyed to Example 6–6:

❶ Get the name of Toliver’s supervisor.

❷ Get Toliver’s supervisor’s ID.

❸ Get Toliver’s employee ID.

❹ Get the employee ID of all employees whose supervisor’s ID is the same as Toliver’s supervisor.

❺ Get Toliver’s supervisor’s ID.

❻ Get Toliver’s employee ID.

❼ Get the ID of the supervisor of Toliver’s supervisor.

❽ Get Toliver’s supervisor’s ID.

❾ Get Toliver’s employee ID.

6.1.8 Using a Quantified Predicate to Compare Column Values with a Set of Values

A quantified predicate is a comparison operator combined with the ALL, ANY, and SOME keywords.

There are many combinations of the ALL, ANY, and SOME keywords and comparison operators. All combinations are not covered in this section. For a complete description of these keywords and operators, see the section on quantified predicates in the *Oracle Rdb7 SQL Reference Manual*.

- ALL combined with a range-checking operator, such as >, is useful for comparing a column's value with all the values in a set.
- = ANY and = SOME are equivalent to the IN predicate. They test if a column value matches one of the values in a set.
- <> ALL tests if a value does not match all of the values in a set. This is the opposite of = ANY.

  Note that <> ANY is not the opposite of = ANY. <> ANY tests if a value does not match one or more of the values in a set. This is almost always true. For example, testing whether the value YELLOW is <> ANY in the set (GREEN, YELLOW, RED) would be true because YELLOW is different from one or more of the members of the set.

  To test whether a value is not a member of a set, use <> ALL.

Example 6–7 shows how to use the ANY and ALL keywords in subqueries.

Example 6–7 Using the ANY and ALL Keywords with Subqueries

```
SQL> --
SQL> -- Who has a degree from a college in Cambridge?
SQL> --
SQL> SELECT EMPLOYEE_ID, COLLEGE_CODE ❶
cont> FROM DEGREES
cont> WHERE COLLEGE_CODE = ANY ❷
cont>          (SELECT COLLEGE_CODE
cont>          FROM COLLEGES
cont>          WHERE CITY = 'Cambridge');
 EMPLOYEE_ID   COLLEGE_CODE
 00170         HVDU
 00181         HVDU
 00186         HVDU
 00189         HVDU
    .
    .
    .
 00345         MIT
 00405         MIT
 00405         MIT
 00415         MIT
36 rows selected
SQL> --
SQL> -- Who has a degree from any of the other colleges?
SQL> --
SQL> SELECT EMPLOYEE_ID, COLLEGE_CODE
cont> FROM DEGREES
cont> WHERE COLLEGE_CODE <> ALL ❸
cont>          (SELECT COLLEGE_CODE
cont>          FROM COLLEGES
cont>          WHERE CITY = 'Cambridge');
 EMPLOYEE_ID   COLLEGE_CODE
 00164         PRDU
 00164         PRDU
 00165         BATE
 00166         COLB
    .
    .
    .
 00435         STAN
 00435         PRDU
 00471         BOWD
129 rows selected
```

The following callouts are keyed to Example 6–7:

❶ COLLEGE_CODE in the DEGREES table is compared to the set (HVDU, MIT) that results from the inner query.

❷ Using = ANY finds the rows in the DEGREES table whose COLLEGE_CODE values are in the set (HVDU, MIT).

❸ Using <> ALL finds the rows in the DEGREES table whose COLLEGE_CODE values are not in the set (HVDU, MIT).

6.1.9 Using the ORDER BY and LIMIT TO Clauses in Subqueries

You can use the ORDER BY and LIMIT TO clauses in subqueries. The method of using these clauses is the same as specified in Chapter 4.

In Example 6–8, all employee IDs are compared to the five lowest paid employees in the company. Those that are not in the group of the five lowest paid employees are displayed.

Example 6–8 Using the ORDER BY and LIMIT TO Clauses in a Subquery

```
SQL> --
SQL> -- List all employees EXCEPT the five lowest paid:
SQL> --
SQL> SELECT EMPLOYEE_ID, LAST_NAME
cont> FROM EMPLOYEES
cont> WHERE EMPLOYEE_ID NOT IN
cont>        (SELECT EMPLOYEE_ID
cont>        FROM SALARY_HISTORY
cont>        WHERE SALARY_END IS NULL
cont>        ORDER BY SALARY_AMOUNT
cont>        LIMIT TO 5 ROWS);
 EMPLOYEE_ID   LAST_NAME
 00165         Smith
 00190         O'Sullivan
 00187         Lasch
 00169         Gray
 00176         Hastings
   .
   .
   .
 00435         MacDonald
 00405         Dement
 00418         Blount
 00471         Herbener
 00416         Ames
95 rows selected
```

6.2 UNION: Combining the Result of SELECT Statements

A method for combining queries by placing one inside another has been discussed. Another way of combining multiple queries is by forming a union of them. Unions differ from subqueries in that neither of the two (or more) queries controls one another. Instead, the queries are executed independently and their output is merged.

The UNION clause merges the result of two queries into one result table by:

- Including rows that satisfy the condition in either one or both queries in the final result table.
- Reducing the output to distinct column values or combinations of values.
- Including all rows of both queries (even if values are duplicated), by using the ALL qualifier.

The general syntax of the UNION clause is:

Syntax query1 UNION [ALL] query2 ;

When performing a UNION operation, Oracle Rdb combines the output of the queries into common columns by:

- Using the column headers of the first query.

  If one of the queries specifies fewer columns than the other query, Oracle Rdb places null values in the rows of the additional column.
- Attempting to convert different data types into a compatible data type. If data types cannot be converted, Oracle Rdb generates an error message.

Before you combine two queries with the UNION clause, you need to understand the output of the each query individually.

Example 6–9 shows two queries before the UNION operation is performed.

Example 6–9 Two Queries Before the UNION Operation Is Performed

```
SQL> --
SQL> --  List employees who have a degree in Electrical Engineering:
SQL> --
SQL> SELECT EMPLOYEE_ID, DEGREE_FIELD
cont> FROM DEGREES
cont> WHERE DEGREE_FIELD CONTAINING 'Elect' ;
 EMPLOYEE_ID   DEGREE_FIELD
 00171         Elect. Engrg.
 00179         Elect. Engrg.
 00183         Elect. Engrg.
 00184         Elect. Engrg.
 00185         Elect. Engrg.
   .
   .
   .
 00226         Elect. Engrg.
 00243         Elect. Engrg.
 00244         Elect. Engrg.
 00369         Elect. Engrg.
 00416         Elect. Engrg.
 00416         Elect. Engrg. ❶
23 rows selected
SQL> --
SQL> --  List employees who work as Electrical Engineers:
SQL> --
SQL> SELECT EMPLOYEE_ID, JOB_CODE
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NULL
cont> AND JOB_CODE = 'EENG';
 EMPLOYEE_ID   JOB_CODE
 00197         EENG
 00198         EENG
 00226         EENG
 00238         EENG ❷
4 rows selected
```

The following callouts are keyed to Example 6–9:

❶ Employee 416 has two Electrical Engineering degrees and so appears twice.

❷ Employee 238 works as an Electrical Engineer, but does not have an Electrical Engineering degree.

6.2.1 Using the UNION Clause with the ALL Qualifier

The UNION ALL clause is discussed first to help you understand the concept of the UNION operation. Until now, you have had to specify keywords such as DISTINCT in your SELECT statements to eliminate duplicate rows. With the UNION clause, the ALL qualifier must be used to include duplicate rows. This is shown in Example 6–10.

Example 6–10 Combining Two Queries Using the UNION ALL Clause

```
SQL> --
SQL> -- List IDs of employees who either work as Electrical Engineers
SQL> -- or have an Electrical Engineering degree or both:
SQL> --
SQL> -- Include an employee twice if the employee has both qualifications:
SQL> --
SQL> SELECT EMPLOYEE_ID, DEGREE_FIELD
cont> FROM DEGREES
cont> WHERE DEGREE_FIELD CONTAINING 'Elect'
cont>       UNION ALL
cont> SELECT EMPLOYEE_ID, JOB_CODE
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NULL
cont> AND JOB_CODE = 'EENG';
 EMPLOYEE_ID   DEGREE_FIELD ❶
 00171         Elect. Engrg.
 00179         Elect. Engrg.
 00183         Elect. Engrg.
 00184         Elect. Engrg.
 00185         Elect. Engrg.
 00189         Elect. Engrg.
 00190         Elect. Engrg.
 00192         Elect. Engrg.
 00197         Elect. Engrg.
 00198         Elect. Engrg.
 00200         Elect. Engrg.
 00202         Elect. Engrg.
 00205         Elect. Engrg.
 00206         Elect. Engrg.
 00207         Elect. Engrg.
 00212         Elect. Engrg.
 00219         Elect. Engrg.
 00226         Elect. Engrg.
 00243         Elect. Engrg.
 00244         Elect. Engrg.
 00369         Elect. Engrg.
 00416         Elect. Engrg.
```

(continued on next page)

Example 6–10 (Cont.) Combining Two Queries Using the UNION ALL Clause

```
 00416         Elect. Engrg.
 00197         EENG
 00198         EENG
 00226         EENG
 00238         EENG
27 rows selected ❷
```

The following callouts are keyed to Example 6–10:

❶ The column names from the first query are used.

❷ By using the ALL qualifier, all rows of both populations are listed even if duplicated; 23 employees with Electrical Engineering degrees plus 4 employees with the Electrical Engineering job code equals 27 rows of output.

6.2.2 Using the UNION clause Without the ALL Qualifier

Combining the same queries using the UNION clause gives you an understanding of how the output is different when the ALL qualifier is not used.

Example 6–11 shows the use of the UNION clause to combine two queries.

Example 6–11 Combining Two Queries Using the UNION Clause

```
SQL> --
SQL> -- List employees who either work as Electrical Engineers
SQL> -- or have an Electrical Engineering degree or both.
SQL> -- Display their ID and job_code or degree_field:
SQL> --
SQL> SELECT EMPLOYEE_ID, JOB_CODE
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NULL
cont> AND JOB_CODE = 'EENG'
cont>        UNION
cont> SELECT EMPLOYEE_ID, DEGREE_FIELD
cont> FROM DEGREES
cont> WHERE DEGREE_FIELD CONTAINING 'Elect' ;
 EMPLOYEE_ID   JOB_CODE
 00171         Elect. Engrg.
```

(continued on next page)

Example 6–11 (Cont.) Combining Two Queries Using the UNION Clause

```
   .
   .
   .
 00238         EENG
 00243         Elect. Engrg.
 00244         Elect. Engrg.
 00369         Elect. Engrg.
 00416         Elect. Engrg.
26 rows selected ❶
SQL> --
SQL> -- List only ID number of those employees:
SQL> --
SQL> SELECT EMPLOYEE_ID
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NULL
cont> AND JOB_CODE = 'EENG'
cont>        UNION
cont> SELECT EMPLOYEE_ID
cont> FROM DEGREES
cont> WHERE DEGREE_FIELD CONTAINING 'Elect' ;
 EMPLOYEE_ID
 00171
 00179
 00183
   .
   .
   .
 00243
 00244
 00369
 00416
23 rows selected ❷
```

The following callouts are keyed to Example 6–11:

❶ When displaying the DEGREE_FIELD or the JOB_CODE column, the output contains 23 rows for those employees with an Electrical Engineering degree minus 1 (employee 416 has two degrees, so one of them is eliminated) plus 4 (all rows for those employees whose job code is EENG are included, whether they have the degree or not). This gives a total of 26 rows.

❷ When listing only the EMPLOYEE_ID for both queries, the output contains 23 rows for those employees with an Electrical Engineering degree minus 1 (employee 416 is included only once) plus 1 for employee 238 who has the EENG job code, but not the degree). This gives a total of 23 rows.

6.3 Using Outer Joins

The inner join operations, which were described in Chapter 4, produce result tables containing only those rows for which the join condition is satisfied. For most applications, this is the desired result. However, in some instances, you may want to include some or all of the rows in which the join condition is not satisfied. To include these rows use an outer join. See Table 6–1 for a description of each type of outer join.

The general syntax for outer joins is:

Syntax

```
SELECT   select-list
FROM   table-name outer-join-type table-name
ON column-name = column-name;
```

Table 6–1 shows several types of outer joins.

Table 6–1 Outer Join Types

Statement	Description
LEFT OUTER JOIN	Includes all rows in the left-specified table and matches to rows in the right-specified table reference. NULL appears in columns where there is no match in the right-specified table reference.
RIGHT OUTER JOIN	Includes all rows in the right-specified table and matches to rows in the left-specified table reference. NULL appears in columns where there is no match in the left-specified table reference.
FULL OUTER JOIN	Includes all rows from the left-specified table reference and all rows from the right-specified table reference in the result. NULL appears in any column that does not have a matching value in the corresponding column.

Consider a query that lists the names of all current employees and various information regarding college degrees held. If no degree is held, the query must list the name and return nulls in the columns relating to degrees.

The first part of the problem, finding all employees who hold degrees, requires only a natural join, as shown in the following example:

```
SQL> SELECT EMPLOYEE_ID, LAST_NAME, DEGREE
cont> FROM EMPLOYEES NATURAL INNER JOIN DEGREES;
 EMPLOYEE_ID   EMPLOYEES.LAST_NAME   DEGREES.DEGREE
 00164         Toliver               MA
 00164         Toliver               PhD
 00165         Smith                 BA
 00166         Dietrich              BA
 00166         Dietrich              PhD
   .
   .
   .
 00416         Ames                  MA
 00416         Ames                  PhD
 00418         Blount                PhD
 00435         MacDonald             MA
 00435         MacDonald             PhD
 00471         Herbener              BA
 00471         Herbener              MA
165 rows selected
```

To include the employees who do not hold degrees, however, is a difficult task. You could first use the NOT IN predicate with a subquery to find employees who do not hold a degree. Using the UNION clause, you could then combine that result table with a query such as the one shown in the previous example to find employees who hold degrees. However, this method is complicated.

The explicit join feature of SQL provides an easier way to obtain the data. Example 6–12 demonstrates how this can be done.

Example 6–12 Using an Outer Join

```
SQL> --
SQL> -- List all employees with and without degrees:
SQL> --
SQL> SELECT E.EMPLOYEE_ID, LAST_NAME, D.DEGREE
cont> FROM EMPLOYEES AS E LEFT OUTER JOIN DEGREES AS D ❶
cont> ON E.EMPLOYEE_ID = D.EMPLOYEE_ID; ❷
 E.EMPLOYEE_ID   E.LAST_NAME      D.DEGREE
 00164           Toliver          MA
 00164           Toliver          PhD
 00165           Smith            BA
 00166           Dietrich         BA
 00166           Dietrich         PhD
   .
   .
   .
 00172           Peters           BA
 00173           Bartlett         BA
 00174           Myotte           BA
 00174           Myotte           MA
 00175           Siciliano        BA
 00176           Hastings         MA
 00177           Kinmonth         BA
 00178           Goldstone        NULL ❸
 00179           Dallas           MA
 00179           Dallas           MA
   .
   .
   .
 00416           Ames             PhD
 00418           Blount           PhD
 00435           MacDonald        MA
 00435           MacDonald        PhD
 00471           Herbener         BA
 00471           Herbener         MA
166 rows selected
```

The following callouts are keyed to Example 6–12:

❶ The LEFT OUTER JOIN statement specifies that rows that match the condition or do not match the condition will be included in the result table.

❷ The join condition. Note that ON replaces the WHERE clause.

❸ All employees from the EMPLOYEES table are included. Employee 00178 has no degree, so the DEGREE column contains a null value for that employee.

For more information on outer joins, see the section on joins in the *Oracle Rdb7 SQL Reference Manual*.

6.4 Derived Tables

A **derived table** is a named virtual table that represents data obtained through the evaluation of a select expression. A derived table is named by the specified correlation name. References to a derived table and its columns can be made within the query using the correlation name. A derived table is similar to a view in that a view is also a virtual table represented by the select expression used to define it. Therefore, a derived table is like a view whose definition is specified within the FROM clause.

The general syntax of the derived table is:

Syntax

```
SELECT   select-list
FROM   (derived-table-statement)
AS   correlation-name   (derived-table-column-names) . . . ;
```

You must specify a correlation name for a derived table. This may determine which column names you can specify in the select-list or subsequent clauses. The select-list and subsequent clauses can reference only the correlation name and the column names of the derived table, and cannot reference the table or column names that defined the derived table.

Example 6–13 is an example of using a derived table.

Example 6–13 Using a Derived Table

```
SQL> --
SQL> -- Find all departments that have fewer than 3 employees:
SQL> --
SQL>  SELECT *
cont> FROM (SELECT DEPARTMENT_CODE, COUNT(*) ❶
cont> FROM JOB_HISTORY
cont> WHERE JOB_END IS NULL
cont> GROUP BY DEPARTMENT_CODE)
cont> AS DEPT_INFO (D_CODE, D_COUNT) ❷
cont> WHERE D_COUNT < 3;
 D_CODE       D_COUNT
 ENG                2
 MCBS               1
 MSMG               1
 MTEL               2
 PERS               2
 SUSA               2
6 rows selected
```

The following callouts are keyed to Example 6–13:

❶ The derived table SELECT statement begins here.

❷ The derived table is named DEPT_INFO and it contains the columns D_CODE and D_COUNT, which contain DEPARTMENT_CODE and COUNT(*) data from the derived table query.

For more information about derived tables, see the *Oracle Rdb7 SQL Reference Manual*.

6.5 Retrieving Data from System Tables

Oracle Rdb stores information about the database as a set of tables called system tables, also called system relations. The system tables are the definitive source of Oracle Rdb metadata. Metadata defines the structure of the database; for example, metadata defines the fields that comprise a particular table and the fields that can index that table.

Querying system tables is another way, in addition to the SHOW statement, of finding information about the structure of the database. Using the SHOW statement in interactive SQL provides an easy method of finding information about the database structure. In fact, the SHOW statement itself queries the system tables automatically to obtain information about tables, views, indexes and so on.

You can query the system tables in an interactive session to obtain information that is not provided by the SHOW command. In programming, querying system tables may be the only way to capture certain information in the program.

Because system tables have a similar structure to tables of the real data, you can issue queries on the system tables in the same way that you do on any other table.

Every Oracle Rdb database that is created using the same version of the product has the same system tables, with the same columns.

Example 6–14 shows how to obtain a list of all system tables, and then how to obtain a more detailed description of one of them. The SHOW SYSTEM TABLES statement is similar to the SHOW TABLES statement used in Section 3.1 for listing user-defined tables.

CAUTION

While querying system tables for information is allowed, you should never attempt to add, delete, or change information in these tables.

Example 6–14 Querying a System Table

```
SQL>  --
SQL>  -- List all system tables used in this version:
SQL>  --
SQL> SHOW SYSTEM TABLES
System tables in database with filename mf_personnel
     RDB$COLLATIONS
     RDB$CONSTRAINTS
     RDB$CONSTRAINT_RELATIONS
     RDB$DATABASE
     RDB$FIELDS
     RDB$FIELD_VERSIONS
     RDB$INDEX_SEGMENTS
     RDB$INDICES
     RDB$INTERRELATIONS
     RDB$MODULES
     RDB$PARAMETERS
     RDB$PRIVILEGES
     RDB$QUERY_OUTLINES
     RDB$RELATIONS
     RDB$RELATION_CONSTRAINTS
     RDB$RELATION_CONSTRAINT_FLDS
     RDB$RELATION_FIELDS
     RDB$ROUTINES
     RDB$STORAGE_MAPS
     RDB$STORAGE_MAP_AREAS
     RDB$TRIGGERS
     RDB$VIEW_RELATIONS
     RDBVMS$COLLATIONS               A view.
     RDBVMS$INTERRELATIONS           A view.
     RDBVMS$PRIVILEGES               A view.
     RDBVMS$RELATION_CONSTRAINTS     A view.
     RDBVMS$RELATION_CONSTRAINT_FLDS A view.
     RDBVMS$STORAGE_MAPS             A view.
     RDBVMS$STORAGE_MAP_AREAS        A view.
     RDBVMS$TRIGGERS                 A view.
```

(continued on next page)

Example 6–14 (Cont.) Querying a System Table

```
SQL>  --
SQL>  -- Show the description of the RDB$VIEW_RELATIONS system table:
SQL>  --
SQL> SHOW TABLE RDB$VIEW_RELATIONS
Information for table RDB$VIEW_RELATIONS

Columns for table RDB$VIEW_RELATIONS:
Column Name                     Data Type        Domain
-----------                     ---------        ------
RDB$VIEW_NAME                   CHAR(31)
RDB$RELATION_NAME               CHAR(31)
RDB$VIEW_CONTEXT                INTEGER
   .
   .
   .
SQL>  --
SQL>  -- Use RDB$VIEW_RELATIONS to find
SQL>  -- the tables or other views on which the CURRENT_INFO view is based:
SQL>  --
SQL> SELECT RDB$RELATION_NAME
cont> FROM RDB$VIEW_RELATIONS
cont> WHERE RDB$VIEW_NAME = 'CURRENT_INFO'; ➊
 RDB$RELATION_NAME
 CURRENT_JOB ➋
 DEPARTMENTS
 JOBS
 CURRENT_SALARY
4 rows selected
```

The following callouts are keyed to Example 6–14:

➊ Notice that the CURRENT_INFO view uses data from two tables and from the two other views in the database.

➋ The CURRENT_INFO view does not use the EMPLOYEES table. The CURRENT_INFO view takes the values for employees' names from the CURRENT_JOB view.

Reference Reading

For more information about the system tables, you can read about system relations in online help for Oracle Rdb.

6.6 Creating Views

You can simplify access to data requiring a lengthy SELECT statement by defining a view.

A view creates a virtual table using the SELECT statement. A view does not store data but looks like a table to the database user. Views can:

- Be based on one or more tables
- Be based on another view
- Contain computed values or function results
- Specify constraints
- Use original column names or correlation names

The general syntax to create a view is:

Syntax CREATE VIEW view-name [(column-name, [column-name . . .])]
AS select-statement;

6.6.1 Simple and Complex Views

The rows in simple views can be changed using INSERT, DELETE, or UPDATE statements. The rows in complex views, also called read-only views, cannot be changed. Complex views are views that:

- Contain more than one table
- Contain a function
- Use the DISTINCT keyword with a SELECT statement
- Contain a GROUP BY or HAVING clause

Example 6–15 shows how to create a simple view.

Example 6–15 Defining a Simple View

```
SQL>--
SQL>-- Create a view to display employee names:
SQL>--
SQL> CREATE VIEW EMP_NAME ❶
cont> AS SELECT
cont>    FIRST_NAME,
cont>    MIDDLE_INITIAL,
cont>    LAST_NAME
cont>    FROM EMPLOYEES;
SQL> --
SQL> -- Use the view to query the database:
SQL> --
SQL> SELECT * FROM EMP_NAME
cont> WHERE LAST_NAME STARTING WITH 'A';
 FIRST_NAME   MIDDLE_INITIAL   LAST_NAME
 Louie        A                Ames
 Leslie       Q                Andriola
2 rows selected
SQL> ROLLBACK; ❷
```

The following callouts are keyed to Example 6–15:

❶ Choose a unique name for the view.

❷ This view is temporary and disappears after the transaction is rolled back. Using the COMMIT statement causes the view to become a permanent part of the database.

Example 6–16 shows how to create a complex view.

Example 6–16 Defining a Complex View

```
SQL> --
SQL> -- Create a view to display employee degrees:
SQL> --
SQL> CREATE VIEW EMP_DEGREES
cont> AS SELECT
cont>    FIRST_NAME,
cont>    LAST_NAME,
cont>    DEGREE
cont>    FROM EMPLOYEES, DEGREES ❶
cont>    WHERE EMPLOYEES.EMPLOYEE_ID = DEGREES.EMPLOYEE_ID;
SQL> --
SQL> --
SQL> SELECT * FROM EMP_DEGREES;
 FIRST_NAME   LAST_NAME        DEGREE
 Alvin        Toliver          MA
 Alvin        Toliver          PhD
 Terry        Smith            BA
 Rick         Dietrich         BA
 Rick         Dietrich         PhD
 Janet        Kilpatrick       BA
   .
   .
   .
 Peter        Blount           PhD
 Johanna      MacDonald        MA
 Johanna      MacDonald        PhD
 James        Herbener         BA
 James        Herbener         MA
165 rows selected
SQL> ROLLBACK;
```

The following callout is keyed to Example 6–16:

❶ This is a complex view because it is based on the EMPLOYEES and the DEGREES tables.

When you query views, performance may not be as high as when querying base tables themselves. This is because the view is evaluated first and then treated as a base table by SQL. For hints on improving the performance of views, see the *Oracle Rdb7 Guide to Database Design and Definition*.

7
Using Multischema Databases

SQL allows multiple schemas to be created within a single physical Oracle Rdb database. This is called a multischema database. The advantages of organizing databases this way are:

Easier maintenance	Separate logical databases used by functional groups within an organization can be combined into a single physical database, and the repetition of maintenance functions can be eliminated.
Increased data integrity across schemas	Data that is shared by separate schemas can come under the same constraints and triggers.
Enhanced data retrieval	Data from multiple schemas can be easily combined into single result tables.

This chapter provides an introduction to multischema databases.

7.1 Multischema Sample Database

All previous examples have referenced the mf_personnel database. In this chapter you will be introduced to the corporate_data database. This is a multischema demonstration database that shows three organizational functions — accounting, personnel, and recruiting — placed in separate schemas under a single physical database. Like mf_personnel, this database comes with the Oracle Rdb product and you can build it in your account to practice with. The same command file that is used to create the mf_personnel database has an option that builds corporate_data. See Section 1.1 or Section 2.1 for details on creating the corporate_data database on OpenVMS and Digital UNIX respectively.

The type of Oracle Rdb database represented by mf_personnel will be referred to as a single-schema database in this chapter for purposes of comparison.

Reference Reading

The *Oracle Rdb7 SQL Reference Manual* discusses multischema database terms, syntax for creating and altering multischema databases, multischema naming conventions, and reference information about how to use multischema databases with the SQL module language and the SQL precompiler.

The *Oracle Rdb7 Guide to Database Design and Definition* describes how to alter, create, and delete multischema databases and elements, and shows the data definitions for the sample multischema corporate_data database used in examples throughout this chapter.

The *Oracle Rdb7 Guide to SQL Programming* shows how to develop host language programs that access multischema databases.

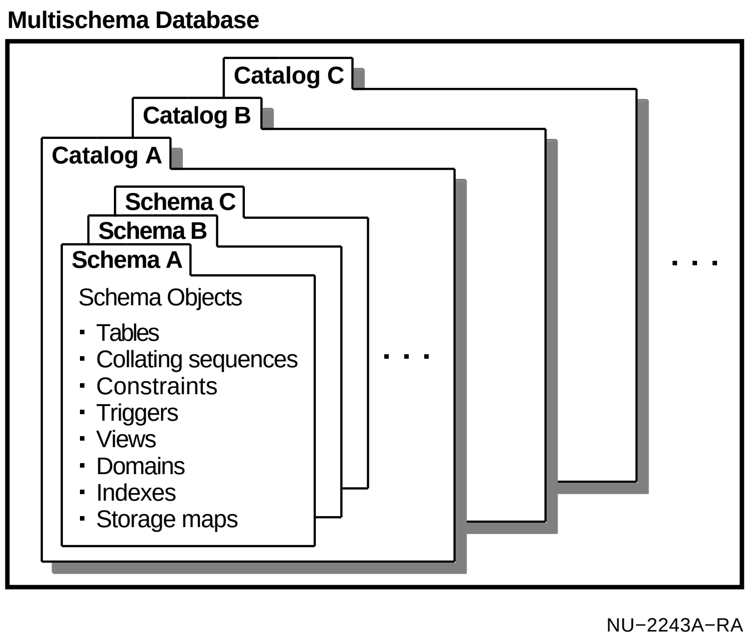
7.2 Multischema Database Structure

A multischema database contains these parts:

Database	An Oracle Rdb physical database. The multischema option does not change how Oracle Rdb names or treats database elements, only how the SQL interface views the database.
Catalog	The logical section of the database used to contain one or more schemas. One or more catalogs can be created within a multischema database.
Schema	The logical section of a catalog used to contain database elements such as tables, domains, views, triggers, and indexes. One or more schemas can be created within a catalog. In single-schema databases, the schema is synonymous with database. In multischema databases the schema is an element within the database, just as a table or view is an element within a schema.

Figure 7–1 shows that a multischema database is physically the same as a single-schema database and is treated that way by Oracle Rdb. All maintenance procedures that would be performed for a single-schema Oracle Rdb database, such as backup, are performed in the same manner for a multischema database.

Figure 7–1 Multischema Database



7.3 Accessing a Multischema Database

The ATTACH statement for a multischema database is used in an identical manner as in an attachment to a single-schema database. See Section 1.5 and Section 1.6 for information on attaching and detaching from a database on OpenVMS. See Section 2.5 and Section 2.6 for information on attaching and detaching from a database on Digital UNIX.

By default, attachment to a multischema database is in multischema mode. This means that multischema naming conventions are in effect. Section 7.6 describes how an option of the ATTACH statement can be used to turn off multischema mode.

7.4 Displaying Multischema Database Information

Information about the multischema database can be displayed using the SHOW statement. Table 7–1 lists some of the statements that you can use to display multischema database elements. Many of these statements are the same as those used to display single-schema database elements as discussed in Chapter 3, but some are unique to the discussion of multischema databases.

Table 7–1 Using the SHOW Statement to Display a List of Elements

To List . . .	Use the Statement . . .
Database name	SHOW DATABASE
All catalogs	SHOW CATALOGS
All schemas	SHOW SCHEMAS
Current catalog and schema	SHOW DEFAULT
User tables and views	SHOW TABLES
All defined views	SHOW VIEWS
All defined domains	SHOW DOMAINS
All defined indexes	SHOW INDEXES

Example 7–1 shows how to display multischema database catalogs and schemas.

Example 7–1 Displaying Catalogs and Schemas

```
SQL> --
SQL> -- Attach to the multischema database:
SQL> --
SQL> ATTACH 'FILENAME corporate_data';
SQL> --
SQL> -- Show current position within the database:
SQL> --
SQL> SHOW DEFAULT ❶
Default alias is RDB$DBHANDLE
Default catalog name is RDB$CATALOG
Default schema name is smith
```

(continued on next page)

Example 7–1 (Cont.) Displaying Catalogs and Schemas

```
SQL> --
SQL> -- Display catalogs:
SQL> --
SQL> SHOW CATALOGS
Catalogs in database with filename corporate_data
        ADMINISTRATION ❷
        RDB$CATALOG ❸
SQL> --
SQL> -- Display schemas:
SQL> --
SQL> SHOW SCHEMAS
Schemas in database with filename corporate_data
    ADMINISTRATION.ACCOUNTING ❹
    ADMINISTRATION.PERSONNEL
    ADMINISTRATION.RECRUITING
    RDB$SCHEMA ❺
```

The following callouts are keyed to Example 7–1:

❶ Your position after attachment to the database is at the top level. This is indicated by RDB$CATALOG and the schema name as the system user name. If this schema has not been previously created, it does not actually exist. It is used only as a starting point.

❷ Only one catalog, named ADMINISTRATION, has been created for this database.

❸ RDB$CATALOG is the default system catalog that is always created in multischema databases. This catalog must always be present and is used if schemas are created and not assigned to any user-defined catalog.

❹ Three schemas; ACCOUNTING, PERSONNEL, and RECRUITING have been created under the ADMINISTRATION catalog. The periods are used to separate naming levels.

❺ RDB$SCHEMA is the system default schema and is used to contain the system tables. It will also be used if a single-schema database is altered to become a multischema database, and will contain database elements such as tables and views. It is not prefixed with a catalog name because it is in the default catalog.

Example 7–2 shows how to display tables.

Example 7–2 Displaying Database Tables

```
SQL> --
SQL> -- Display tables:
SQL> --
SQL> SHOW TABLES
User tables in database with filename corporate_data
     ADMINISTRATION.ACCOUNTING.DAILY_HOURS ➊
     ADMINISTRATION.ACCOUNTING.DEPARTMENTS ➋
     ADMINISTRATION.ACCOUNTING.PAYROLL
     ADMINISTRATION.ACCOUNTING.WORK_STATUS
     ADMINISTRATION.PERSONNEL.CURRENT_INFO
      A view.
     ADMINISTRATION.PERSONNEL.CURRENT_JOB
      A view.
     ADMINISTRATION.PERSONNEL.CURRENT_SALARY
      A view.
     ADMINISTRATION.PERSONNEL.DEPARTMENTS ➋
     ADMINISTRATION.PERSONNEL.EMPLOYEES
     ADMINISTRATION.PERSONNEL.HOURLY_HISTORY
     ADMINISTRATION.PERSONNEL.JOB_HISTORY
     ADMINISTRATION.PERSONNEL.REVIEW_DATE
      A view.
     ADMINISTRATION.PERSONNEL.SALARY_HISTORY
     ADMINISTRATION.RECRUITING.CANDIDATES
     ADMINISTRATION.RECRUITING.COLLEGES
     ADMINISTRATION.RECRUITING.DEGREES
     ADMINISTRATION.RECRUITING.RESUMES
```

The following callouts are keyed to Example 7–2:

➊ The SHOW TABLES statement issued at the default level catalog and schema displays the three-level naming convention used to identify tables in the multischema database.

➋ Database elements, such as tables, can have identical names but must be placed in separate schemas.

Example 7–3 shows how to display views.

Example 7–3 Displaying Database Views

```
SQL> SHOW VIEWS
User tables in database with filename corporate_data
     ADMINISTRATION.PERSONNEL.CURRENT_INFO
      A view.
     ADMINISTRATION.PERSONNEL.CURRENT_JOB
      A view.
     ADMINISTRATION.PERSONNEL.CURRENT_SALARY
      A view.
     ADMINISTRATION.PERSONNEL.REVIEW_DATE
      A view.
```

7.4.1 Displaying Specific Schema Elements

To display elements from specific schemas, use the SHOW statement with the name of the element (see Table 7–2).

Table 7–2 Using the SHOW Statement to Display Schema Elements

To Display . . .	Use the Statement . . .
One table	SHOW TABLE table_name
One element of one table, such as column names	SHOW TABLE (item) table_name
One view	SHOW VIEW view_name
One domain	SHOW DOMAIN domain_name
All indexes defined on one table	SHOW INDEXES ON table_name
	SHOW TABLES (INDEXES) table_name
One index	SHOW INDEX index_name

7.4.2 Using the SHOW Statement with a Full Element Name

Example 7–4 shows how to reference database elements using fully qualified names.

Example 7–4 Specifying Full Element Names

```
SQL> --
SQL> -- Show the current position in the database:
SQL> --
SQL> SHOW DEFAULT
Default alias is RDB$DBHANDLE
Default catalog name is RDB$CATALOG
Default schema name is smith
SQL> SHOW TABLE (COLUMNS) COLLEGES ❶
%SQL-F-SCHNOTDEF, Schema smith is not defined
SQL> SHOW TABLE (COLUMNS) ADMINISTRATION.RECRUITING.COLLEGES ❷
Information for table ADMINISTRATION.RECRUITING.COLLEGES
    Stored name is COLLEGES

Columns for table ADMINISTRATION.RECRUITING.COLLEGES:
Column Name   Data Type  Domain
-----------   ---------  ------
COLLEGE_CODE                    CHAR(4)   ADMINISTRATION.PERSONNEL.CODE
 Primary Key constraint ADMINISTRATION.RECRUITING.COLLEGES_PRIMARY_COLLEGE_CODE
COLLEGE_NAME                    CHAR(20)   ADMINISTRATION.PERSONNEL.NAME
CITY                            CHAR(20)   ADMINISTRATION.PERSONNEL.NAME
STATE                           CHAR(4)   ADMINISTRATION.PERSONNEL.STATE_CODE
ZIP_CODE                        CHAR(5)   ADMINISTRATION.PERSONNEL.POSTAL_CODE
```

The following callouts are keyed to Example 7–4:

❶ An error occurs because an invalid schema is specified by default. This schema does not exist.

❷ Because you are positioned at the top level after attaching to the database, the fully qualified element name must be used.

7.4.3 Using the SET Statement to Access a Specific Catalog and Schema

When you first attach to a multischema database, your default catalog is RDB$CATALOG and your default schema is your system user name. On OpenVMS it appears in uppercase type; on Digital UNIX it appears in lowercase type. All examples in this chapter display the OpenVMS convention.

To work within a specific catalog and schema, you must specify these defaults by using the SET statement, as shown in Example 7–5.

Example 7–5 Setting Access to a Specific Catalog and Schema

```
SQL> --
SQL> -- Attach to the corporate_data database
SQL> -- and display the default catalog and schema:
SQL> --
SQL> ATTACH 'FILENAME corporate_data';
SQL> SHOW DEFAULT
Default alias is RDB$DBHANDLE
Default catalog name is RDB$CATALOG
Default schema name is smith
SQL> --
SQL> -- Set default access to the ADMINISTRATION
SQL> -- catalog and PERSONNEL schema:
SQL> --
SQL> SET CATALOG 'ADMINISTRATION'; ❶
SQL> SET SCHEMA 'PERSONNEL';
SQL> SHOW TABLE EMPLOYEES
Information for table EMPLOYEES
    Stored name is EMPLOYEES

Columns for table EMPLOYEES:
Column Name   Data Type  Domain
-----------   ---------  ------
EMPLOYEE_ID                     CHAR(5)   ID
 Primary Key constraint EMPLOYEES_PRIMARY_EMPLOYEE_ID
LAST_NAME                       CHAR(20)   NAME
FIRST_NAME                      CHAR(20)   NAME
MIDDLE_INITIAL                  CHAR(1)   MIDDLE_INITIAL
ADDRESS_DATA_1                  CHAR(25)   ADDRESS_LINE
ADDRESS_DATA_2                  CHAR(25)   ADDRESS_LINE
CITY                            CHAR(20)   NAME
STATE                           CHAR(4)   STATE_CODE
ZIP_CODE                        CHAR(5)   POSTAL_CODE
SEX                             CHAR(1)
BIRTHDAY                        DATE ANSI
STATUS                          CHAR(1)   STATUS_CODE
   .
   .
   .
```

The following callout is keyed to Example 7–5:

❶ The SET statement is used to set up the default catalog and schema for the session. The catalog and schema specified become the default. This saves you from having to type in the full element name every time. Later you can change these settings by issuing another SET statement.

7.4.4 Setting a New Default Schema

To view information on tables in other schemas, the current default schema selection must be changed, as shown in Example 7–6.

Example 7–6 Changing the Default Schema

```
SQL> SHOW DEFAULT
Default alias is RDB$DBHANDLE
Default catalog name is ADMINISTRATION
Default schema name is PERSONNEL
SQL> SHOW TABLE PAYROLL ➊
No tables found
SQL> SET SCHEMA 'ACCOUNTING'; ➋
SQL> SHOW DEFAULT
Default alias is RDB$DBHANDLE
Default catalog name is ADMINISTRATION
Default schema name is ACCOUNTING
SQL> SHOW TABLE PAYROLL
Information for table PAYROLL
    Stored name is PAYROLL

Columns for table PAYROLL:
Column Name   Data Type  Domain
-----------   ---------  ------
JOB_CODE                        CHAR(4)   CODE
 Primary Key constraint PAYROLL_PRIMARY_JOB_CODE
WAGE_CLASS                      CHAR(1)
JOB_TITLE                       CHAR(20)   PERSONNEL.NAME
MINIMUM_SALARY                  INTEGER(2)  PERSONNEL.SALARY
MAXIMUM_SALARY                  INTEGER(2)  PERSONNEL.SALARY

Table constraints for PAYROLL:
PAYROLL_PRIMARY_JOB_CODE
 Primary Key constraint
 Column constraint for PAYROLL.JOB_CODE
 Evaluated on COMMIT
 Source:
        PAYROLL.JOB_CODE PRIMARY KEY

WAGE_CLASS_VALUES
 Check constraint
 Table constraint for PAYROLL
 Evaluated on COMMIT
 Source:
        CHECK              (
                                    WAGE_CLASS in ('1','2','3','4')
                                    or WAGE_CLASS IS NULL
                                    )
```

(continued on next page)

Example 7–6 (Cont.) Changing the Default Schema

```
   .
   .
   .
```

The following callouts are keyed to Example 7–6:

❶ You cannot view this table because it is outside the default schema.

❷ Setting the schema to ACCOUNTING allows you to display the PAYROLL table.

Example 7–7 shows how to specify elements outside your default schema.

Example 7–7 Displaying Elements from Other Schemas

```
SQL> SHOW DEFAULT
Default alias is RDB$DBHANDLE
Default catalog name is ADMINISTRATION
Default schema name is ACCOUNTING
SQL> SHOW TABLE PERSONNEL.SALARY_HISTORY ❶
Information for table PERSONNEL.SALARY_HISTORY
    Stored name is SALARY_HISTORY

Columns for table PERSONNEL.SALARY_HISTORY:
Column Name   Data Type  Domain
-----------   ---------  ------
EMPLOYEE_ID                     CHAR(5)   PERSONNEL.ID
 Foreign Key constraint PERSONNEL.SALARY_HISTORY_FOREIGN1
SALARY_AMOUNT                   INTEGER(2)  PERSONNEL.SALARY
SALARY_START                    DATE ANSI
 Not Null constraint PERSONNEL.SALARY_HISTORY_NOT_NULL1
SALARY_END                      DATE ANSI

Table constraints for PERSONNEL.SALARY_HISTORY:
PERSONNEL.SALARY_HISTORY_FOREIGN1
 Foreign Key constraint
 Column constraint for PERSONNEL.SALARY_HISTORY.EMPLOYEE_ID
 Evaluated on COMMIT
 Source:
       SALARY_HISTORY.EMPLOYEE_ID REFERENCES          EMPLOYEES (EMPLOYEE_ID)
   .
   .
   .
```

The following callout is keyed to Example 7–7:

❶ To display a table from another schema, the schema name must be specified.

Example 7–8 shows how to display information about views.

Example 7–8 Using the SHOW VIEWS Statement

```
SQL> SHOW VIEW PERSONNEL.CURRENT_INFO ❶
Information for table CURRENT_INFO
    Stored name is CURRENT_INFO

    Columns for view CURRENT_INFO:
Column Name   Data Type  Domain
-----------   ---------  ------
LAST_NAME                      CHAR(20)
FIRST_NAME                     CHAR(20)
ID                             CHAR(5)
DEPARTMENT                     CHAR(20)
JOB                            CHAR(20)
JSTART                         DATE ANSI
SSTART                         DATE ANSI
SALARY                         INTEGER(2)
 Source:
       SELECT
                        CJ.LAST_NAME,
                        CJ.FIRST_NAME,
                        CJ.EMPLOYEE_ID,
                         D.DEPARTMENT_NAME,
                         P.JOB_TITLE,
                        CJ.JOB_START,
                        CS.SALARY_START,
                        CS.SALARY_AMOUNT
                  FROM ADMINISTRATION.PERSONNEL.CURRENT_JOB CJ,
                       ADMINISTRATION.PERSONNEL.DEPARTMENTS D, ❷
                       ADMINISTRATION.ACCOUNTING.PAYROLL p,
                       ADMINISTRATION.PERSONNEL.CURRENT_SALARY CS
                 WHERE CJ.DEPARTMENT_CODE = D.DEPARTMENT_CODE
                   AND CJ.JOB_CODE = P.JOB_CODE
                   AND CJ.EMPLOYEE_ID = CS.EMPLOYEE_ID
```

The following callouts are keyed to Example 7–8:

❶ The CURRENT_INFO view is displayed from the PERSONNEL schema.

❷ The view is composed of columns from tables in the ACCOUNTING and PERSONNEL schemas.

7.5 Querying a Multischema Database with SQL

Retrieving data from tables in a multischema database is the same as with a single-schema database, except that you must identify the catalog and schema, as shown in Example 7–9.

The first query in the example uses fully qualified column and table names. The second query uses qualified names only where necessary. The table and columns in last query need not be qualified, because the catalog and schema are identified with the SET CATALOG and SET SCHEMA statements prior to execution of the query.

Example 7–9 Querying Tables in the Default Catalog and Schema

```
SQL> ATTACH 'FILENAME corporate_data';
SQL> --
SQL> -- Display name, employee ID, and city for all employees
SQL> -- living in Massachusetts. Fully qualify all table and column names:
SQL> --
SQL> SELECT ADMINISTRATION.PERSONNEL.EMPLOYEES.LAST_NAME, ❶
SQL> ADMINISTRATION.PERSONNEL.EMPLOYEES.EMPLOYEE_ID,
SQL> ADMINISTRATION.PERSONNEL.EMPLOYEES.CITY FROM
SQL> ADMINISTRATION.PERSONNEL.EMPLOYEES
SQL> WHERE ADMINISTRATION.PERSONNEL.EMPLOYEES.STATE = 'MA';
 LAST_NAME             EMPLOYEE_ID   CITY
 Myotte                00174         Bennington
 Siciliano             00175         Farmington
 Pfeiffer              00191         Marlborough
 Gutierrez             00211         Farmington
 Harrison              00228         Boston
 McElroy               00232         Cambridge
 Rodrigo               00249         Bennington
 Mistretta             00415         Bennington
 MacDonald             00435         Marlborough
9 rows selected
SQL> --
SQL> -- Now perform the same query, but use fully qualified
SQL> -- table and column names only where required:
SQL> --
SQL> SELECT LAST_NAME, EMPLOYEE_ID, CITY FROM ❷
SQL> ADMINISTRATION.PERSONNEL.EMPLOYEES
SQL> WHERE STATE = 'MA';
 LAST_NAME             EMPLOYEE_ID   CITY
 Myotte                00174         Bennington
 Siciliano             00175         Farmington
 Pfeiffer              00191         Marlborough
 Gutierrez             00211         Farmington
```

(continued on next page)

Example 7–9 (Cont.) Querying Tables in the Default Catalog and Schema

```
 Harrison              00228         Boston
 McElroy               00232         Cambridge
 Rodrigo               00249         Bennington
 Mistretta             00415         Bennington
 MacDonald             00435         Marlborough
9 rows selected
SQL> --
SQL> -- Last, perform the same query, but identify the catalog and schema
SQL> -- first so that the table name need not be fully
SQL> -- qualified.
SQL> --
SQL> SET CATALOG 'ADMINISTRATION'; ❸
SQL> SET SCHEMA 'PERSONNEL';
SQL> --
SQL> -- Because the EMPLOYEES table is in the default schema, no
SQL> -- explicit schema name is required:
SQL> --
SQL> SELECT LAST_NAME, EMPLOYEE_ID, CITY
cont> FROM EMPLOYEES ❹
cont> WHERE STATE = 'MA';
 LAST_NAME             EMPLOYEE_ID   CITY
 Myotte                00174         Bennington
 Siciliano             00175         Farmington
 Pfeiffer              00191         Marlborough
 Gutierrez             00211         Farmington
 Harrison              00228         Boston
 McElroy               00232         Cambridge
 Rodrigo               00249         Bennington
 Mistretta             00415         Bennington
 MacDonald             00435         Marlborough
9 rows selected
```

The following callouts are keyed to Example 7–9:

❶ In this query, although not required, each table and column name is fully qualified.

❷ In this query, only the table name needs to be fully qualified because the columns are all part of the ADMINISTRATION.PERSONNEL.EMPLOYEES table.

❸ The SET statement establishes the default catalog and schema.

❹ No explicit catalog and schema names are required in this query because the EMPLOYEES table is in the default catalog and schema.

Example 7–10 shows how to query tables outside the default schema.

Example 7–10 Querying Tables in Other Schemas

```
SQL> SHOW DEFAULT
Default alias is RDB$DBHANDLE
Default catalog name is ADMINISTRATION
Default schema name is PERSONNEL
SQL> --
SQL> -- Display candidates’ names and status:
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME, CANDIDATE_STATUS
cont> FROM RECRUITING.CANDIDATES; ❶
 LAST_NAME              FIRST_NAME             CANDIDATE_STATUS
 Wilson                 Oscar                  N
 Schwartz               Trixie                 N
 Boswick                Fred                   N
3 rows selected
```

The following callout is keyed to Example 7–10:

❶ When accessing tables in other schemas or catalogs, you must add the names of those elements to the table name. To access the CANDIDATE_STATUS table, you must add the RECRUITING schema name.

7.5.1 Joining Tables in a Multischema Database

Example 7–11 shows how to join tables in the same schema.

Example 7–11 Joining Tables in the Same Schema

```
SQL> --
SQL> SHOW DEFAULT
Default alias is RDB$DBHANDLE
Default catalog name is ADMINISTRATION
Default schema name is PERSONNEL
```

(continued on next page)

Example 7–11 (Cont.) Joining Tables in the Same Schema

```
SQL> --
SQL> -- Display current salaries of all employees:
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME, SALARY_AMOUNT
cont> FROM EMPLOYEES AS E, SALARY_HISTORY AS SH ❶
cont> WHERE E.EMPLOYEE_ID = SH.EMPLOYEE_ID
cont> AND SALARY_END IS NULL;
 E.LAST_NAME            E.FIRST_NAME           SH.SALARY_AMOUNT
 Toliver                Alvin                        $51,712.00
 Smith                  Terry                        $11,676.00
 Dietrich               Rick                         $18,497.00
 Kilpatrick             Janet                        $17,510.00
 Nash                   Norman                       $52,254.00
 Gray                   Susan                        $30,880.00
 Wood                   Brian                        $10,664.00
 D'Amico                Aruwa                        $24,064.00
 Peters                 Janis                        $55,413.00
   .
   .
   .
 Silver                 Glenn                        $12,350.00
 Stornelli              James                        $52,639.00
 Belliveau              Paul                         $54,649.00
 Lapointe               Jo Ann                       $10,329.00
 Crain                  Jesse                        $93,340.00
 Lapointe               Hope                         $57,410.00
 Andriola               Leslie                       $50,424.00
 Dement                 Alvin                        $57,597.00
 Mistretta              Kathleen                     $86,124.00
 Ames                   Louie                        $26,743.00
 Blount                 Peter                        $63,080.00
 MacDonald              Johanna                      $84,147.00
 Herbener               James                        $52,000.00
100 rows selected
```

The following callout is keyed to Example 7–11:

❶ Joining tables in the same catalog and schema requires no special naming.

Example 7–12 shows how to join tables across schemas.

Example 7–12 Joining Tables Across Schemas

```
SQL> SHOW DEFAULT
Default alias is RDB$DBHANDLE
Default catalog name is ADMINISTRATION
Default schema name is PERSONNEL
SQL> --
SQL> -- Display employee names and degrees earned:
SQL> --
SQL> SELECT LAST_NAME, FIRST_NAME, DEGREE, DEGREE_FIELD
cont> FROM EMPLOYEES AS E, RECRUITING.DEGREES AS D ❶
cont> WHERE E.EMPLOYEE_ID = D.EMPLOYEE_ID;
 E.LAST_NAME            E.FIRST_NAME           D.DEGREE   D.DEGREE_FIELD
 Toliver                Alvin                  MA         Applied Math
 Toliver                Alvin                  PhD        Statistics
 Smith                  Terry                  BA         Arts
 Dietrich               Rick                   BA         Arts
 Dietrich               Rick                   PhD        Applied Math
 Kilpatrick             Janet                  BA         Arts
 Kilpatrick             Janet                  MA         Applied Math
 Nash                   Norman                 MA         Applied Math
 Nash                   Norman                 PhD        Applied Math
 Gray                   Susan                  BA         Arts
 Gray                   Susan                  PhD        Applied Math
 Wood                   Brian                  BA         Arts
 D’Amico                Aruwa                  MA         Applied Math
 D’Amico                Aruwa                  MA         Elect. Engrg.
 Peters                 Janis                  BA         Arts
   .
   .
   .
 MacDonald              Johanna                PhD        Business Admin
 Herbener               James                  BA         Arts
 Herbener               James                  MA         Business Admin
165 rows selected
```

The following callout is keyed to Example 7–12:

❶ Cross schema joins require schema and catalog names when necessary.

7.5.2 Using an SQL Command File to Set the Default Catalog and Schema

If you work with one catalog and schema most of the time, you might want to place the SET statements in a file, as shown in Example 7–13.

You might also want to make this file your SQL initialization file. See Section 1.8.6 or Section 2.8.6 for information on how to set up an SQL initialization file on OpenVMS or Digital UNIX, respectively.

Example 7–13 Command File Content: start_multi.sql

```
SET NOVERIFY
--
PRINT 'Attaching to the corporate_data database...';
--
ATTACH 'FILENAME corporate_data';
--
SET CATALOG 'ADMINISTRATION';
--
SET SCHEMA 'PERSONNEL';
--
SHOW DEFAULT
```

The following example shows how to run the command file:

```
SQL> @START_MULTI

Attaching to the corporate_data database...
Default alias is RDB$DBHANDLE
Default catalog name is ADMINISTRATION
Default schema name is PERSONNEL
```

7.6 Multischema Access Modes

Sometimes it is necessary to access a multischema database with the multischema option turned off. Some typical reasons are:

- A single-schema database was altered to become multischema, and application programs containing unmodified SQL code are expected to access the database.
- You are using a layered software product that does not support multischema naming to access the database.

To turn off the multischema attribute of a database, use the MULTISCHEMA IS OFF option of the ATTACH statement.

The general syntax of the statement is:

Syntax ATTACH 'FILENAME database-name MULTISCHEMA IS OFF';

7.6.1 Multischema Database Element Naming

With the multischema attribute on, each database element is accessed using its fully qualified name. A fully qualified name is also known as the element's SQL name. Each multischema element also has a name that allows it to be accessed when multischema mode has been turned off. This is called the element's stored name.

Example 7–14 shows how to display SQL names for tables in a multischema database.

Example 7–14 Displaying SQL Names for Database Elements

```
SQL> --
SQL> -- Display tables in multischema mode.
SQL> -- Two tables have the name 'DEPARTMENTS'.
SQL> --
SQL> ATTACH 'FILENAME corporate_data';
SQL> SHOW TABLES
User tables in database with filename corporate_data
     ADMINISTRATION.ACCOUNTING.DAILY_HOURS
     ADMINISTRATION.ACCOUNTING.DEPARTMENTS ❶
     ADMINISTRATION.ACCOUNTING.PAYROLL
     ADMINISTRATION.ACCOUNTING.WORK_STATUS
     ADMINISTRATION.PERSONNEL.CURRENT_INFO
      A view.
     ADMINISTRATION.PERSONNEL.CURRENT_JOB
      A view.
     ADMINISTRATION.PERSONNEL.CURRENT_SALARY
      A view.
     ADMINISTRATION.PERSONNEL.DEPARTMENTS ❷
     ADMINISTRATION.PERSONNEL.EMPLOYEES
     ADMINISTRATION.PERSONNEL.HOURLY_HISTORY
     ADMINISTRATION.PERSONNEL.JOB_HISTORY
     ADMINISTRATION.PERSONNEL.REVIEW_DATE
      A view.
     ADMINISTRATION.PERSONNEL.SALARY_HISTORY
     ADMINISTRATION.RECRUITING.CANDIDATES
     ADMINISTRATION.RECRUITING.COLLEGES
```

(continued on next page)

Example 7–14 (Cont.) Displaying SQL Names for Database Elements

```
     ADMINISTRATION.RECRUITING.DEGREES
     ADMINISTRATION.RECRUITING.RESUMES
SQL> DISCONNECT DEFAULT;
```

The following callouts are keyed to Example 7–14:

❶ A table in the ACCOUNTING schema has the name DEPARTMENTS.

❷ A table in the PERSONNEL schema also has the name DEPARTMENTS. When multischema mode is on, access to these tables must be qualified using the schema name.

7.6.2 Assigning Stored Names

Stored names for database elements can be assigned explicitly by the creator of the element, or Oracle Rdb will assign a default stored name, as shown in Example 7–15.

Example 7–15 Displaying Stored Table Names

```
SQL> --
SQL> -- Attach to the database with multischema mode off.
SQL> -- The two 'DEPARTMENTS' tables are shown with their
SQL> -- default stored names.
SQL> --
SQL> ATTACH 'FILENAME corporate_data MULTISCHEMA IS OFF';
```

(continued on next page)

Example 7–15 (Cont.) Displaying Stored Table Names

```
SQL> SHOW TABLES
User tables in database with filename corporate_data
     CANDIDATES
     COLLEGES
     CURRENT_INFO                       A view.
     CURRENT_JOB                        A view.
     CURRENT_SALARY                     A view.
     DAILY_HOURS
     DEGREES
     DEPARTMENTS ❶
     DEPARTMENTS1 ❷
     EMPLOYEES
     HOURLY_HISTORY
     JOB_HISTORY
     PAYROLL
     RESUMES
     REVIEW_DATE                        A view.
     SALARY_HISTORY
     WORK_STATUS
```

The following callouts are keyed to Example 7–15:

❶ DEPARTMENTS is the default name assigned to this table by Oracle Rdb. The creator of the database has the option of assigning unique stored names to elements but, in this case, that was not done. Because it was the first instance of the table name DEPARTMENTS created, it received this name.

❷ DEPARTMENTS1 is also the default name assigned to this table by Oracle Rdb. Because it was the second instance created, the number 1 was added to its name to distinguish it from the first instance of the DEPARTMENTS table. If DEPARTMENTS was used again, it would receive the stored name DEPARTMENTS2 by default, and so on.

Reference Reading

For a more detailed discussion of this topic, see the section about names in multischema databases in the *Oracle Rdb7 SQL Reference Manual*.

7.6.3 Matching SQL Names to Stored Names

As an application developer, you may have to match a table's SQL name to its stored name. This can be difficult if two or more tables have identical SQL names.

SQL names can be matched to stored names using the following two methods:

- Use the SHOW statement in multischema mode.
- Use the system tables to match the stored name to the SQL name.

7.6.3.1 Using the SHOW Statement to Match SQL Names to Stored Names

Example 7–16 shows how to use the SHOW statement to display a stored table name.

Example 7–16 Using the SHOW Statement to Display Stored Names

```
SQL> --
SQL> -- Attach to the corporate_data database
SQL> -- and display the DEPARTMENTS table:
SQL> --
SQL> ATTACH 'FILENAME corporate_data';
SQL> SET CATALOG 'ADMINISTRATION';
SQL> SET SCHEMA 'PERSONNEL';
SQL> SHOW DEFAULT
Default alias is RDB$DBHANDLE
Default catalog name is ADMINISTRATION
Default schema name is PERSONNEL
SQL> SHOW TABLE DEPARTMENTS
Information for table DEPARTMENTS
    Stored name is DEPARTMENTS ❶

   Columns for table DEPARTMENTS:
Column Name   Data Type  Domain
-----------   ---------  ------
DEPARTMENT_CODE                 CHAR(4)   CODE
 Primary Key constraint DEPARTMENTS_PRIMARY1
DEPARTMENT_NAME                 CHAR(20)   NAME

    Table constraints for DEPARTMENTS:
DEPARTMENTS_PRIMARY1
    .
    .
    .
```

The following callout is keyed to Example 7–16:

❶ The stored name is given here, and it may be practical to determine stored names this way for a database with few duplicates. If the database has many duplicate names, however, you can use the system tables method of determining stored names, as shown in Section 7.6.3.2.

7.6.3.2 Using the System Tables to Match SQL Names to Stored Names

You can query the system tables to map SQL names to stored names. Example 7–17 shows how to display the system tables for the corporate_ data database.

Example 7–17 Displaying System Tables

```
SQL> SHOW SYSTEM TABLES
System tables in database with filename corporate_data
     RDB$CATALOG.RDB$SCHEMA.RDB$CATALOG_SCHEMA
     RDB$CATALOG.RDB$SCHEMA.RDB$COLLATIONS
     RDB$CATALOG.RDB$SCHEMA.RDB$CONSTRAINTS
     RDB$CATALOG.RDB$SCHEMA.RDB$CONSTRAINT_RELATIONS
     RDB$CATALOG.RDB$SCHEMA.RDB$DATABASE
     RDB$CATALOG.RDB$SCHEMA.RDB$FIELDS
     RDB$CATALOG.RDB$SCHEMA.RDB$FIELD_VERSIONS
     RDB$CATALOG.RDB$SCHEMA.RDB$INDEX_SEGMENTS
     RDB$CATALOG.RDB$SCHEMA.RDB$INDICES
     RDB$CATALOG.RDB$SCHEMA.RDB$INTERRELATIONS
     RDB$CATALOG.RDB$SCHEMA.RDB$MODULES
     RDB$CATALOG.RDB$SCHEMA.RDB$PARAMETERS
     RDB$CATALOG.RDB$SCHEMA.RDB$PRIVILEGES
     RDB$CATALOG.RDB$SCHEMA.RDB$QUERY_OUTLINES
     RDB$CATALOG.RDB$SCHEMA.RDB$RELATIONS
     RDB$CATALOG.RDB$SCHEMA.RDB$RELATION_CONSTRAINTS
     RDB$CATALOG.RDB$SCHEMA.RDB$RELATION_CONSTRAINT_FLDS
     RDB$CATALOG.RDB$SCHEMA.RDB$RELATION_FIELDS
     RDB$CATALOG.RDB$SCHEMA.RDB$ROUTINES
     RDB$CATALOG.RDB$SCHEMA.RDB$STORAGE_MAPS
     RDB$CATALOG.RDB$SCHEMA.RDB$STORAGE_MAP_AREAS
     RDB$CATALOG.RDB$SCHEMA.RDB$SYNONYMS
     RDB$CATALOG.RDB$SCHEMA.RDB$TRIGGERS
     RDB$CATALOG.RDB$SCHEMA.RDB$VIEW_RELATIONS
     RDB$CATALOG.RDB$SCHEMA.RDBVMS$CATALOG_SCHEMA
      A view.
     RDB$CATALOG.RDB$SCHEMA.RDBVMS$COLLATIONS   A view.
     RDB$CATALOG.RDB$SCHEMA.RDBVMS$INTERRELATIONS
      A view.
     RDB$CATALOG.RDB$SCHEMA.RDBVMS$PRIVILEGES   A view.
     RDB$CATALOG.RDB$SCHEMA.RDBVMS$RELATION_CONSTRAINTS
      A view.
     RDB$CATALOG.RDB$SCHEMA.RDBVMS$RELATION_CONSTRAINT_FLDS
      A view.
```

(continued on next page)

Example 7–17 (Cont.) Displaying System Tables

```
RDB$CATALOG.RDB$SCHEMA.RDBVMS$STORAGE_MAPS  A view.
RDB$CATALOG.RDB$SCHEMA.RDBVMS$STORAGE_MAP_AREAS
 A view.
RDB$CATALOG.RDB$SCHEMA.RDBVMS$SYNONYMS      A view.
RDB$CATALOG.RDB$SCHEMA.RDBVMS$TRIGGERS      A view.
```

Use the following steps to match a database table's SQL name to its stored name using system tables:

Step	Action
1	Display the stored names for tables in the database using the SELECT statement with system tables. (See Example 7–18.)
2	Translate the stored name to an SQL name and display the schema identifier for each stored name. (See Example 7–19.)
3	Use the schema identifier to determine the schema name and to display the catalog identifier. (See Example 7–20.)
4	Use the catalog identifier to determine the catalog name. (See Example 7–21.)

Example 7–18 shows how to display the stored table names.

Example 7–18 Displaying the Stored Names for the Tables in the Database

```
SQL> --
SQL> -- Attach to the database and set schema to RDB$SCHEMA which
SQL> -- contains the system tables:
SQL> --
SQL> ATTACH 'FILENAME corporate_data';
SQL> SET SCHEMA 'RDB$SCHEMA'; ❶
```

(continued on next page)

Example 7–18 (Cont.) Displaying the Stored Names for the Tables in the Database

```
SQL> --
SQL> -- Display stored names of all user tables and views:
SQL> --
SQL> SELECT RDB$RELATION_NAME FROM RDB$RELATIONS ❷
cont> WHERE RDB$SYSTEM_FLAG = 0; ❸
 RDB$RELATION_NAME
 EMPLOYEES
 DEPARTMENTS
 JOB_HISTORY
 SALARY_HISTORY
 HOURLY_HISTORY
 CANDIDATES
 RESUMES
 COLLEGES
 DEGREES
 WORK_STATUS
 PAYROLL
 DEPARTMENTS1
 DAILY_HOURS
 CURRENT_JOB
 CURRENT_SALARY
 CURRENT_INFO
 REVIEW_DATE
17 rows selected
```

The following callouts are keyed to Example 7–18:

❶ The attach to the database is in multischema mode, so the schema must be set to RDB$SCHEMA to access the system tables.

❷ Display stored names for tables and views that are in the database.

❸ User tables and views have 0 assigned as an indicator value in RDB$SYSTEM_FLAG.

Example 7–19 shows how to match a stored name to a schema ID.

Example 7–19 Finding the Table's SQL Name and Schema ID

```
SQL> --
SQL> -- Query RDBVMS$SYNONYMS system table to link the SQL name
SQL> -- to the stored name and find out the schema ID number:
SQL> --
SQL> SELECT RDBVMS$USER_VISIBLE_NAME, RDBVMS$SCHEMA_ID
cont> FROM RDBVMS$SYNONYMS ❶
cont> WHERE RDBVMS$STORED_NAME='DEPARTMENTS' ❷
cont> AND RDBVMS$OBJECT_TYPE=31; ❸
 RDBVMS$USER_VISIBLE_NAME          RDBVMS$SCHEMA_ID
 DEPARTMENTS                                      2
1 row selected
SQL> --
SQL> --
SQL> SELECT RDBVMS$USER_VISIBLE_NAME, RDBVMS$SCHEMA_ID
cont> FROM RDBVMS$SYNONYMS
cont> WHERE RDBVMS$STORED_NAME='DEPARTMENTS1'
cont> AND RDBVMS$OBJECT_TYPE=31;
 RDBVMS$USER_VISIBLE_NAME          RDBVMS$SCHEMA_ID
 DEPARTMENTS                                      4
1 row selected
```

The following callouts are keyed to Example 7–19:

❶ The RDBVMS$SYNONYMS system table connects the stored name of a table to its SQL name. The RDBVMS$USER_VISIBLE_NAME column contains the SQL name of the table. The RDBVMS$SCHEMA_ID column contains the number used to identify its schema.

❷ The RDBVMS$STORED_NAME column contains the stored name of the table.

❸ Value 31 refers to a table. Other database elements are identified by other values.

Both tables have the same SQL name but different stored names because Oracle Rdb requires that all database elements of the same type have unique names. Given the rules for schema elements within a multischema database, because both tables have the same SQL name, they must exist in different schemas (as the different schema identifiers for both indicate).

Example 7–20 shows how to use the schema identifier to determine the schema name and its catalog identifier.

Example 7–20 Finding the Schema Name and Identifying the Parent Catalog

```
SQL> --
SQL> -- Use the schema identifier to get the schema name
SQL> -- and parent catalog ID:
SQL> --
SQL> SELECT RDBVMS$CATALOG_SCHEMA_ID, ❶
cont> RDBVMS$CATALOG_SCHEMA_NAME, ❷
cont> RDBVMS$PARENT_ID ❸
cont> FROM RDBVMS$CATALOG_SCHEMA ❹
cont> WHERE RDBVMS$CATALOG_SCHEMA_ID > 0; ❺
 RDBVMS$CATALOG_SCHEMA_ID   RDBVMS$CATALOG_SCHEMA_NAME       RDBVMS$PARENT_ID
                        1   RDB$SCHEMA                                     -1
                        2   PERSONNEL                                      -2
                        3   RECRUITING                                     -2
                        4   ACCOUNTING                                     -2
4 rows selected
SQL>
```

The following callouts are keyed to Example 7–20:

❶ This column provides the schema identifier. It matches the RDBVMS$SCHEMA_ID column from the RDBVMS$SYNONYMS system table.

❷ This column provides the schema name.

❸ This column provides the ID number of the catalog that this schema belongs to.

❹ This system table contains the name and definition of each SQL catalog and schema in this database.

❺ Schemas have ID numbers beginning at 1 and increasing. This query condition ensures that only schemas will be displayed.

The table with the stored name DEPARTMENTS and the schema identifier of 2 is contained in the schema called PERSONNEL. The table with the stored name DEPARTMENTS1 and the schema identifier of 4 is contained in the schema called ACCOUNTING.

The values displayed under the RDBVMS$PARENT_ID column are the parent catalog identifiers for the schemas displayed under the RDBVMS$CATALOG_SCHEMA_NAME column. The parent identifiers are the same for both the PERSONNEL and ACCOUNTING schemas. This indicates that both schemas reside in the same catalog.

Example 7–21 shows how to use the catalog identifier to find the catalog name.

Example 7–21 Displaying the Catalog Identifier and Name

```
SQL> --
SQL> -- Use the schema parent identifier to determine catalog name:
SQL> --
SQL> SELECT RDBVMS$CATALOG_SCHEMA_ID,
cont> RDBVMS$CATALOG_SCHEMA_NAME,
cont> RDBVMS$PARENT_ID
cont> FROM RDBVMS$CATALOG_SCHEMA
cont> WHERE RDBVMS$CATALOG_SCHEMA_ID < 0; ❶
RDBVMS$CATALOG_SCHEMA_ID   RDBVMS$CATALOG_SCHEMA_NAME ❷      RDBVMS$PARENT_ID
                      -1   RDB$CATALOG                                      0
                      -2   ADMINISTRATION                                   0

2 rows selected
```

The following callouts are keyed to Example 7–21:

❶ Values of less than zero indicate that you are searching for the catalog identifiers.

❷ The RDBVMS$CATALOG_SCHEMA_NAME column displays the catalogs in this database.

The corporate_data database contains two catalogs; the default database RDB$CATALOG catalog with the catalog identifier of −1, and the ADMINISTRATION catalog with the catalog identifier of −2. Because the schemas PERSONNEL and ACCOUNTING belong to a catalog with an identifier equal to −2, you know that the catalog's name is ADMINISTRATION. Thus, the table with the stored name of DEPARTMENTS corresponds to the table named ADMINISTRATION.PERSONNEL.DEPARTMENTS.

The table with the stored name of DEPARTMENTS1 corresponds to the table named ADMINISTRATION.ACCOUNTING.DEPARTMENTS.

8
Using Date-Time Data Types

SQL includes a set of date-time data types and functions that allow you to manipulate date and time data. By using these data types, functions, and arithmetic operations you can:

- Store and query many types of date-time data
- Extract and process individual fields within a date-time data type
- Convert date-time data types to other data types for arithmetic manipulation and display
- Perform date-time arithmetic operations using SQL that cannot be performed by using high-level languages

This chapter provides introductory information about date-time data types and built-in functions.

Reference Reading

For more information about using date-time data types, see the *Oracle Rdb7 SQL Reference Manual*.

8.1 Date-Time Data Types and Functions

SQL provides specific data types for expressing dates and times. Table 8–1 provides a list of the data types, their format, and a description of their use.

Table 8–1 Date-Time Data Types

Data Type Name	Format	Description
DATE VMS[1]	dd-mmm-yyyy hh:mm:ss.cc	A timestamp containing year to second.
DATE ANSI	yyyy-nn-dd	A date of three fields specifying year, month, and day.
TIME[2]	hh:mm:ss	A time of three fields specifying hour, minute, and second.
TIMESTAMP	yyyy-nn-dd hh:mm:ss.cc	A data type composed of all date-time fields from year to second. Prior to Oracle Rdb V7.0, the format was yyyy-nn-dd:hh:mm:ss.cc. This format will continue to work. However, replacing the colon between the day and the hour with a space conforms to the SQL92 standard.
YEAR-MONTH INTERVAL	±yy-nn	A data type that describes the signed duration between two dates in years and months.
DAY-TIME INTERVAL	±dd:hh:mm:ss.cc	A data type that describes the signed duration between two dates in days to seconds.

[1]The DATE data type introduced in Oracle Rdb Version 1.0 is called DATE VMS to distinguish it from the DATE ANSI data type introduced in Oracle Rdb Version 4.1. The DATE VMS data type cannot be used in date-time arithmetic.

[2]The TIME data type specified without a precision specification defaults to no fractional seconds precision, namely hh:mm:ss. You must specify TIME(2) for SQL to return fractional seconds precision in the form hh:mm:ss.cc.

SQL also provides special functions that can be used with date-time data types. Table 8–2 describes these functions.

Table 8–2 Date-Time Functions

Function	Format	Description
CURRENT_DATE	yyyy-nn-dd	Returns today's date in DATE ANSI format.
CURRENT_TIME	hh:mm:ss	Returns the present time in TIME format.
CURRENT_TIMESTAMP[1] TIMESTAMP data type (ANSI) format	yyyy-nn-dd:hh:mm:ss.cc	Returns the present date and time in ANSI format.
CURRENT_TIMESTAMP[1] DATE VMS data type format	dd-mmm-yyyy hh:mm:ss.cc	Returns the present date and time in DATE VMS format.
EXTRACT	Integer	Returns a single date-time field as an integer from column of date type DATE, TIME, TIMESTAMP, or INTERVAL.

[1]The CURRENT_TIMESTAMP function has two formats. By default, SQL displays or stores CURRENT_TIMESTAMP in DATE VMS format. If you change the default with the SET DEFAULT DATE FORMAT statement to ANSI format, SQL displays or stores CURRENT_TIMESTAMP in ANSI format.

8.1.1 DATE VMS Data Type

Date data types specified in the mf_personnel database are of type DATE VMS (regardless of whether you are working on an OpenVMS or a Digital UNIX system). This represents the standard date-time definition prior to Oracle Rdb V4.1 and is still the default date-time data type for Oracle Rdb databases. Domains and columns specified as DATE VMS cannot be used in date-time arithmetic unless they are converted to DATE ANSI using the CAST function.

The date literal format for the DATE VMS data type is basically the same on Digital UNIX as on OpenVMS. However, the XPG4 date and time services used on Digital UNIX to support locale-specific month abbreviations do not support the fractional seconds portion of the time. Therefore, any DATE VMS text literal that contains fractional seconds is truncated such that the fractional seconds are zero. For example, DATE VMS expressed as `'10-JUL-1996 12:34:22.56'` on OpenVMS is expressed as `'10-JUL-1996 12:34:22.00'` on Digital UNIX.

Digital UNIX applications that require the storage of text literals with 10ths and 100ths of seconds should use the SQL TIMESTAMP literal format. For example:

```
CAST(TIMESTAMP'1996-07-10 12:34:22.56' AS DATE VMS)
```

Examples of conversion using the CAST function are shown in Section 4.13.1 and in Section 8.1.5.

Example 8–1 shows how DATE VMS is specified in the mf_personnel database.

Example 8–1 DATE VMS Specification

```
SQL> -- Display the EMPLOYEES table from the mf_personnel database:
SQL> --
SQL> SHOW TABLE EMPLOYEES
Information for table EMPLOYEES

Comment on table EMPLOYEES:
personal information about each employee

Columns for table EMPLOYEES:
Column Name                     Data Type        Domain
-----------                     ---------        ------
EMPLOYEE_ID                     CHAR(5)          ID_DOM
   .
   .
   .
BIRTHDAY                        DATE VMS         DATE_DOM ➊
   .
   .
   .
SQL> --
SQL> -- Display the DATE_DOM definition:
SQL> --
SQL> SHOW DOMAIN DATE_DOM ➊
DATE_DOM                        DATE VMS
 Comment:       standard definition for complete dates
 Edit String:   DD-MMM-YYYY
SQL> --
SQL> -- Display the birthday for employee 00164:
SQL> --
SQL> SELECT BIRTHDAY FROM EMPLOYEES
cont>  WHERE EMPLOYEE_ID= '00164';
 BIRTHDAY
 28-Mar-1947 ➋
1 row selected
```

The following callouts are keyed to Example 8–1:

❶ The date domain is defined as DATE VMS using the edit string formatting clause to force SQL to display the date in the format dd-mmm-yyyy with no time portion.

When defining columns and domains, the data type for DATE will be interpreted as DATE VMS unless DATE ANSI is explicitly specified, the SET DEFAULT DATE FORMAT statement is used, or the SET DIALECT statement is used to set the default format as DATE ANSI. See the *Oracle Rdb7 SQL Reference Manual* for more details on using these statements.

❷ The format includes digits and letters. Note the difference between this format and DATE ANSI shown in Example 8–2.

8.1.2 DATE ANSI Data Type

DATE ANSI is a distinct data type from DATE VMS. It contains year, month, and day fields (yyyy-nn-dd).

Example 8–2 shows how DATE ANSI is specified in the corporate_data database.

Example 8–2 DATE ANSI Specification

```
SQL> --
SQL> -- Display the EMPLOYEES table from the corporate_data
SQL> -- database:
SQL> --
SQL> SHOW TABLE EMPLOYEES
Information for table EMPLOYEES
    Stored name is EMPLOYEES

Columns for table EMPLOYEES:
Column Name                     Data Type        Domain
-----------                     ---------        ------
EMPLOYEE_ID                     CHAR(5)          ID
   .
   .
   .
BIRTHDAY                        DATE ANSI ❶
STATUS                          CHAR(1)          STATUS_CODE
   .
   .
   .
```

(continued on next page)

Example 8–2 (Cont.) DATE ANSI Specification

```
SQL> --
SQL> -- Display the birthday for employee 00164:
SQL> --
SQL> SELECT BIRTHDAY FROM EMPLOYEES
cont>  WHERE EMPLOYEE_ID= '00164';
 BIRTHDAY
 1947-03-28 ❷
1 row selected
```

The following callouts are keyed to Example 8–2:

❶ DATE ANSI is specified for the BIRTHDAY column in the corporate_data database.

❷ Unlike DATE VMS, DATE ANSI data is displayed in year-to-day format (yyyy-nn-dd).

8.1.3 TIMESTAMP Data Type

TIMESTAMP contains all of the date and time fields: year, month, day, hour, minute, second, and fractions of a second.

Example 8–3 shows how a TIMESTAMP is defined in the corporate_data database.

Example 8–3 TIMESTAMP Specification

```
SQL> -- Display the DAILY_HOURS table from the
SQL> -- corporate_data database:
SQL> --
SQL> SET CATALOG 'ADMINISTRATION';
SQL> SET SCHEMA 'ACCOUNTING';
SQL> SHOW TABLE DAILY_HOURS
Information for table DAILY_HOURS
    Stored name is DAILY_HOURS

Columns for table ACCOUNTING.DAILY_HOURS:
Column Name                     Data Type        Domain
-----------                     ---------        ------
EMPLOYEE_ID                     CHAR(5)          PERSONNEL.ID
START_TIME                      TIMESTAMP(2) ❶
END_TIME                        TIMESTAMP(2)
```

(continued on next page)

Example 8–3 (Cont.) TIMESTAMP Specification

```
   .
   .
   .
SQL> --
SQL> -- Insert employee starting and ending times:
SQL> --
SQL> INSERT INTO DAILY_HOURS
cont>       (EMPLOYEE_ID, START_TIME, END_TIME)
cont>       VALUES ('00164', TIMESTAMP'1992-04-23 07:58:23.16',
cont>                TIMESTAMP'1992-04-23 17:08:15.06'); ❷
1 row inserted
SQL> --
SQL> -- Display start time for employee 00164:
SQL> --
SQL> SELECT EMPLOYEE_ID, START_TIME
cont>  FROM DAILY_HOURS
cont>  WHERE EMPLOYEE_ID= '00164';
 EMPLOYEE_ID   START_TIME
 00164         1992-04-23:07:58:23.16 ❸
1 row selected
```

The following callouts are keyed to Example 8–3:

❶ TIMESTAMP(2) indicates that precision is set to two places to the right of the decimal point. It was unnecessary to specify this, however, because TIMESTAMP displays this fractional precision by default. To omit fractional seconds specify TIMESTAMP(0).

❷ The literal format is used to insert TIMESTAMP values.

❸ The standard display is year-to-second format (yyyy-nn-dd hh:mm:ss.cc).

8.1.4 TIME Data Type

TIME specifies 24-hour military time containing hours, minutes, seconds, and optionally, fractions of a second fields.

TIME has limited value as a column or domain specification. In Example 8–4, TIMESTAMP is converted to TIME format. The CAST function is being used for date-time field conversion.

Example 8–4 Displaying Data in TIME Format

```
SQL> -- Display starting time without fractional seconds
SQL> -- for employee 00164:
SQL> --
SQL> SET CATALOG 'ADMINISTRATION';
SQL> SET SCHEMA 'ACCOUNTING';
SQL> SELECT CAST(START_TIME AS TIME) AS STARTING_TIME  ❶
cont> FROM DAILY_HOURS
cont> WHERE EMPLOYEE_ID= '00164';
 STARTING_TIME
 07:58:23 ❷
1 row selected
```

The following callouts are keyed to Example 8–4:

❶ START_TIME is specified as a TIMESTAMP and CAST is used to convert it to TIME, which is more readable. TIME(2) could have been specified to display the fractional seconds.

❷ The format is hours, minutes, and seconds (hh:mm:ss). Data appears with the column name STARTING_TIME because it was specified as the column name in the SELECT statement.

8.1.5 INTERVAL Data Type

INTERVAL is used to describe the duration or time between two events.

Intervals fall into two categories: year-month intervals and day-time intervals. The INTERVAL data type takes qualifiers to specify the contents of the interval field.

Table 8–3 lists the qualifiers for the two INTERVAL types.

Table 8–3 Interval Qualifiers

Interval Category	Interval Qualifiers
YEAR-MONTH	YEAR
	YEAR TO MONTH
	MONTH
DAY-TIME	DAY

(continued on next page)

Table 8–3 (Cont.) Interval Qualifiers

Interval Category	Interval Qualifiers
	DAY TO HOUR
	DAY TO MINUTE
	DAY TO SECOND
	HOUR
	HOUR TO MINUTE
	HOUR TO SECOND
	MINUTE
	MINUTE TO SECOND
	SECOND

The two interval categories are essential to any date-time interval calculation because arithmetic operations are not possible without informing SQL as to which YEAR-MONTH or DAY-TIME interval result you require. There are two main reasons why you must communicate this information to SQL and why the categories are neither compatible nor comparable in any way:

- You cannot convert a YEAR-MONTH interval to a DAY-TIME interval.

  For example, you cannot convert a YEAR-MONTH interval of two years and five months into hours to produce an accurate DAY-TIME interval. First, you do not know whether or not the year value includes a leap year. Second, you do not know what months are represented in the five-month interval. For example, the months from January to May contain a different number of days than the months from February to June, and this number would differ depending on the year as well.

- You cannot convert a DAY-TIME interval to a YEAR-MONTH interval.

  For example, you cannot convert a DAY-TIME interval of 1000 days into a YEAR-MONTH interval in months to produce an accurate YEAR-MONTH interval. The answer depends strictly on when the interval starts in absolute time.

8.1.6 Using the INTERVAL Data Type

Example 8–5 shows how INTERVAL is used to define a column in the corporate_data database.

Example 8–5 INTERVAL Specification

```
SQL> -- Display the INTERVAL in the DAILY_HOURS table
SQL> -- of the corporate_data database:
SQL> --
SQL> SET CATALOG 'ADMINISTRATION';
SQL> SET SCHEMA 'ACCOUNTING';
SQL> SHOW TABLE DAILY_HOURS
Information for table DAILY_HOURS
    Stored name is DAILY_HOURS

    Columns for table DAILY_HOURS:
    Column Name                     Data Type        Domain
    -----------                     ---------        ------
    EMPLOYEE_ID                     CHAR(5)          PERSONNEL.ID
    START_TIME                      TIMESTAMP(2)
    END_TIME                        TIMESTAMP(2)
    HOURS_WORKED                    INTERVAL ➊
                                     HOUR (2) TO SECOND (2)
     Computed:       BY (END_TIME - START_TIME) HOUR TO SECOND
SQL> --
SQL> -- Display hours worked for employee number 00164:
SQL> --
SQL> SELECT CAST(START_TIME AS TIME) AS STARTING_TIME,
cont>       CAST(END_TIME AS TIME) AS ENDING_TIME, HOURS_WORKED ➋
cont>  FROM DAILY_HOURS
cont>  WHERE EMPLOYEE_ID = '00164';
 STARTING_TIME   ENDING_TIME   HOURS_WORKED
 07:58:23        17:08:15      09:09:51.90 ➌
1 row selected
```

The following callouts are keyed to Example 8–5:

➊ HOURS_WORKED is specified as an INTERVAL data type. The INTERVAL is computed by subtracting the START_TIME from the END_TIME timestamps. An INTERVAL qualifier must be specified to determine the result. In this case, HOUR TO SECOND is used to show hours worked. HOUR(2) indicates the leading field will occupy 2 spaces. This is also known as leading field precision. SECOND(2) indicates that fractions of a second will display.

➋ Casting the TIMESTAMP data type as TIME is used to clarify the output by displaying only the time portion of the timestamps.

❸ The interval is calculated and displayed as specified by the INTERVAL qualifier HOUR TO SECOND.

Reference Reading

For a full discussion of INTERVAL qualifiers and precision, see the date-time data types section of the *Oracle Rdb7 SQL Reference Manual*.

8.2 Date-Time Data Type Literal Formats

Table 8–4 shows date-time literals and the many permutations of INTERVAL literals. Precision can be specified for literal fields.

INTERVAL maintains literal formats to accommodate the full range of date-time combinations. The numbers within single quotes are examples of values that can be input in INTERVAL format for date-time computations. The INTERVAL qualifier must be specified to inform SQL how to interpret the value, and correct separator characters must be included. Note that negative values can be used for date-time computations.

Table 8–4 Date-Time Data Type Literal Formats

Date-Time Literal Formats	Example
DATE 'yyyy-nn-dd'	DATE '1992-02-04'
TIME 'hh:mm:ss.cc'	TIME '07:14:21.43'[1]
TIMESTAMP 'yyyy-nn-dd hh:mm:ss.cc' [2]	TIMESTAMP '1991-03-12 04:15:20.45'
INTERVAL '±dd:hh:mm:ss.cc'[3]	—
INTERVAL '±literal-value' YEAR	INTERVAL '2' YEAR
INTERVAL '±literal-value' YEAR TO MONTH	INTERVAL '2-01' YEAR TO MONTH
INTERVAL '±literal-value' MONTH	INTERVAL '8' MONTH
INTERVAL '±literal-value' DAY	INTERVAL '07' DAY

[1]The default value for the TIME data type is TIME(0) or TIME with no fractional precision. Thus, the example shows a TIME literal that requires a TIME(2) data type declaration.

[2]Prior to Oracle Rdb V7.0 the day and hour fields were separated with a colon. Beginning in Oracle Rdb V7.0, these fields can be separated by a space, which conforms to the SQL92 standard. Either format is acceptable to Oracle Rdb V7.0.

[3]This table provides examples for each permutation of the date-time INTERVAL literal qualifiers allowed by the INTERVAL data type.

(continued on next page)

Table 8–4 (Cont.) Date-Time Data Type Literal Formats

Date-Time Literal Formats	Example
INTERVAL '±literal-value' DAY TO HOUR	INTERVAL '14:10' DAY TO HOUR
INTERVAL '±literal-value' DAY TO MINUTE	INTERVAL '+14:13:27' DAY TO MINUTE
INTERVAL '±literal-value' DAY TO SECOND	INTERVAL '–25:11:16:22.51' DAY TO SECOND
INTERVAL '±literal-value' HOUR	INTERVAL '15' HOUR
INTERVAL '±literal-value' HOUR TO MINUTE	INTERVAL '15:33' HOUR TO MINUTE
INTERVAL '±literal-value' HOUR TO SECOND	INTERVAL '22:41:18.25' HOUR TO SECOND
INTERVAL '±literal-value' MINUTE	INTERVAL '39' MINUTE
INTERVAL '±literal-value' MINUTE TO SECOND	INTERVAL '29:16' MINUTE TO SECOND
INTERVAL '±literal-value' SECOND	INTERVAL '43.39' SECOND

As shown in Table 8–4, you separate each field with special syntax characters. Each field must be numeric and can contain leading zeros. The seconds field includes a fractional portion that SQL does not treat as a separate field. SQL requires that you include a value for each literal field and that the value be within the valid range for that field. Refer to the *Oracle Rdb7 SQL Reference Manual* for information about valid field ranges.

Example 8–6 shows how to use an INTERVAL literal value with a qualifier in date-time arithmetic.

Example 8–6 Using INTERVAL with the DATE Data Type

```
SQL> -- Using the corporate_data database, determine
SQL> -- how old Toliver will be five years from today.
SQL> --
SQL> ATTACH 'FILENAME corporate_data';
SQL> SET CATALOG 'ADMINISTRATION'
SQL> SET SCHEMA 'PERSONNEL';
```

```
SQL> SELECT EMPLOYEE_ID, LAST_NAME, FIRST_NAME,
cont>  ((CURRENT_DATE + INTERVAL'5' YEAR) - BIRTHDAY)YEAR AS AGE ➊
cont>  FROM EMPLOYEES
cont>  WHERE EMPLOYEE_ID = '00164';
 EMPLOYEE_ID   LAST_NAME             FIRST_NAME             AGE
 00164         Toliver               Alvin                   53
1 row selected
```

The following callout is keyed to Example 8–6:

➊ To add an INTERVAL to a DATE data type, use the literal format. INTERVAL '5' adds five years to CURRENT_DATE. Using INTERVAL '5-6' would add five years and six months to CURRENT_DATE.

8.3 Using the EXTRACT Function

The EXTRACT function allows you to access individual fields from a column of the data type DATE, TIME, TIMESTAMP, or INTERVAL, and returns an integer. It can also be used with the keyword JULIAN to count the number of days from the first day of the year, or the keyword WEEKDAY to give an ordinal number indicating position in the week.

The values that the EXTRACT function can return are:

- YEAR
- MONTH
- DAY
- HOUR
- MINUTE
- SECOND
- WEEKDAY
- JULIAN

The general syntax of the statement is:

Syntax

```
SELECT . . .
EXTRACT  (date-time-field   FROM    extract-source)
FROM . . . ;
```

The result of EXTRACT is always a numeric (INTEGER), except for second, which returns a scaled numeric (INTEGER(2)) value. In addition to the date-time field names, SQL provides the WEEKDAY and JULIAN keywords. WEEKDAY returns a number 1 (Monday) through 7 (Sunday), and JULIAN returns a value of 1 to 365 or 1 to 366. Example 8–7 shows how to use the EXTRACT function.

Example 8–7 Extracting Date-Time Information

```
SQL> -- Display the hours worked by employee 00164:
SQL> --
SQL> SET CATALOG 'ADMINISTRATION';
SQL> SET SCHEMA 'ACCOUNTING';
SQL> SELECT EXTRACT(YEAR FROM START_TIME) AS YEAR, ❶
cont>       EXTRACT(MONTH FROM START_TIME) AS MONTH, ❶
cont>       EXTRACT(DAY FROM START_TIME) AS DAY, ❶
cont>       EXTRACT(HOUR FROM HOURS_WORKED) AS HOURS ❷
cont>  FROM DAILY_HOURS
cont>  WHERE EMPLOYEE_ID = '00164';
        YEAR         MONTH           DAY         HOURS
        1992             4            23             9
1 row selected
SQL> --
SQL> -- Display the day of the week from starting time:
SQL> --
SQL> SELECT EXTRACT(WEEKDAY FROM START_TIME) AS WEEK_DAY ❸
cont>  FROM ACCOUNTING.DAILY_HOURS
cont>  WHERE EMPLOYEE_ID = '00164';
    WEEK_DAY
           4
1 row selected
SQL> --
SQL> -- Display the birthday of employee 00164:
SQL> --
SQL> SET SCHEMA 'PERSONNEL';
SQL> SELECT BIRTHDAY FROM EMPLOYEES
cont>  WHERE EMPLOYEE_ID = '00164';
 BIRTHDAY
 1947-03-28
1 row selected
```

(continued on next page)

Example 8–7 (Cont.) Extracting Date-Time Information

```
SQL> --
SQL> -- Display the birthday as the Julian date:
SQL> --
SQL> SELECT EXTRACT(JULIAN FROM BIRTHDAY) AS JULIAN_DATE ❹
cont>  FROM EMPLOYEES
cont>  WHERE EMPLOYEE_ID = '00164';
 JULIAN_DATE
          87
1 row selected
```

The following callouts are keyed to Example 8–7:

❶ The column START_TIME is a timestamp containing YEAR to SECOND fields. These fields can be extracted individually to give you the information that you want.

❷ Extract the HOUR field from the INTERVAL HOURS_WORKED.

❸ WEEKDAY is extracted from the timestamp START_TIME. WEEKDAY is an integer value representing the day of the week. In this case the 5 indicates Friday and the 1 indicates Monday. WEEKDAY can only be extracted from DATE and TIMESTAMP data types.

❹ The JULIAN keyword is used with the EXTRACT function to return the number of days from the beginning of the year, in this example 1947, in which the birthday occurred.

8.4 Rules for Performing Date-Time Arithmetic

You may need to use date-time data type variables and constants in arithmetic expressions. The legal arithmetic operations that SQL allows are listed in Table 8–5. Date-time refers to a variable or literal of data type DATE ANSI, TIME, or TIMESTAMP. INTERVAL refers to the intervals YEAR-MONTH or DAY-TIME.

Table 8–5 Valid Arithmetic Operations with Date-Time Data Types

Operand 1	Operator	Operand 2	Resulting Data Type
DATE ANSI	+	TIME	TIMESTAMP
date-time	–	date-time	INTERVAL (qualified)
date-time	+ or –	INTERVAL	date-time
INTERVAL	+ or –	INTERVAL	INTERVAL
INTERVAL	* or /	numeric	INTERVAL
numeric	+ or –	INTERVAL	INTERVAL

When an arithmetic operation results in an INTERVAL, a qualifier must be specified. See Table 8–3 for a full listing of INTERVAL qualifiers. Example 8–8 shows how to specify an INTERVAL qualifier.

Example 8–8 Using CURRENT_DATE and INTERVAL

```
SQL> -- Find the age of every employee:
SQL> --
SQL> SET CATALOG 'ADMINISTRATION';
SQL> SET SCHEMA 'PERSONNEL';
SQL> SELECT EMPLOYEE_ID, LAST_NAME, FIRST_NAME,
cont>       (CURRENT_DATE - BIRTHDAY)YEAR AS AGE ❶
cont>  FROM EMPLOYEES;
 EMPLOYEE_ID   LAST_NAME             FIRST_NAME            AGE
 00164         Toliver               Alvin                  48
 00165         Smith                 Terry                  40
 00166         Dietrich              Rick                   41
   .
   .
   .
 00471         Herbener              James                  67
100 rows selected
```

The following callout is keyed to Example 8–8:

❶ Subtraction of two date-time data types results in an interval that must be qualified. In this case YEAR is the qualifier.

In Example 8–9, START_TIME must be cast as TIME before it can be subtracted from CURRENT_TIME. This is because you can only use data types with similiar fields in date-time arithmetic.

Example 8–9 Subtracting TIME

```
SQL> -- How long has Toliver worked today?
SQL> --
SQL> SET CATALOG 'ADMINISTRATION';
SQL> SET SCHEMA 'ACCOUNTING';
SQL> SELECT EMPLOYEE_ID,
cont> (CURRENT_TIME - CAST(START_TIME AS TIME)) HOUR TO MINUTE AS HOURS_WORKED
cont> FROM DAILY_HOURS
cont> WHERE EMPLOYEE_ID = '00164';
 EMPLOYEE_ID   HOURS_WORKED
 00164          07:29
1 row selected
```

In Example 8–10, the SUM function is used to add the INTERVAL HOURS_WORKED to determine the total time on the job for employee 00164. The result is given as a qualified INTERVAL of hours-to-seconds.

Example 8–10 Using SUM with INTERVAL

```
SQL> -- How many hours has employee 00164 worked in total?
SQL> --
SQL> SET CATALOG 'ADMINISTRATION';
SQL> SET SCHEMA 'ACCOUNTING';
SQL> SELECT SUM(HOURS_WORKED) AS WEEKLY_HOURS
cont>  FROM DAILY_HOURS
cont>  WHERE EMPLOYEE_ID = '00164';
 WEEKLY_HOURS
  18:58:19.25
1 row selected
```

Index

D

E

F

Q

R

S

T

U

V

W