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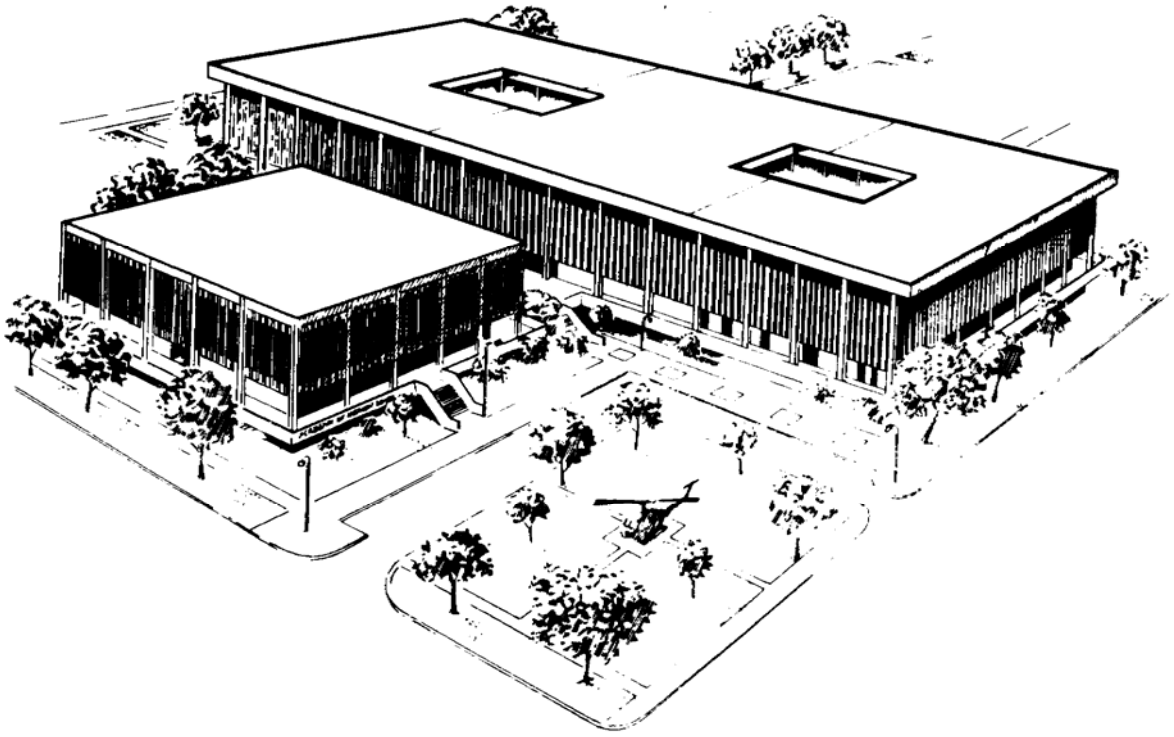

SURGICAL DRESSING STERILIZER

SUBCOURSE MD0354 EDITION 100

DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

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CORRESPONDENCE COURSE OF
THE U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL

SUBCOURSE MD0354

SURGICAL DRESSING STERILIZER

INTRODUCTION

As a Medical Equipment Repairer, you are responsible for ensuring that the Castle M/C 3333 Surgical Dressing Sterilizer functions properly and safely. The sterilizer has a sophisticated electronic circuitry. It is computer controlled by a microprocessor integrated circuit. All pressures and temperatures are sensed with transducers.

In this lesson, you will first learn about the characteristics of the sterilizer which includes its major components including its controls and indicators. Next, you will learn the major operational procedures, calibrating/ validating procedures, and how to perform the preventive maintenance checks and services (PMCS) on the sterilizer.

Subcourse Components:

This subcourse consists of two lessons and appendixes. They are

- Lesson 1. Operation and Maintenance.
- Lesson 2, Isolate Malfunctions.
- Appendix A, Coded Troubleshooting Guide.
- Appendix B, Uncoded Troubleshooting Guide.

Here are some suggestions that may be helpful to you in completing this subcourse:

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.

--After completing each set of lesson exercises, compare your answers with those on the solution sheet that follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

Credit Awarded:

Upon successful completion of the examination for this subcourse, you will be awarded 5 credit hours.

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Branch at Fort Sam Houston, Texas.

You can enroll by going to the web site http://atrrs.army.mil and enrolling under "Self Development" (School Code 555).

A listing of correspondence courses and subcourses available through the Nonresident Instruction Section is found in Chapter 4 of DA Pamphlet 350-59, Army Correspondence Course Program Catalog. The DA PAM is available at the following website: http://www.usapa.army.mil/pdffiles/p350-59.pdf.

LESSON ASSIGNMENT

LESSON 1	Operation and Maintenance.
TEXT ASSIGNMENT	Paragraphs 1-1 through 1-12.
LESSON OBJECTIVES	After completing this lesson, you should be able to:
	1-1. Identify characteristics of the sterilizer.
	1-2. Identify the components of the sterilizer.
	1-3. Perform operation checkout procedures.
	1-4. Perform calibration/ validation procedures.
	1-5. Perform preventive maintenance checks and services.
SUGGESTION	After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 1

OPERATION AND MAINTENANCE

Section I. CHARACTERISTICS

1-1. GENERAL

The Castle M/C 3333 Surgical Dressing Sterilizer is equipped with a microcomputer that monitors and sequences all cycle phases. A microprocessor provides both audible and visual notification of component failure or improper sterilizer operation. The sterilizer employs pressure/vacuum pulsing to condition goods prior to processing at the exposure temperature during the wrapped goods cycle. The sterilizer uses the following manufacturer's recommended temperature, exposure, and drying times for the following types of goods and materials.

a. **Wrapped Goods.**

(1) Linen packs. 135ºC (Celsius), (275ºF [Fahrenheit]), three minutes minimum exposure, and three minutes minimum drying time.

(2) Hard and dry goods. 135ºC (275ºF), ten minutes exposure, and 15 minutes minimum drying time.

(3) Temperature sensitive dry goods. 121ºC (250ºF), 20 minutes exposure, no minimum drying time.

b. **Unwrapped Instruments and Metals.** 135ºC (275ºF), three minutes exposure, no minimum drying time.

c. **Liquids.** 100º-121ºC (212º-250ºF), exposure time as required, slow exhaust.

1-2. MAJOR COMPONENTS

Knowing the functions of each major component and how they relate to each other is necessary for you to effectively service the sterilizer. The following paragraphs describe the functions of the major components. Refer to figures 1-1 through 1-4.

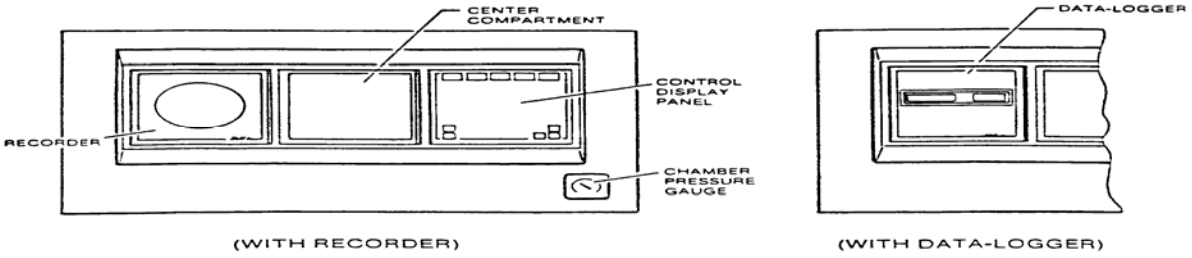


Figure 1-1. Control Head configurations, control end.

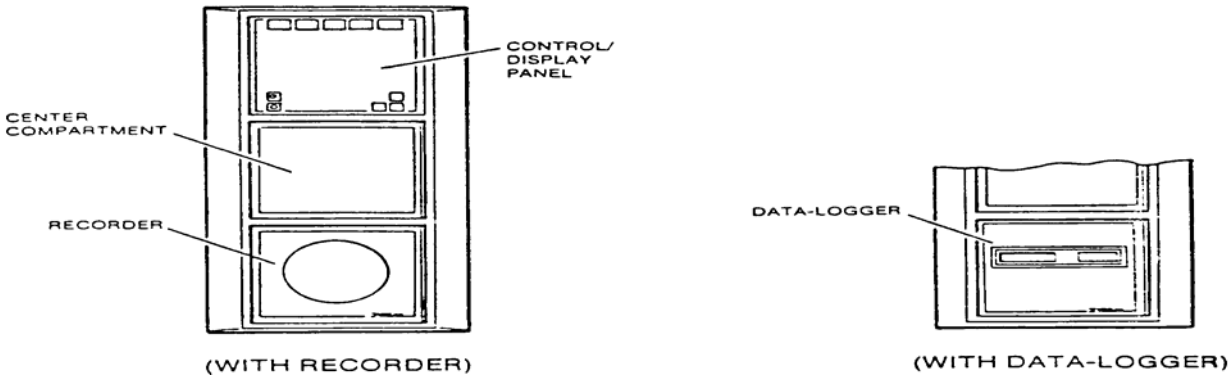


Figure 1-2. Remote location package, vertical mount.

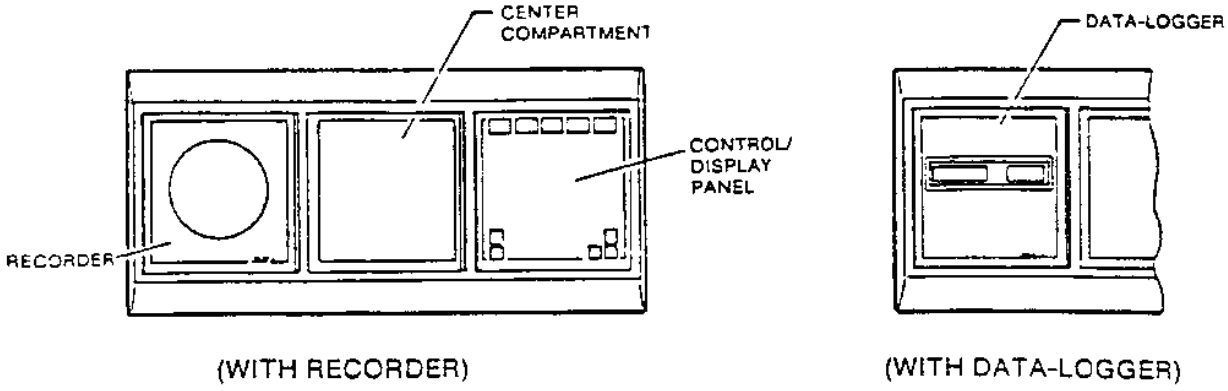


Figure 1-3. Remote location package, horizontal model.

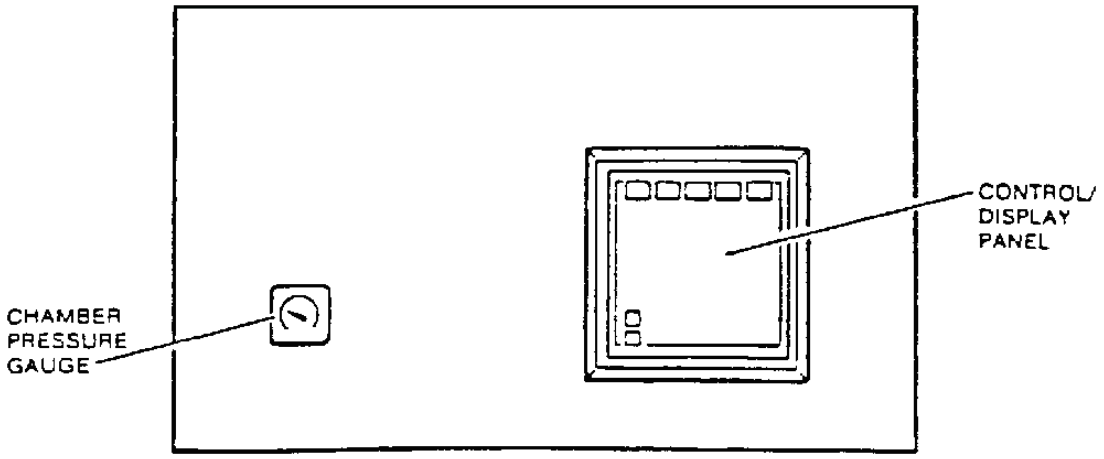


Figure 1-4. Remote end, double door unit.

a. **Center Compartment.** The center compartment contains the operations manuals.

(1) Access to control box. Use the following procedures to access the housing components and control box.

(a) Apply a half-turn to the slotted fastener head located in the lower right hand corner of the center compartment's rear wall.

(b) Raise and latch the blue control housing in the UP position.

(2) Operations booklet. The operations booklet is located inside the magnetically latched frame of the center compartment door. Refer to the booklet's Forward for further operational details.

(3) Operator's instructions. Use the operator's instructions as a guide for the daily operation of the sterilizer. When you are not using the operations booklet and instructions guide, store them in the bracket attached to the back of the center compartment door frame.

(4) Storage. Use the storage area for ready-access storage of the recorder charts, print rolls, ink cartridges, and other items.

b. **Recorder.** Federal requirements mandate that a record of the unit's performance be maintained for at least two years.

(1) Recorder chart. The recorder chart is graduated to record chamber temperature in degrees Celsius. It records pressure in Pisa (pounds per square inch absolute) or BAR over a 12-hour period.

(2) Red pen. The red pen records chamber temperature in degrees Celsius.

(3) Blue pen. The blue pen records chamber pressure in pounds per square inch absolute (psia) or BAR.

(4) Span/null. The Span/null adjusts the record's electrical measuring circuit to a related pen arm position. This ensures accurate recording.

(5) Cycle counter. The cycle counter registers the total number of completed cycles that have been run on the sterilizer.

(6) Door actuated switch. This switch energizes the recorder when the recorder door is closed. It also de-energizes the recorder when the door is opened. You may pull out the switch to energize the recorder while the recorder door is opened. Pen arms automatically lift off the chart and move to holding ramps when the recorder is de-energized.

c. **Data-Logger.** The data-logger is a solid state printer. It documents and records each cycle's performance including lot control, cycle parameters, and diagnostics. It also provides space to record test results and has a digital clock display. Refer to the special data-logger manual for details.

d. **Chamber Pressure Gauge.** This gauge constantly monitors the chamber pressure in the following range.

Range: 0 to 30 inches mercury (Hg) vacuum pressure/ 0 to 60psia--1 to 4 BAR.

e. **Remote End Control Head.** The remote end control head displays the full range of indicators and operative switches as shown in figure 1-2, except for time, temperature, and cycle selectors. Enter all variable selections at the control end control/display panel.

f. **Verti-Glide Door.** The verti-glide door is counterbalanced for ease in raising and lowering the door using the door handle. Do not use excessive force. The door automatically latches when you gently raise it to the fully closed position. Press the button in the door handle to release the door for opening. Steam pressure seals the door for cycle operation.

g. **Door Operation with Liquids Cycle.**

(1) Allow ample cooling time to prevent possible thermal shock or liquids boiling over when the door is opened or when the load is removed. After a complete cycle, check to ensure that the chamber pressure gauge is at zero. Failure to observe this warning when sterilizing a liquid load may cause violent agitation of the liquid. This may result in the liquid boiling over or flasks exploding.

(2) Wear an elbow length heat resistant glove to protect you against escaping residual steam when you lower the verti-glide door. After the liquids cycle has completed, lower the verti-glide approximately one inch from the top for the residual steam to escape. After 15 minutes, carefully remove the flasks. Be careful not to agitate the load.

h. **Wire Sizes.** The sterilizer uses the following five applications for wire sizes and types.

(1) A high voltage supply (120 volts alternating current (vac) or greater) is used for pumps which are in excess of 1/4 HP. These wires are marked with red letters and are at least 16 American wire gauge (AWG).

(2) Ground wires (protective and functional) are required by code to be 16 AWG. Although both protective and functional earths may be the drain wire for the shielded cables, protective earths have a G/Y insulation, while functional earths have a black insulation.

(3) Neutral wires are 16 AWG. These wires are marked as NEUT (neutral) in black letters. The one exception is the 14 AWG wire located in the power box.

(4) The 120v control lines are 18 AWG with red lettering. The one exception to this is the 14 AWG wire located in the power box.

(5) Low voltage control lines (less than 30v) are 16 AWG with violet lettering. On some models, wires terminating at the control board are 18 AWG.

1-3. CONTROLS, INDICATORS, AND DISPLAYS

This section discusses the functions of specific parts within the major components of the sterilizer. You must understand the functions of the following controls and status indicators to ensure the sterilizer's continued operation. Refer to figure 1-5.

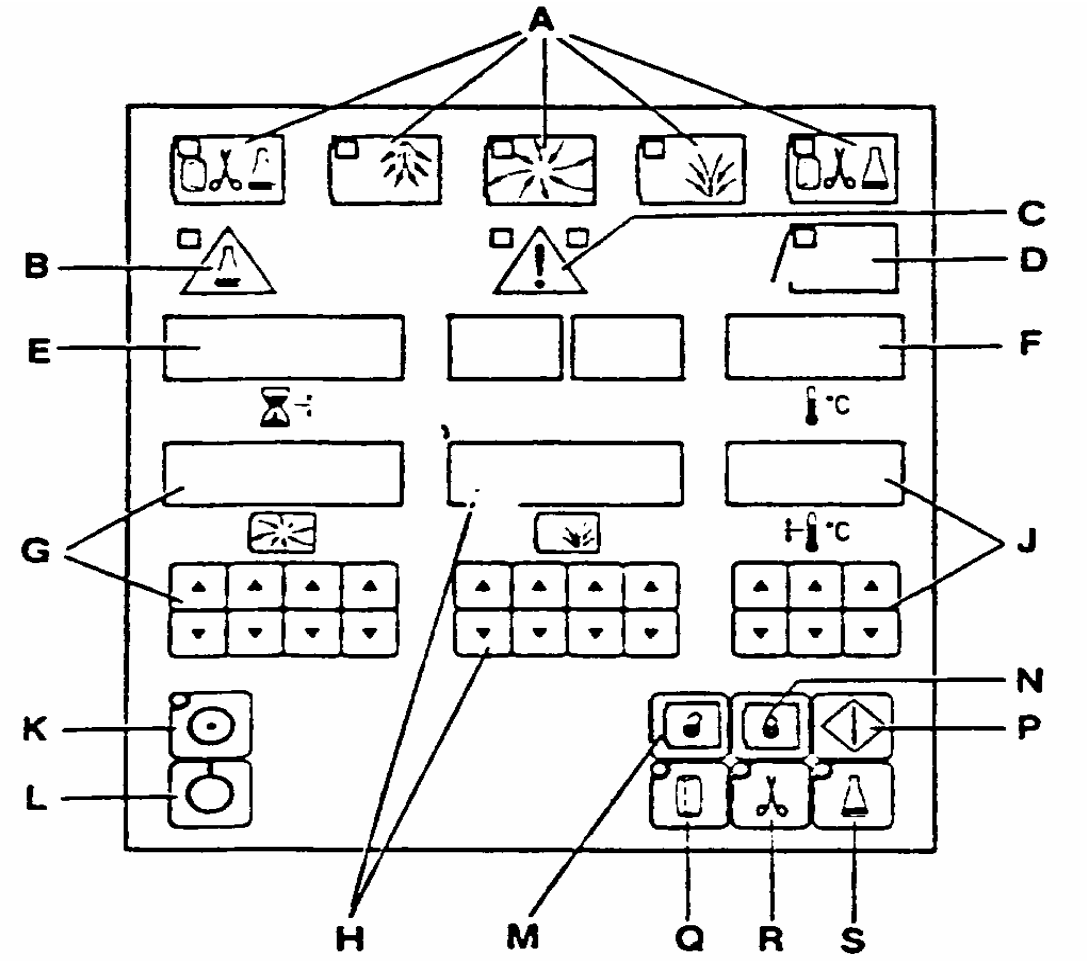


Figure 1-5. Sterilizer control/display panel.

NOTE: The letters in parenthesis correspond to the letters in figure 1-5.

a. **Cycle Phase Indicators (A).** When lit, these lights indicate that a cycle phase has been reached or is in progress. Each cycle phase indicator light remains on until a cycle advances to its next phase or is completed. They are located from left to right on the control panel (top row in figure 1-5). They indicate the following:

(1) The unit is ready for automatic processing.

(2) The load is being conditioned.

(3) The load is being processed.

(4) The load is being conditioned for removal.

(5) The cycle is complete.

b. **Liquid Load Indicator (B).** The liquid load indicator lights to identify the completion of a liquid load cycle just prior to the completion of a cycle. The light remains on until the next cycle is started (if a liquid) or is selected (if a non-liquid) or if the control/display panel is turned off.

c. **Warning and Caution Indicator (C).** This indicator displays a red warning light and digit reference code to identify a serious malfunction. It displays a yellow caution light and digital reference code to identify a less serious problem area. When the warning indicator is activated, it is accompanied by an audible tone.

d. **Unsealed Door Indicator (D).** This indicator lights to indicate that pressure has not been applied to create a door-to-chamber seal.

e. **Phase Time Display (E).** The time display shows the time remaining in digital hours and minutes for an exposure phase. It then displays the time remaining for a drying phase if one is selected.

f. **Chamber Temperature Indicator (F).** This indicator displays chamber temperature in degrees Celsius when the control/display panel is turned on.

g. **Exposure Time Selectors (G).** Use the exposure time selectors to set the desired time that the exposure temperature should be maintained in the chamber. Four vertical pairs of selector switches, grouped together, provide the means to select exposure period in hours and/or minutes. Press the upper switch to increase the value of the singular digit displayed directly above it. Press the lower switch to decrease the value.

NOTE: The last exposure time selected and used for a particular cycle (wrapped goods, unwrapped instruments, or liquids) remains in memory and is re-displayed for use, or change, when that particular cycle is selected again.

h. **Exhaust Time Selector (H).** Use the exhaust time selector to set the desired drying period to be maintained in the chamber. The switches operate in the same manner as the exposure time selector.

i. **Exposure Temperature Selector (J).** Use the exposure temperature selectors to set the desired temperature to be maintained in the chamber during the exposure period. The selector consists of three vertical pairs of switches, grouped together, which provide the means to select the exposure temperature in degrees Celsius. The switches operate in the same manner as the exposure time selector.

j. **Controls ON Switch (K).** Use this switch to turn on the control/display panel indicators, selectors, and switches. The jacket is heated to the selected temperature. The ready cycle phase indicator comes on when the jacket temperature is reached.

k. **Controls OFF Switch (L).** Use this switch to turn off the control/display indicators, selectors, and switches. The maintenance of jacket temperatures ceases. Times and temperatures for the last selected program for all programmed cycles remain in the memory. They do not need to be reset when sterilizer operation is restarted unless new times and temperatures are desired for that cycle.

NOTE: When using the controls off switch to abort a cycle in response to a coded warning or caution, be sure to record the code for future reference. Warning or caution codes are erased when the control panel is turned off unless equipped with a data logger.

l. **Unseal Door Switch (M).** Single door units do not require the use of this switch for normal operation because the door unseals automatically. Pressing an unsealed door switch closes the related three-way door gasket solenoid to steam pressure and opens it to drain, which releases the door-to-chamber seal. An unseal door switch does not function on a double door unit unless the opposite door is sealed.

m. **Seal Door Switch (N).** Single door units require the use of this switch for normal operation. Press a seal door switch to open the related three-way door gasket solenoid to steam pressure and close it to drain, creating a door-to-chamber seal.

n. **Cycle Start Switch (P).** Use this switch to start an automatic cycle on single door units. On double door units, it starts an automatic cycle after both doors are sealed.

o. **Wrapped Goods Selector (Q).** The wrapped goods selector permits the energizing of predetermined components that will accomplish a wrapped goods cycle. When more than one of the same type of cycles are run in a series, press the selector for the first cycle only.

p. **Unwrapped Instruments Selector (R).** Press this selector to permit the energizing of predetermined components to accomplish an unwrapped instruments cycle. When more than one of the same cycle are run in a series, press the selector for the first cycle only.

q. **Liquids Selector (S).** Press this selector to permit the energizing of predetermined components to accomplish a liquids cycle. When more than one of the same cycle are run in a series, press the selector for the first cycle only.

Section II. OPERATION

1-4. MAJOR PROCEDURES

The previous section covered how the components of the entire unit function together as a single unit. This section discusses the procedures you should employ to remedy four selected types of major malfunctions (power restoration, emergency manual gasket retract, vacuum leak test cycle, and solid state relays [SSR]). You will also learn the functions of each cycle phase.

a. **Power Restoration.** Use the following procedures to activate the control panel after the electrical power to the sterilizer has been interrupted. Refer to figures 1-5 and 1-6.

(1) Turn the MAINS supply switch ON.

(2) Turn the MAINS circuit breakers ON.

(3) Turn the battery pack circuit breaker ON.

(4) Connect the data-logger battery (if required).

(5) Press the controls on switch on the control panel.

(6) Wait approximately 30 seconds for the exhaust indicator to go out.

(7) Close the door and press the seal door switch on the remote end control/display panel if the unit is a double door model.

(8) Close the door and press the seal door switch on the control/display panel.

(9) Wait for the unseal door light to go out.

(10) Press the unseal door switch on the control/display panel.

(11) Wait approximately 30 seconds for the unseal door light to come on.

(12) Open the door completely. Power restoration is now complete, and the unit is ready for operation.

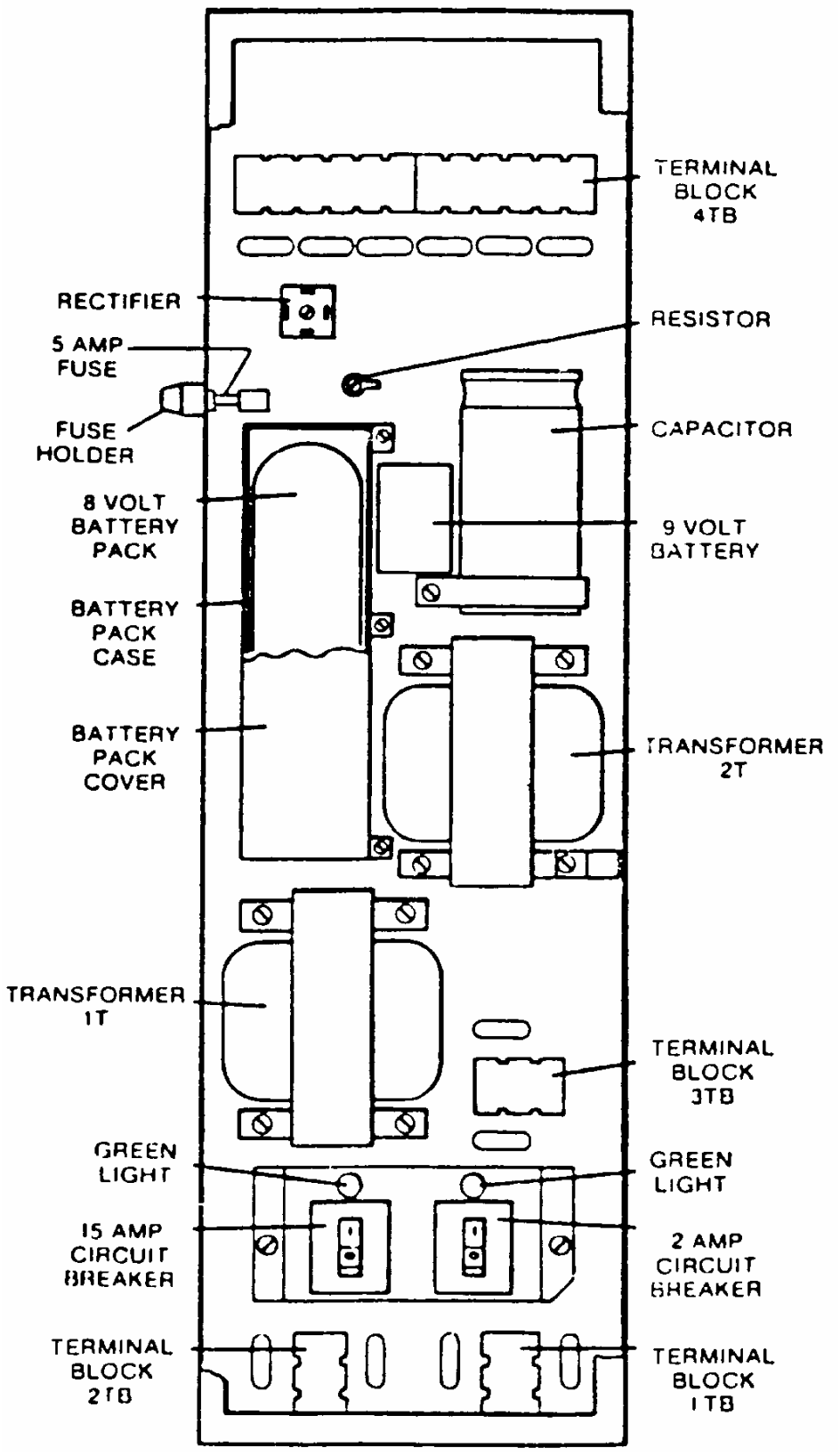


Figure 1-6. Power box components, single input power supply.

b. **Emergency Manual Gasket Retract Procedure.** Use the following emergency procedures to remove a load from the chamber when an incomplete cycle results from a power interruption to the unit.

WARNING

The chamber pressure must be at an atmospheric reading and the solenoid valve 6SOL must be de-energized to avoid personal injury or damage to the equipment.

(1) Ensure that the controls are off.

(2) Ensure that the chamber pressure is at an atmospheric reading.

(3) Ensure that the MAINS circuit breakers in the power supply box are in the OFF (0) position.

(4) Press and turn the manual operator extension tube located on solenoid valve 6SOL.

(5) Wait approximately 30 seconds; then open the door.

(6) Return the manual operator on solenoid valve 6SOL to the normal position.

(7) When power is restored, proceed as a normal start-up.

c. **Vacuum Leak Test Cycle.** Use the following procedures to run a vacuum leak test cycle. The jacket must be hot for this test.

(1) Press the controls off switch on the control/display panel.

(2) Press the controls on switch on the control/display panel.

(3) Press the close door switch (es). Do not select a cycle.

(4) Press the cycle start switch on the control/display panel.

(5) Wait for the cycle complete indictor to come on.

(6) Press the open door switch on the control/display panel.

d. **Solid State Relays (SSR) Functions.** Refer to table 1-1 for a listing of SSR functions when troubleshooting malfunctions.

SSR	TYPE	FUNCTION
0	Output	Jacket Temperature Control
1	Output	Chamber Temperature Control
3	Output	Chamber Drain
4	Output	Store Exhaust Water
5	Output	Water to Ejector
6	Output	Controls Direction of Door #0
7	Input	Indicates if Door #0 is Sealed
8	Input	Indicates if Door #1 is Closed
9	Input	Indicates if Door #1 is Closed
10	Input	Indicates if Door #1 is Sealed
11	Output	Controls Direction of Door #1
14	Output	Air In/Vent Valve

Table 1-1. SSR Functions

1-5. OPERATION SEQUENCE

The following simplified explanations give you a general knowledge of cycle functions for each type of cycle phase. Refer to figures 1-7 through 1-10. A more detailed description is found in paragraph 1-6, Cycle Phase Description.

a. **Solid State Relay Lights.** Each action during a phase is indicated by a numbered SSR light located in the panel control box. When an SSR light is on, the corresponding solenoid valve should be energized. All two-way solenoids used in this equipment are normally closed.

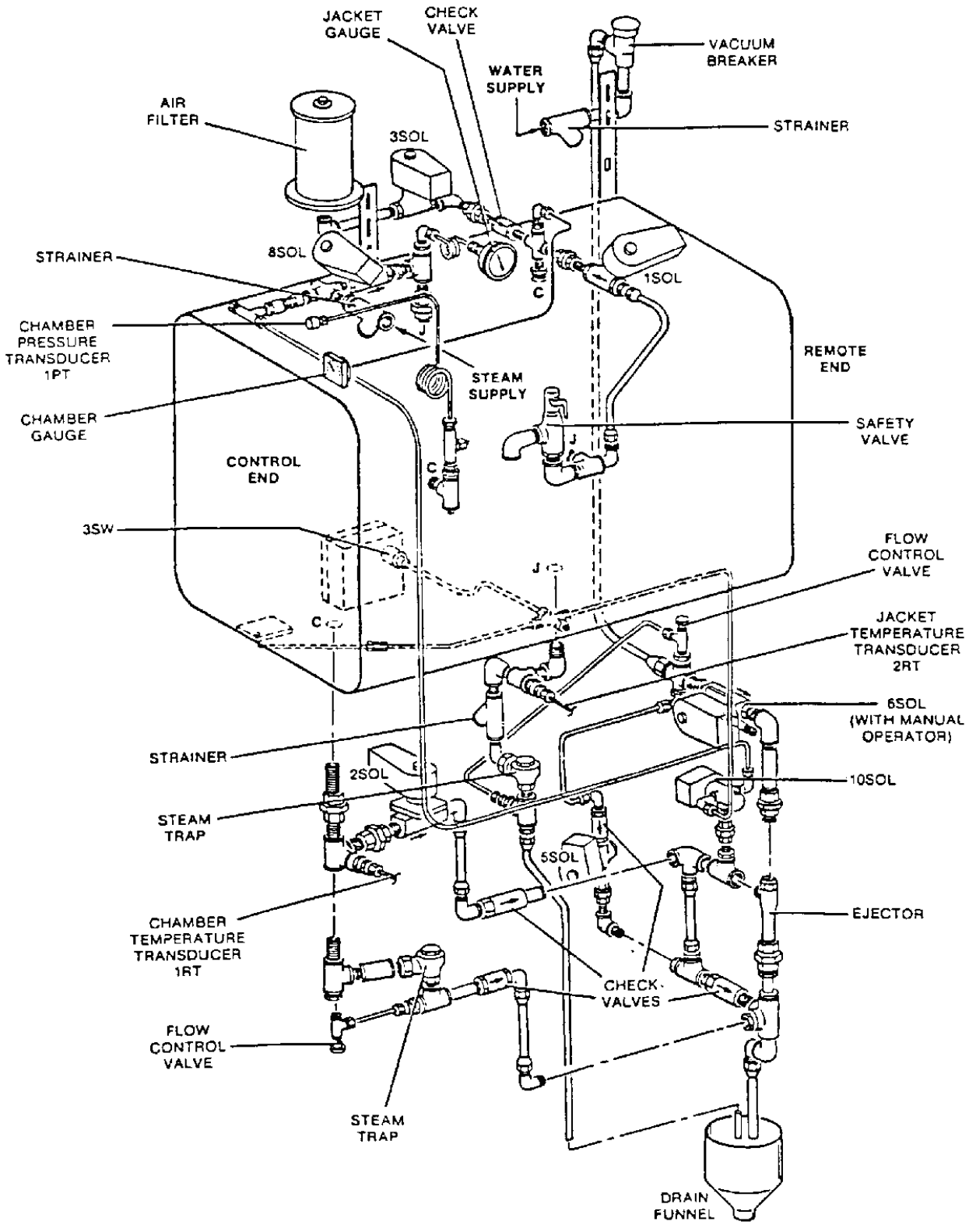
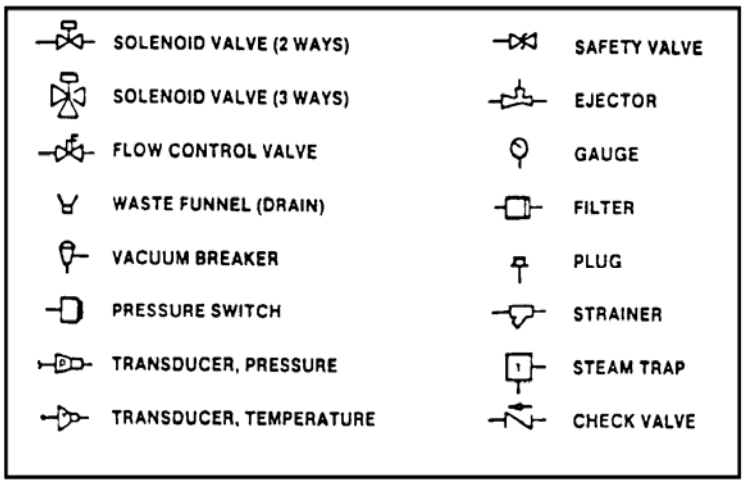


Figure 1-7. Location of components (single door).



TEMP. SET POINT (T SET), °C	PULSE HEIGHT (F), PSIA
LESS THAN 111	18
111—113	21
114—116	23
117—119	25
120—122	28
123 OR GREATER	30

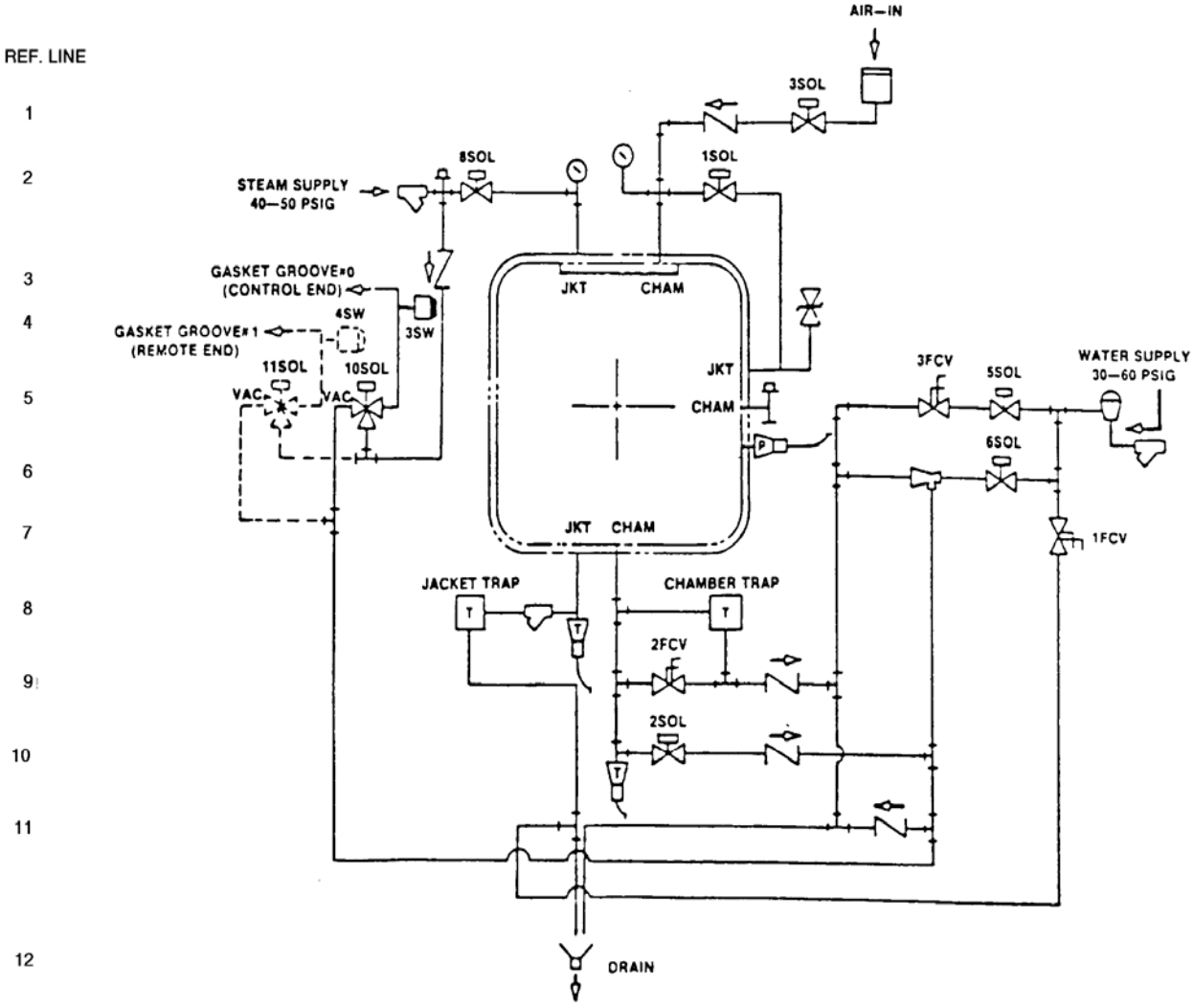


Figure 1-8. Piping schematic.

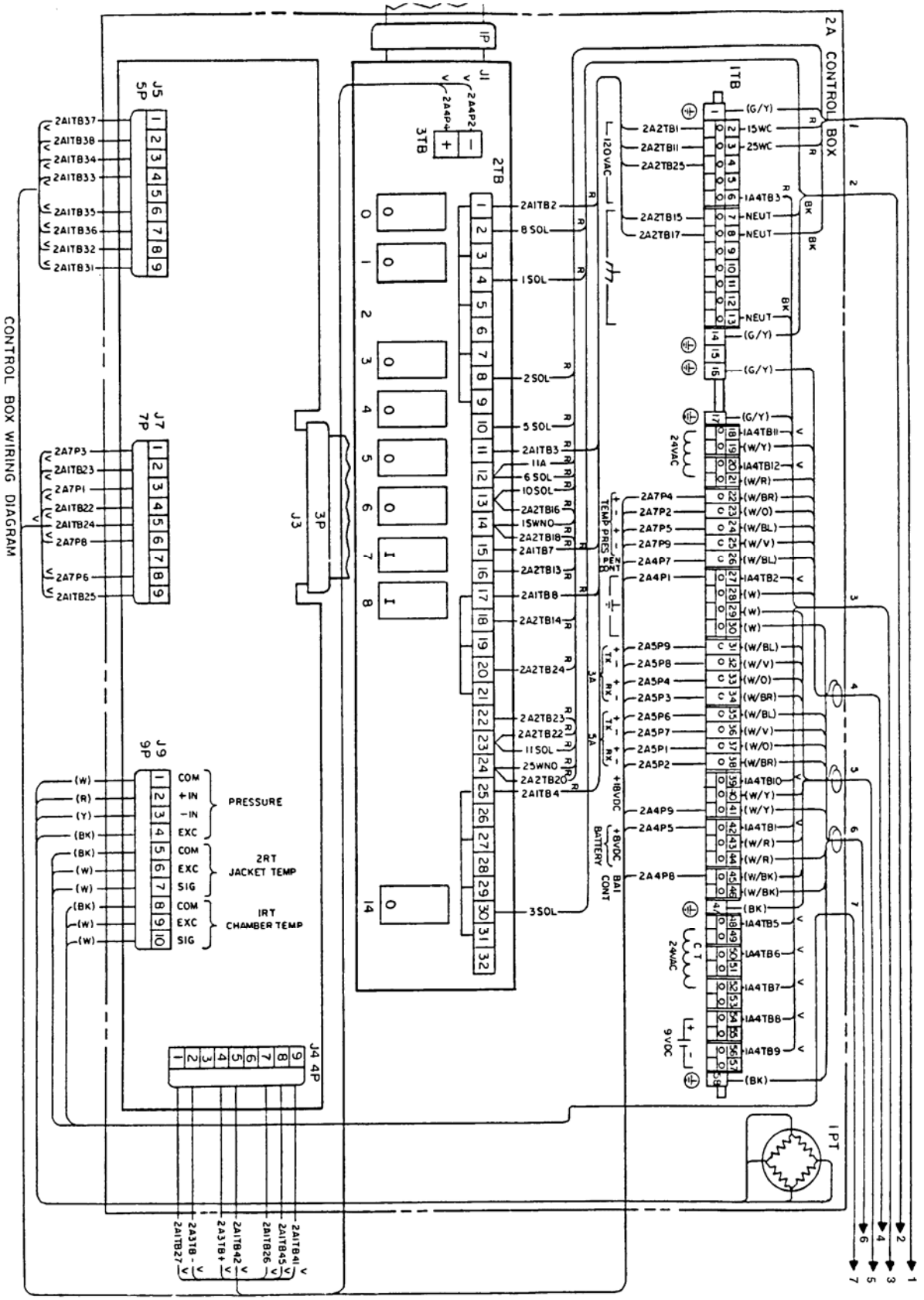


Figure 1-9. Control box wiring diagram.

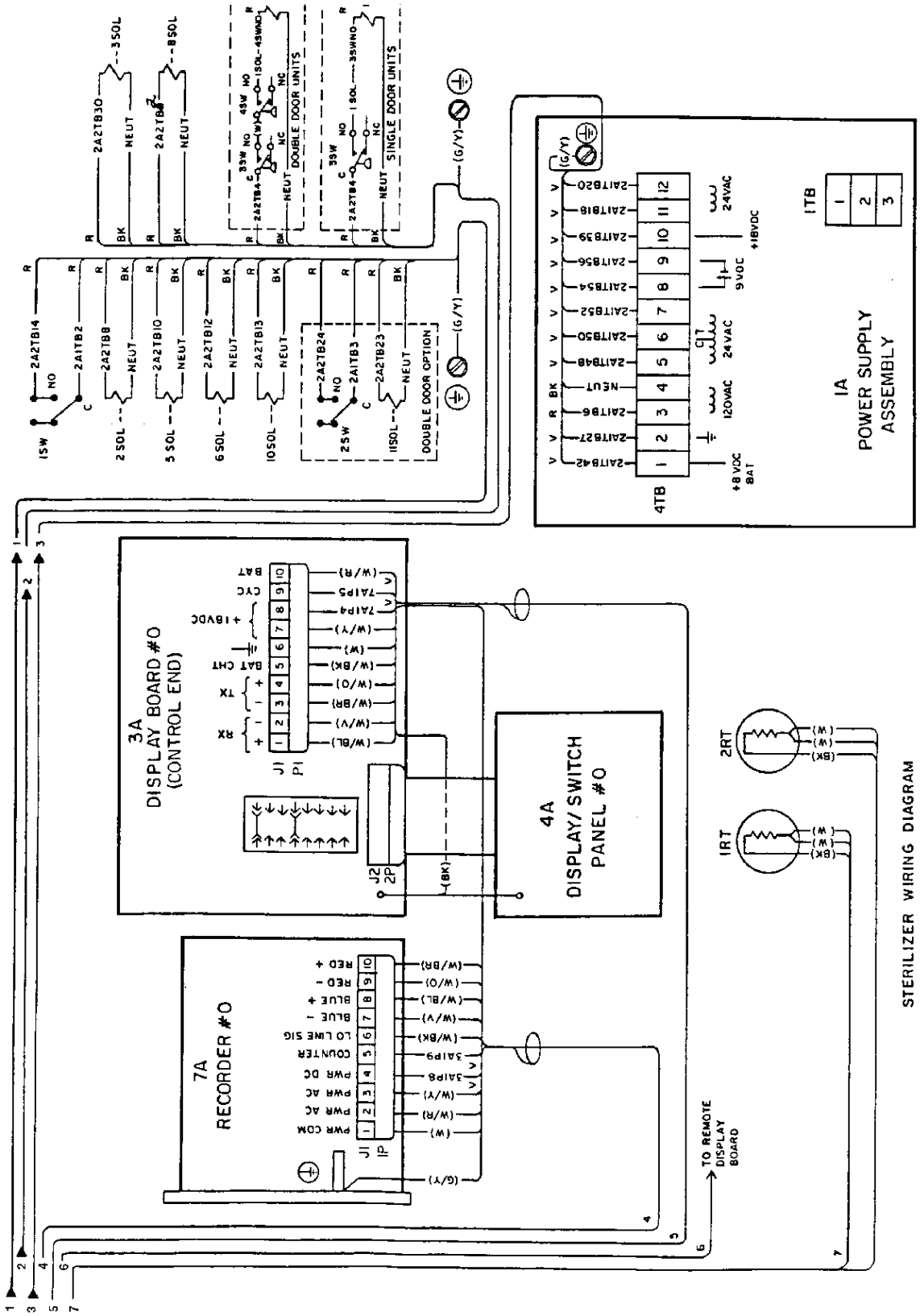


Figure 1-10. Sterilizer wiring diagram.

b. **Principles of Operation.** Each cycle goes through the same series of phases: ready, conditioning, exposure, exhaust, and complete. The cycle indicator light labeled "A" in figure 1-5 stays lit during each phase. The following simplified explanations provide you with a general knowledge of what happens in each phase of the three cycles (wrapped goods, unwrapped goods, and liquid).

(1) Wrapped goods cycle.

(a) Ready. When proper conditions are reached, the unit is ready.

(b) Conditioning. Steam purges the chamber of air for a set time depending on the size of the sterilizer. The load is then conditioned by three successive pressure and negative pulses.

(c) Exposure. Steam heats and pressurizes the chamber at the required temperature for the selected time.

(d) Exhaust. Chamber pressure is vented and vacuum drawn to dry the load for the selected time. After the drying time expires, the chamber is returned to atmospheric pressure.

(e) Complete. The gasket retracts in 30 seconds, and a buzzer sounds to alert you to manually open the door. On a double door unit, press either unseal door switch after the buzzer sounds for both gaskets to retract.

(2) Unwrapped instruments cycle (16 x 16).

(a) Ready. When the proper conditions are reached, the unit is ready.

(b) Conditioning. Steam purges the chamber of air for 60 seconds. The chamber is then heated to the selected temperature.

(c) Exposure. The chamber is maintained at the required temperature for the selected exposure time.

(d) Exhaust. Chamber pressure is vented, and a vacuum is drawn to dry the load for the selected time. After the drying time expires, the chamber is returned to atmospheric pressure.

(e) Complete. The gasket retracts in 30 seconds, and a buzzer sounds to alert you to manually open the door. On a double door unit, press either unseal door switch after the buzzer sounds for both gaskets to retract.

(3) Unwrapped instruments cycle (20 x 20).

(a) Ready. When the proper conditions are reached, the unit is ready.

(b) Conditioning. Steam purges the chamber of air for 90 seconds. The load is then conditioned for two successive pressure and negative pulses.

(c) Exposure. Steam heats and pressurizes the chamber at the required temperature for the selected time.

(d) Exhaust. Chamber pressure is vented, and a vacuum is drawn to dry the load for the selected time. After the drying time expires, the chamber is returned to atmospheric pressure.

(e) Complete. The gasket retracts in 30 seconds, and a buzzer sounds to alert the operator to manually open the door. On a double door unit, press either unseal door switch after the buzzer sounds for both gaskets to retract.

(4) Liquids cycle.

(a) Ready. When proper conditions are reached, the unit is ready.

(b) Conditioning. Steam purges the chamber of air for a set time depending on the size of the sterilizer. The chamber is heated to the selected temperature.

(c) Exposure. The chamber is held at the required temperature for the selected time.

(d) Exhaust. The chamber and jacket pressure are slowly reduced to atmospheric pressure to avoid agitation of the liquids.

(e) Complete. The gasket retracts in 30 seconds, and a buzzer sounds. On a double door unit, press either unseal door switch after the buzzer sounds for both gaskets to retract.

1-6. CYCLE PHASE DESCRIPTIONS

Paragraph 1-5 provided you an overview of the cycle phases. This paragraph discusses the step-by-step processes involved during each phase throughout the entire cycle. The unit is pre-programmed to execute each phase automatically after you press the cycle start switch (labeled "P" in figure 1-5).

a. **Wrapped Goods Cycle.** Refer to figure 1-11.

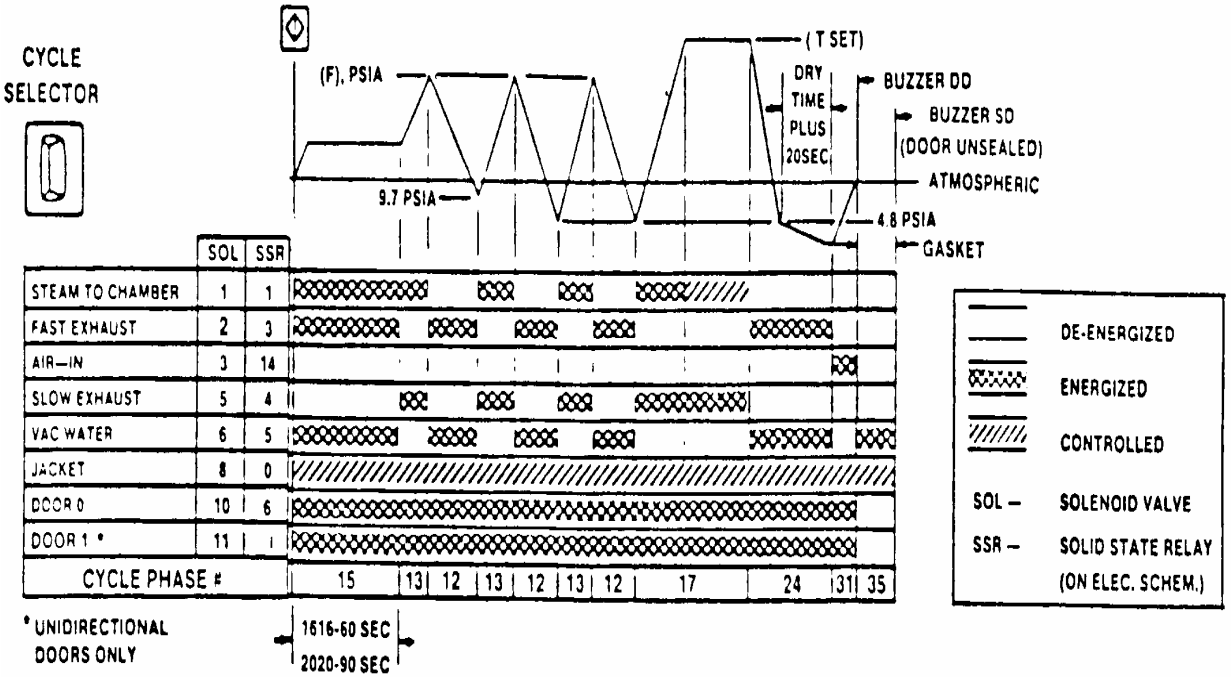


Figure 1-11. Wrapped goods cycle.

(1) Control ON. Use this switch to energize (opened to steam supply) 8SOL. Steam enters and heats the jacket to the selected temperature by energizing (opening) and de-energizing (closing) 8SOL.

(2) Seal door. Press the seal door switch (label "N" in figure 1-5) to energize (opened to steam/closed to ejector) 10SOL on single door units. 10SOL (control end) and 11SOL (remote end) are energized on double door units. The gasket groove(s) is/are pressurized, sealing the chamber. Select the wrapped cycle and enter the appropriate times and preset temperature.

(3) Phase 15: purge. Press the cycle start switch (labeled "P" in figure 1-5) to (after a 5-second delay) energize 1SOL, 2SOL, and 6SOL (opened). Steam enters the chamber from the jacket through 1SOL. It purges the chamber of air and steam through 2SOL to the ejector. During the purge, steam and air are pulled from the chamber by the negative pressure created by the ejector. The steam then travels to the ejector where it is cooled by water or down the drain where it is also cooled by water. After the time period noted, 2SOL and 6SOL are de-energized (closed) and the purge is complete.

(4) Phase 13: pressure pulse (first). Steam pressurizes the chamber through 1SOL. 5SOL is energized (opened), permitting cooling water to condense steam from the chamber and drain to waste. When the chamber pressure reaches (F), psia, 1SOL and 5SOL are de-energized (closed) and Phase 12, negative pulse, begins.

(5) Phase 12: negative pulse (first). 2SOL and 6SOL are energized (opened). Chamber steam is exhausted to the ejector, condensed, and drained. When the chamber pressure is reduced to 9.7psia, 2SOL and 6SOL are de-energized (closed).

(6) Phase 13: pressure pulse (second). Steam pressurizes the chamber through 1SOL. 1SOL and 5SOL are energized (opened). When the chamber pressure reaches (F) psia, 1SOL and 5SOL are de-energized (closed), and the second Phase 12, negative pulse, begins.

(7) Phase 12: negative pulse (second). This phase is identical to first Phase 12, negative pulse, except the chamber pressure is reduced to 4.8psia before 2SOL and 6SOL are de-energized (closed), and the third Phase 12, negative pulse, begins.

(8) Phase 13: pressure pulse (third). Steam pressurizes the chamber through 1SOL. 1SOL and 5SOL are energized (opened). When the chamber pressure reaches (F), psia, 1SOL and 5SOL are de-energized (closed), and the second Phase 12, negative pulse, begins.

(9) Phase 12: negative pulse (third). This phase is identical to second Phase 12, negative pulse.

(10) Phase 17: heat/exposure. 1SOL and 5SOL are (opened). The steam pressurizes the chamber. When the selected exposure temperature is reached (as sensed by the temperature transducer in the chamber drain line), the exposure time begins. 1SOL de-energizes (closes) and energizes (opens) as necessary to maintain the selected exposure temperature. When the exposure time for a wrapped goods cycle expires, 1SOL and 5SOL are de-energized (closed).

(11) Phase 24: vent/dry. 2SOL and 6SOL are energized (opened). The chamber pressure is reduced to 4.8psia. 2SOL and 6SOL remain energized (opened) for 20 seconds if no drying was selected. 2SOL and 6SOL are de-energized (closed).

(a) Vent will last until the dry timer displays time and begins to count down. This phase is also known as exhaust.

(b) At the end of the dry time, there is a 20 second delay before the next phase.

(12) Phase 31: air-IN. 3SOL is energized (opened). Filtered atmospheric air enters the chamber and raises the chamber pressure to atmospheric reading. When the chamber pressure reaches atmospheric reading, 3SOL is de-energized (closed).

(13) Phase 35: gasket retract (single door units). 10SOL is de-energized (closed to steam/opened to ejector). 6SOL is energized (opened). Water to the ejector creates a negative pressure in the gasket groove, retracting the door gasket within 30 seconds. Then the complete buzzer sounds and shuts off after the door is opened or one minute has elapsed.

(14) Phase 35: gasket retract (double door units). The complete buzzer sounds and shuts off after either the unseal door ("M" in figure 1-5) has been pressed or one minute has elapsed. Pressing the desired unseal door de-energizes (closes to steam/opens to the ejector) the gasket solenoid valves (10SOL and 11SOL). 6SOL is energized (opened). Water to the ejector creates a negative pressure in the gasket grooves, retracting the door gaskets within 30 seconds, and doors can be opened.

b. **Unwrapped Instruments Cycle (16 x 16 only)**. Refer to figure 1-12.

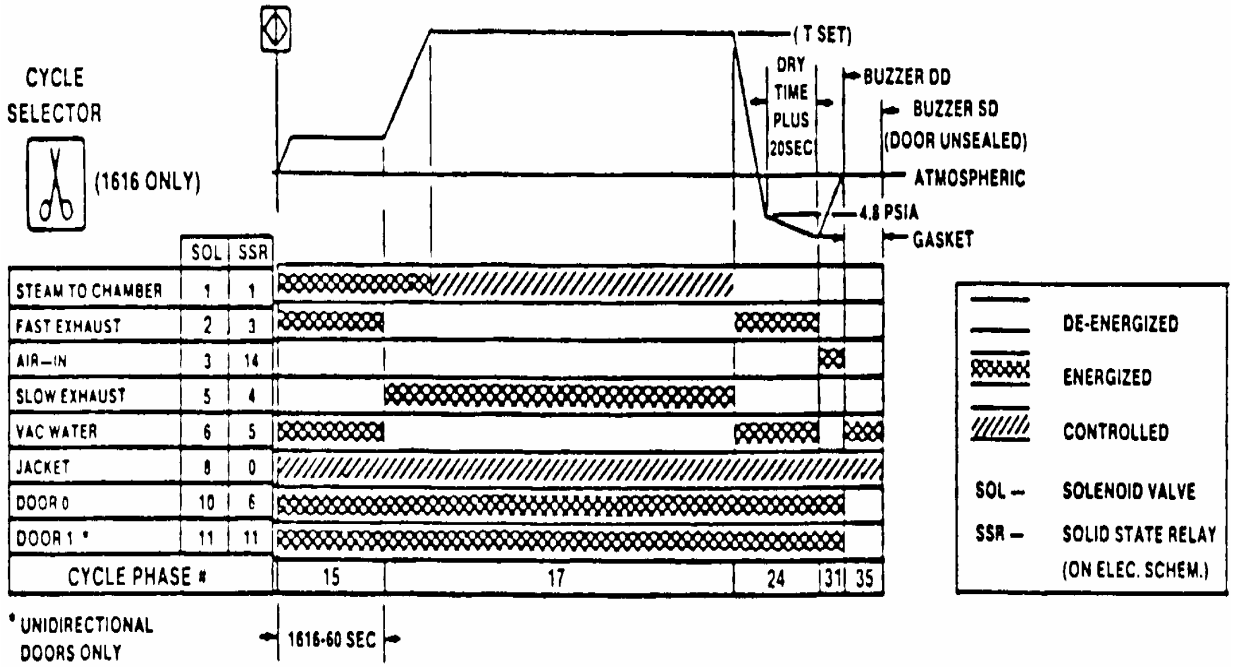


Figure 1-12. Unwrapped instrument cycle (16 x 16 only).

(1) Control On. Use this switch to energize 8SOL as necessary (opened to steam supply). Steam enters and heats the jacket to the selected temperature. The microprocessor maintains the temperature by energizing (opening) and de-energizing (closing) 8SOL with input from the jacket thermistor the same as in the wrapped cycle.

(2) Seal door. 10SOL is energized (opened from steam to gasket/closed to ejector) on single door units. 10SOL (control end) and 11SOL (remote end) are energized on double door units. Gasket groove(s) is/are pressurized, sealing the chamber. Select the wrapped cycle and enter the appropriate times and preset temperature.

(3) Phase 15: purge. Press the cycle start switch to energize (open). After a 5 second delay, 1SOL, 2SOL, and 6SOL are energized. Steam enters the chamber from the jacket through 1SOL and purges the chamber of air through 2SOL to the ejector. After 60 seconds, 2SOL and 6SOL are de-energized (closed), and the purge is complete.

(4) Phase 17: heat/exposure. 1SOL and 5SOL are energized (opened). Steam pressurizes the chamber. When the selected exposure temperature is reached (as sensed by the temperature transducer in the chamber drain line), the exposure time begins. 1SOL de-energizes (closes) and energizes (opens) as necessary to maintain the selected exposure temperature. When the exposure time for an unwrapped instruments cycle expires, 1SOL and 5SOL are de-energized (closed).

(5) Phase 24: vent/dry. 2SOL and 6SOL are energized (opened). Chamber pressure is reduced to 4.8psia (vacuum). 2SOL and 6SOL remain energized (opened) for the duration of the selected drying time or for 20 seconds if no drying was selected. 2SOL and 6SOL are de-energized (closed).

(a) Vent will last until the dry timer displays time and begins to count down. This phase is also known as exhaust.

(b) At the end of the dry time, there is a 20 second delay before the next phase.

(6) Phase 31: air-in. 3SOL is energized (opened). Filtered atmospheric air enters the chamber and raises the chamber pressure to atmospheric reading. When the chamber pressure reaches the atmospheric reading, 3SOL is de-energized (closed).

(7) Phase 35: gasket retract (single door units). 10SOL is de-energized (closed to steam/opened from the ejector to the gasket). 6SOL is energized (opened). The water in the ejector creates a negative pressure in the gasket groove, retracting the door gasket within 30 seconds. The complete buzzer then sounds and shuts off after the door is opened or one minute has elapsed.

(8) Phase 35: gasket retract (double door units). The complete buzzer sounds and shuts off after you either press the unseal door switch or one minute has elapsed. Pressing the desired unseal door switch re-energizes (closes to steam/opens to ejector), the gasket solenoid valves (10SOL and 11SOL). 6SOL is energized (opened). Water to the ejector creates a negative pressure on the gasket grooves, retracting the door gaskets within 30 seconds, and the doors can be opened.

c. **100º-121ºC Liquids Cycle.** Use this cycle to sterilize all liquids. Refer to figure 1-13.

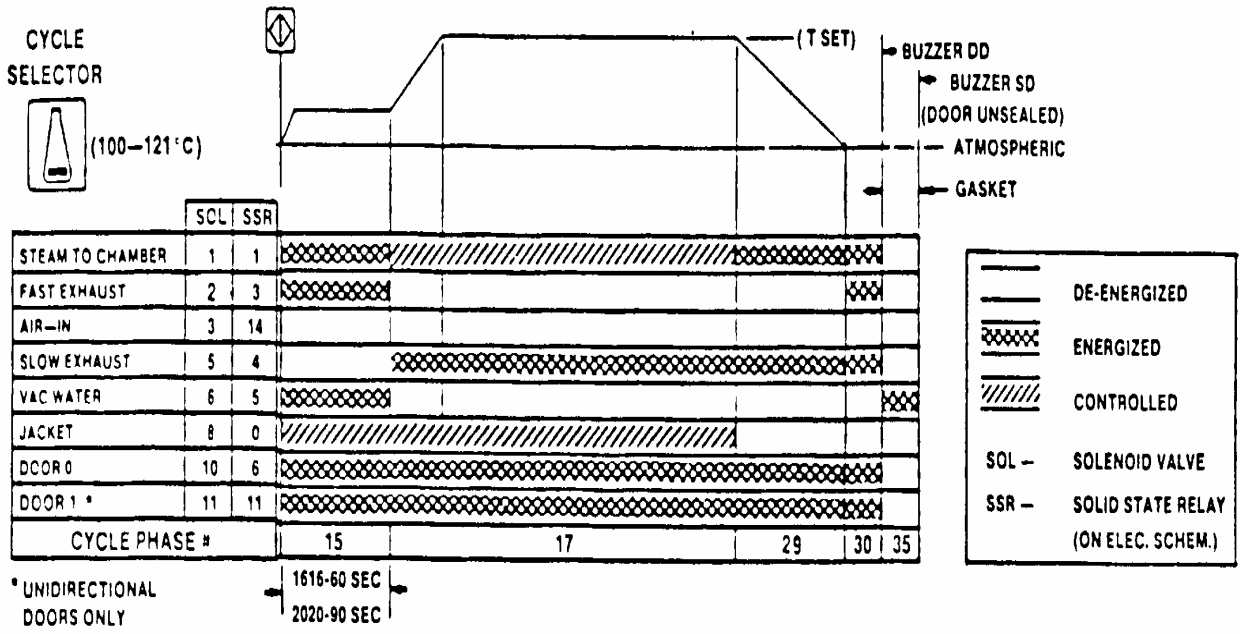


Figure 1-13. 100º-121ºC liquids cycle.

(1) Control ON. This switch energizes (opened to steam supply) 8SOL. Steam enters and heats the jacket to the selected temperature by energizing (opening) and de-energizing (closing) 8SOL as necessary.

(2) Seal door. This switch energizes (opened to steam/closed to the ejector) 10SOL on single door units. 10SOL (control end) and 11SOL (remote end) are energized on double door units. Gasket groove(s) is/are pressurized, sealing the chamber. Select liquids cycle and enter the appropriate times and preset temperature.

(3) Phase 15: purge. Press the cycle start switch to energize (open). After a 5 second delay, 1SOL, 2SOL, and 6SOL are energized. Steam enters the chamber from the jacket through 1SOL and purges the chamber of air through 2SOL to the ejector. The steam is cooled through the ejector and flows to the drain. After the time period noted, 2SOL and 6SOL are de-energized (closed), and the purge is complete.

(4) Phase 17: heat/exposure. 1SOL and 5SOL are opened. Steam pressurizes the chamber. When the selected exposure temperature is reached (as sensed by the temperature transducer in the chamber drain line), the exposure time begins. 1SOL de-energizes (closes) and energizes (opens) as necessary to maintain the selected exposure temperature. When the exposure time for a Liquids cycle expires, 1SOL and 5SOL remain energized (opened), and 8SOL is de-energized (closed).

(5) Phase 29: slow exhaust. The jacket pressure is released to the chamber through 1SOL, and the chamber pressure is slowly released through 2FCV until atmospheric pressure is reached.

(6) Phase 30. 2SOL is energized for a timed period (approximately 20 seconds).

(7) Phase 35: gasket retract (single door units). 10SOL is de-energized (closed to steam/opened to the ejector). 6SOL is energized (opened). Water to the ejector creates a negative pressure in the gasket groove, retracting the door gasket within 30 seconds. The complete buzzer then sounds and shuts off after you open the door or one minute has elapsed.

(8) Phase 35: gasket retract (double door units). The complete buzzer sounds and shuts off after you press either unseal door switch or one minute has elapsed. Press the desired unseal door switch to de-energize (closes to steam/opens to the ejector) the gasket solenoid valves (10SOL and 11SOL). 6SOL is energized (opened). Water to the ejector creates a negative pressure in the gasket grooves, retracting the door gaskets within 30 seconds, and the doors can be opened.

d. **Vacuum Leak Test Cycle.** Perform the vacuum leak test when 79 appears in the digital display. Refer to figure 1-14.

(1) Control On. This switch energizes (opened to steam supply) 8SOL. Steam enters and heats the jacket to the selected temperature. The jacket transducer maintains temperature by energizing and de-energizing 8SOL.

(2) Seal door. 10SOL is energized (opened to steam/closed to the ejector) on single door units. 10SOL (control end) and 11SOL (remote end) are energized on double door units. The gasket groove(s) is/are pressurized, sealing the chamber. Do not select a cycle.

(3) Phase 15: purge. Press the cycle start switch to start. After a 5 second delay, 1SOL, 2SOL, and 6SOL are energized. Steam enters the chamber from the jacket through 1SOL and purges the chamber of air through 2SOL to the ejector. After one minute, 2SOL and 6SOL are de-energized (closed), and purge is complete.

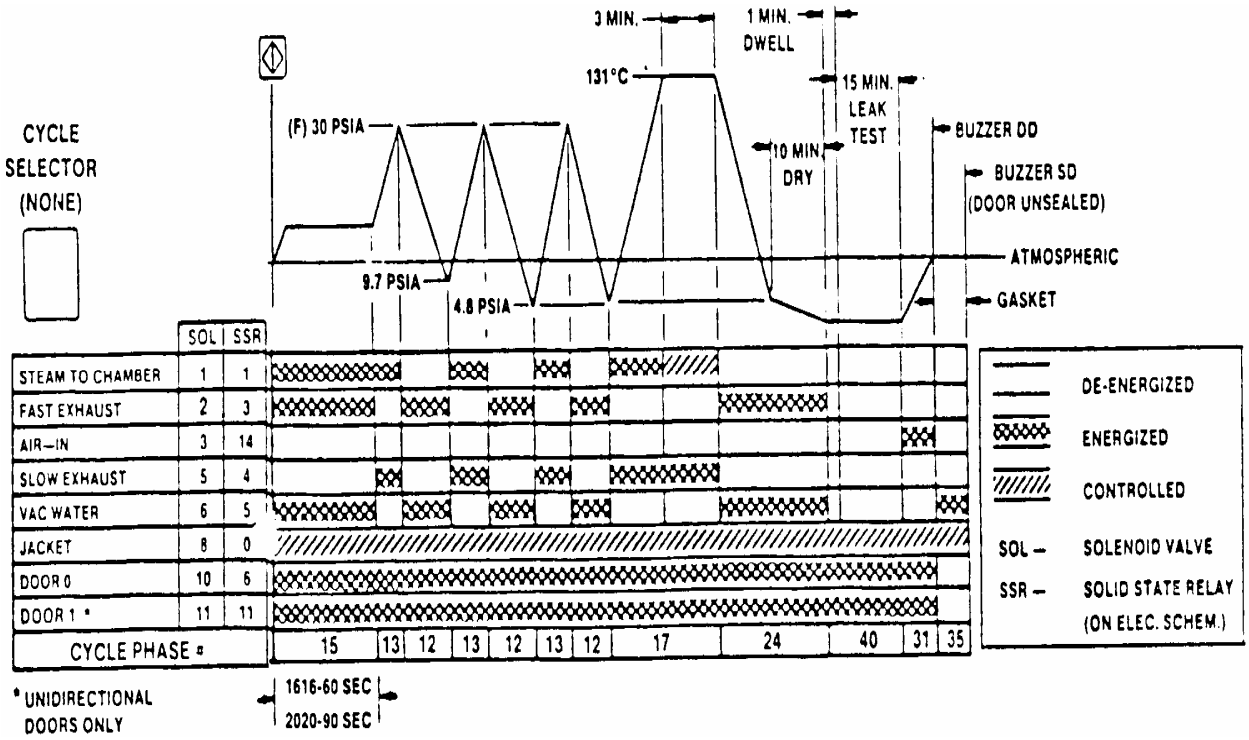


Figure 1-14. Vacuum leak test cycle.

(4) Phase 13: pressure pulse (first). Steam pressurizes the chamber through 1SOL. 5SOL is energized (opened) permitting cooling water to condense steam from the chamber and drain to waste. When the chamber pressure reaches (F) 44psia, 1SOL and5 SOL are de-energized (closed) and Phase 12, negative pulse, begins.

(5) Phase 12: negative pulse (first). 2SOL and 6SOL are energized (opened). Chamber steam is exhausted to the ejector, condensed, and drained. When the chamber pressure is reduced to 9.7psia, 2SOL and 6SOL are de-energized (closed).

(6) Phase 13: pressure pulse (second). Steam pressurizes the chamber through 1SOL. 1SOL and 5SOL are energized (opened). When the chamber pressure reaches (F) 44psia, 1SOL and 5SOL are de-energized (closed), and the second Phase 12, negative pulse, begins.

(7) Phase 12: negative pulse (second). This phase is identical to first Phase 12, negative pulse, except the chamber pressure is reduced to 4.8psia before 2SOL and 6SOL are de-energized (closed), and the third Phase 12, negative pulse, begins.

(8) Phase 13: pressure pulse (third). This phase is identical to second Phase 12, negative pulse.

(9) Phase 17: heat/exposure. 1SOL and 5SOL are energized (opened). Steam pressurizes the chamber. When the 131ºC exposure temperature is reached (as sensed by the temperature transducer in the chamber drain line), the exposure time begins. 1SOL de-energizes (closes) and energizes (opens) as necessary to maintain selected exposure temperature. When the three minute exposure time expires, 1SOL and 5SOL are de-energized (closed).

(10) Phase 24: vent/dry. 2SOL and 6SOL are energized (opened). The chamber pressure is reduced to 4.8psia. 2SOL and 6SOL remain energized (opened) for a 10 minute drying time. Then 2SOL and 6SOL are de-energized (closed).

(a) Vent will last until the dry timer displays time and begins to count down. This phase is also known as exhaust.

(b) At the end of the dry time, there is a 20-second delay before the next phase.

(11) Phase 40: leak test. A one minute dwell period allows the chamber to stabilize at the negative pressure. This is followed by a 15 minute leak test. Pressure is recorded at the beginning and end of the 15 minute leak test. If the established leak rate is exceeded, the leak test fails, and warning code 79 is signaled on the control/display panel.

(12) Phase 31: air-in. 3SOL is energized (opened). Filtered atmospheric air enters the chamber and raises the chamber pressure to the atmospheric reading. When the chamber pressure reaches the atmospheric reading, 3SOL is de-energized (closed).

(13) Phase 35: gasket retract (single door units. 10SOL is de-energized (closed to steam/opened to the ejector). 6SOL is energized (opened). Water to the ejector creates a negative pressure in the gasket groove, retracting the door gasket within 30 seconds. The complete buzzer then sounds and shuts off after the door is opened or one minute has elapsed.

(14) Phase 35: gasket retract (double door units). The complete buzzer sounds and shuts off after either the unseal door switch has been pressed or one minute has elapsed. Pressing the desired unseal door switch de-energizes (closes to steam/opens to the ejector) the gasket solenoid valves (10SOL and 11SOL). 6SOL is energized (opened). Water to the ejector creates a negative pressure in the gasket grooves, retracting the door gaskets within 30 seconds, and doors can be opened.

1-7. SAFETY PRECAUTIONS SUMMARY

Observe the following safety precautions to ensure safe operation of the sterilizer.

a. **Door Operation with Liquid Cycle.**

(1) Allow ample cooling time to prevent possible thermal shock or liquids boiling over when the door is opened or when the load is removed. When the cycle is complete, check that the chamber pressure gauge is at zero.

(2) Wear an elbow length heat resistant glove to protect against escaping residual steam when lowering the verti-glide door.

b. **Emergency Manual Gasket Retract Procedure.** To remove a load from the chamber when an incomplete cycle results from a power interruption to the unit, ensure that the chamber reading is at atmospheric reading and de-energize the unit.

1-8. OPERATION CHECKOUT PROCEDURE

Now that you know the functions of the entire unit, you will use this knowledge to perform an operational checkout. Perform the following procedures to verify that the sterilizer is working properly, against a known standard.

a. Turn on the power at the wall box.

b. Ensure CB1 and CB2 are on by checking if the green lights above them are on. This indicates that 120vac is present.

c. Ensure that the door is open. If not, flip the control board to MANUAL and energize SSR number 5. It may also be necessary to energize SSR number 14 if there is a vacuum in the chamber.

d. Ensure that DS1 on the control board and DS18 on the display board are lit. This indicates that 18 volts direct current (vdc) and 5vdc are present.

NOTE: Any light emitting diode (led) that appears dimmer than normal could indicate a power supply problem.

e. Ensure that the control on (display board) is on and the door unsealed and exhaust lights are on. The exhaust light may or may not be on. If the unit did not have power to it, the exhaust light will come on. If the unit was just off, then the exhaust light will not come on. The door unsealed light will come on. The exhaust led only comes on after the incoming power has been interrupted.

f. Ensure that SSR number 0 comes on if there is no ready light.

g. Make a selection (unwrapped), set sterilizer time for one minute, and set the preset to 112ºC.

h. Close the door (SSR number 8 led is on).

i. Lock the door (SSR numbers 6 and 7 leds are now on). Check the door-unsealed light on the control display to ensure that it is off.

j. Push the cycle start switch and then follow the cycle graph for the proper SSRs and solenoid sequence.

NOTE: You can only check SSRs if the control panel is opened.

Section III. CALIBRATION/VERIFICATION AND ADJUSTMENTS

1-9. CALIBRATION/VERIFICATION PROCEDURES

In the previous section, you learned to verify that the sterilizer is operating according to a known standard. Now you will learn how to calibrate/verify the sterilizer when the unit deviates from the known standard. If the unit fails calibration, you must repair it before returning it to service. A properly calibrated sterilizer is essential to ensure its safe use during surgery. Perform the following procedures to calibrate/verify the sterilizer.

a. **Calibrate the Chamber and Jacket Temperature.** The temperature signal for the chamber and jacket is developed by the thermistors, 1-RTD and 2-RTD. The voltage at the thermistors changes as the temperature changes and is changed to a binary number by U-16, the Analog to Digital Convertor (adc). Calibration performed by replacing the thermistors with a specific resistor value. This specific resistor value represents a specific temperature and should produce a known DC voltage. Changing the ZERO and SPAN adjustable resistors will cause the correct voltage to appear at the input to the Analog to Digital Convertor. The ZERO and SPAN adjustments are interactive. Changing one has an effect on the other. The adjustments are made back and forth until no more change is noted, and the voltages measured are stable. The thermistors will be replaced with resistors located in the RTD Test Box. Switches in the RTD Test Box will select which thermistor channel to calibrate.

(1) Perform a reference voltage check.

(a) Press controls on switch on the display board.

(b) Note that the 14 pin male DIP connector from the RTD Test Box is connected to the J1 female DIP connector on the upper left corner of the control board.

(c) Remove the pressure transducer wire harness from J9 on the control board.

(d) Plug the wire harness plug from the RTD Test Box into J9.

(e) Connect the meter leads from the digital voltmeter (dvm) to the RTD Test Box.

(f) Turn the rotary switch on the RTD Test Box to the Vr position.

(g) The meter should read 5.00vdc ± 0.25 volts. If this is incorrect, the power supplies or the adc may be defective.

(h) Record the actual reference voltage.

(2) Calibrate the chamber temperature.

(a) Turn the rotary switch on the RTD test box to the Ch position.

(b) Place toggle switch on the RTD test box to zero position.

(c) Adjust the chamber zero potentiometer, R-92, until the meter reads 0.196vdc ± 0.005 volts.

(d) Place toggle switch on the RTD test box to Span position.

(e) Adjust the chamber span potentiometer, R-92, until the meter reads the reference voltage recorded earlier, ± 0.05 volts.

(f) Repeat steps (a) through (d) until both readings are within specification.

(g) Always make the final adjustment or check with the toggle switch in the zero position.

(3) Calibrate the jacket temperature.

(a) Turn the rotary switch on the RTD test box to the Ja position.

(b) Place toggle switch on the RTD test box to zero position.

(c) Adjust the jacket zero potentiometer, R-103, until the meter reads 0.196vdc ± 0.005 volts.

(d) Place toggle switch on the RTD test box to SPAN position.

(e) Adjust the jacket span potentiometer, R-104, until the meter reads the reference voltage recorded earlier, ± 0.05 volts.

(f) Repeat steps (b) through (e) until both readings are within specification.

(g) Always make the final adjustment or check with the toggle switch in the zero position.

(h) Remove the RTD test box wire harness plug from connector J9. Reinstall the pressure transducer wiring harness plug in J9 that was removed earlier.

NOTE: Leave the 14 pin connector in J1.

b. **Calibrate the Chamber Pressure.** Pressure will be calibrated by pressurizing and drawing a vacuum on the chamber while monitoring the absolute pressure with a Heise meter. Absolute pressure is a measure of pressure that uses zero as a total vacuum. Atmospheric pressure is approximately 14.7psia at sea level or 12.0psia one mile above sea level. Absolute pressure is noted by the letter "a" as in psia. Gauge pressure uses the air pressure around us as zero and is shown as psig.

NOTE: The Heise meter is connected to a chamber pressure line and is placed at the same level as the connection. The connecting tubing should have a loop in it to collect any condensate.

(1) Energize the Heise meter. With the door open the Heise meter should read approximately 12.0psia.

NOTE: The readings done with the Heise meter are noted for Denver, Colorado (one mile above sea level). Other locations will be different.

(2) Close the sterilizer door.

(3) Turn the rotary switch on the RTD test box to the Tr position.

(4) Place the auto/manual switch on the control board to the MANUAL position.

(5) Set manual relay control switch number 6 to the ON position. The SSR 6 led should be on, and the door should be sealed.

(6) Set manual relay control switches numbers 0 and 1 to the ON position. SSR 0 and SSR 1 leds should be on, and steam should enter the jacket and the chamber.

(7) When the Heise meter indicates 45psia, set the manual relay control switches for SSR 0 and 1 to the OFF position.

(8) Adjust the pressure span potentiometer, R-64, until the dvm reads the same as the Heise meter. Note that the decimal point is one digit different between the two meters.

(9) Set the manual control switches for SSRs 3 and 5 to the ON position. This will cause a vacuum to be drawn on the chamber.

(10) When the Heise meter reads 5.0psia, set the manual relay control switches for SSR 3 and 5 to the OFF position.

(11) Adjust the pressure zero potentiometer, R-126, until the dvm reads the same as the Heise meter. Note that the decimal point is one digit different between the two meters.

(12) Repeat steps 5 through 11 until both readings are within specification.

(13) Return chamber pressure to zero psig.

(14) Place auto/manual switch in the AUTO position.

(15) Set the RTD box to the Vr position.

(16) Disconnect the meter leads from the RTD Test Box.

(17) Turn OFF the Heise meter.

1-10. ADJUSTMENT PROCEDURES

To make adjustments, follow the procedures presented in the following paragraphs.

NOTE: Make the door adjustments with a hot chamber and door so that the adjustments are made under a normal heat expansion condition.

WARNING

Do not use the door latch to support the weight of the door. Before repairing the door, support the weight of the door by placing blocking under it.

WARNING

When adjusting the door, ensure that the door lug bolts are secure. If they are loose, apply Lock-tite 242 to the bolts and torque to 75 foot pounds to ensure the integrity of the door, maintain a sealed system, and prevent steam burns.

NOTE: When adjusted, the door counterbalance weights should touch the floor slightly at the same time that the door latches. There should be tension on the door cables. The top of the door should be even with the top of the machined surface of the headring. If the door is not properly adjusted, then perform the following adjustments.

a. **Make Door Adjustments.** If the door is not fully closed, the door will not lock. If this happens, steam could leak and burn you when the unit goes into its cycle. Refer to figure 1-15.

NOTE: When properly adjusted, the door should travel fully upward and downward without binding, and with a minimum amount of friction and noise.

(1) Adjust the door counterbalance weight.

(a) Screw the eye bolts into or out of the weight.

(b) Tighten the eye bolt lock nut.

(c) Ensure that the weight guides are adjusted for minimum friction during the upward and downward travel of the door.

(2) Adjust the door latch.

(a) Remove the lower face panel for access to the door cover.

(b) Remove the door cover which is secured with four screws.

(c) Loosen the four door latch adjustment screws.

(d) Adjust the door latch so that it springs forward evenly to contact the latching bar when the door is in the fully raised position. The latch must not support the weight of the door when it is latched.

(e) Tighten the adjustment screws.

(f) Replace the door cover and lower the face panel.

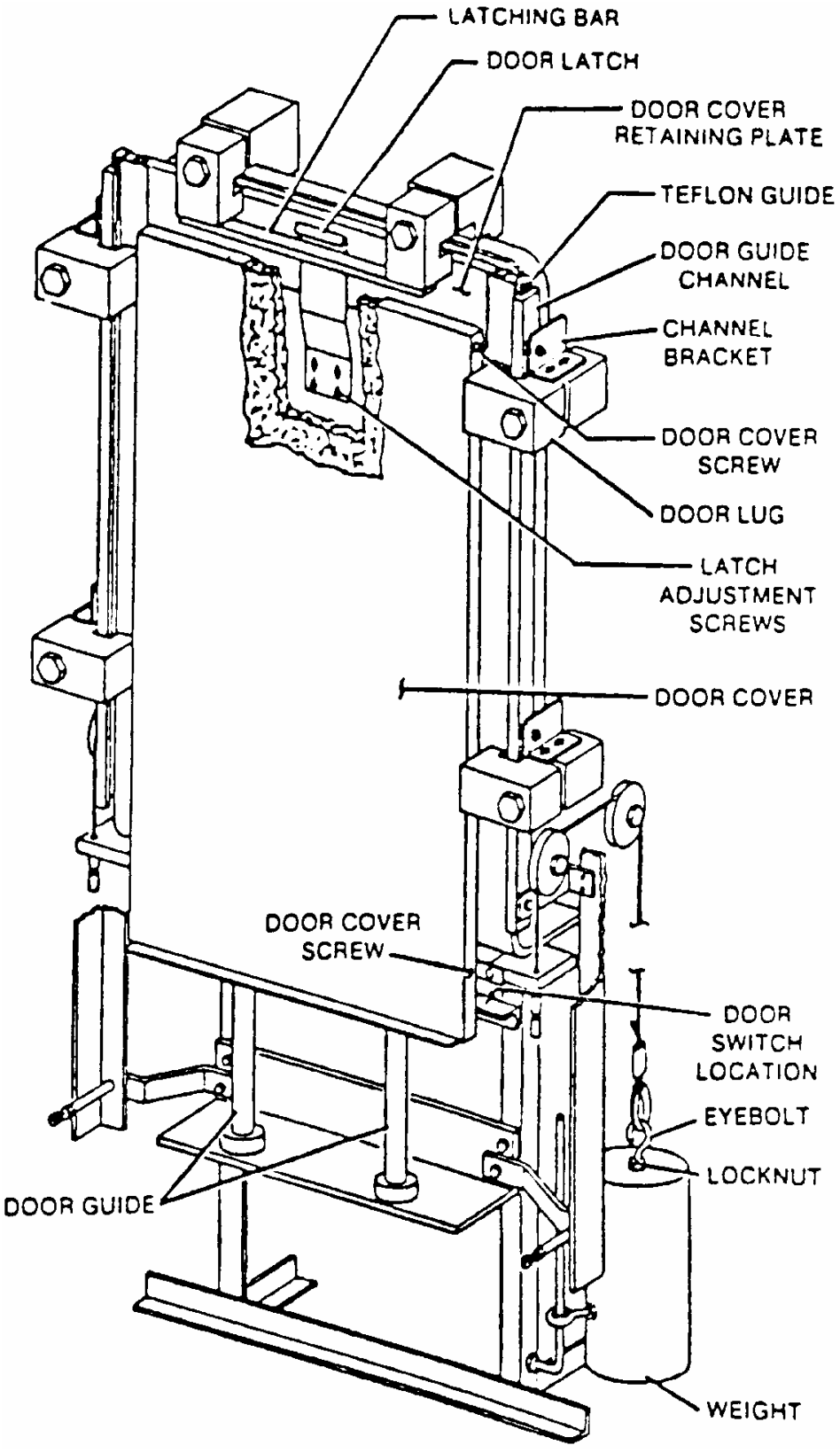


Figure 1-15. Door assembly.

(3) Adjust the door switch. Refer to figure 1-16.

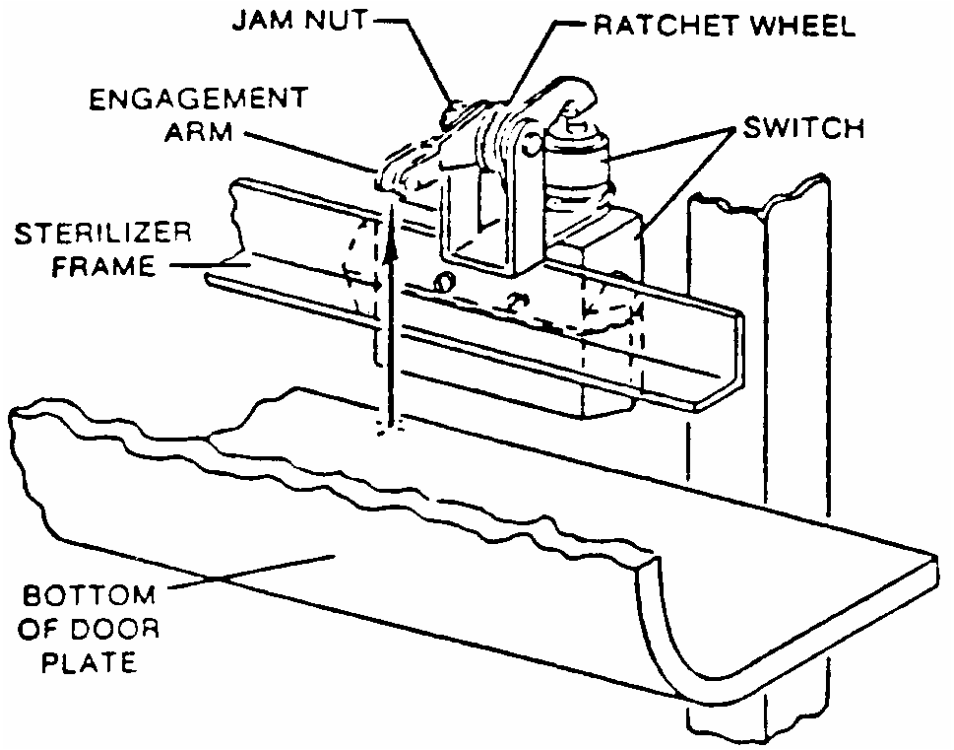


Figure 1-16. Door switch adjustment.

NOTE: The door switch is located on the right surface of the front frame cross member under the door. The control end door switch operation is identified by the number 8 light on the relay board. The remote end operation switch is identified by the number 9 light on the double door units.

(a) Perform checks.

1 Raise the latch and control head to observe the relay panel indicator lights.

2 Raise the door to the closed position. The SSR number 8 light should come on just before the door latch locks on the latching bar.

(b) Make adjustments.

1 Remove the lower face panel or the right side panel on cabinet models.

2 Loosen the door switch jam nut.

3 Rotate the ratchet wheel to adjust the switch engagement arm up or down as required to attain the specified tolerance.

4 Tighten the jam nut and reassemble the panel(s) in reverse order of removal.

(4) Adjust the door guide alignment.

NOTE: The door guides are the cylindrical rods below the door. They control the position of the door during travel.

(a) Perform checks.

1 Lower the door to the fully open position.

2 Check that the top of the door is parallel with the inside of the headring.

(b) Perform alignment.

1 Loosen the securing bolts on the bottom of the door guides.

2 Align the guides to level the door using a level bubble.

3 Raise and lower the door to check for binding.

4 Readjust only one of the guides to eliminate binding or friction.

(5) Adjust the door cover.

NOTE: The door cover should be centered in the lower face panel with an alignment and centering clearance of 1/16 inch (1.2mm) on all sides.

(a) Loosen the two cover screws and center the lower door edge in the face panel.

(b) Loosen the cover retaining plate screws and move the cover plate to center the upper edge of the door cover.

(6) Align the door. Refer to figure 1-15.

(a) Check that the side play clearance of the teflon guides within the door guide channels are 1/32 to 1/16 of an inch (0.8mm to 1.6mm) when the door is hot. Loosen the two channel bracket screws and move the bracket to obtain required Teflon guide clearance.

(b) Ensure that the door is aligned and centered squarely with the chamber. Measure from the door guide channel to the inside surface of the chamber. The dimension should be within 1/32 to 1/16 of an inch (.8mm to 1.6mm). You can attain adjustment by loosening the two screws in the door channel bracket and movement of the bracket.

(c) Raise the door to position the upper edge between the lugs and the headring. Clearance of the door plate from either surface should be 1/32 + 1/64 of an inch (.8mm + .4mm). You can attain adjustment by loosening the hex nut that secures the door guide channel to the channel bracket.

b. **Adjust the Chamber Bleed Valve.** You adjust the chamber bleed valve to allow the liquid to evaporate without disturbing the liquid. Refer to figure 1-17.

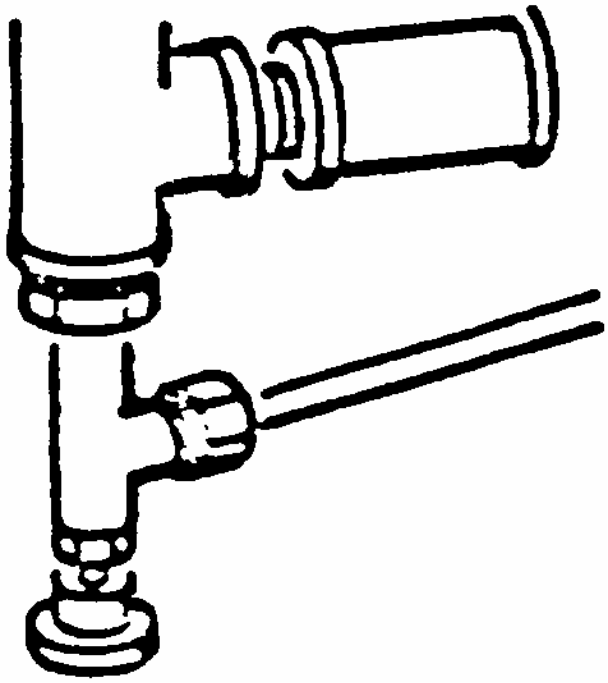


Figure 1-17. Chamber bleed valve.

NOTE: The setting of the chamber bleed valve in the liquid cool bypass line determines the length of time required for releasing chamber pressure during a liquids cycle.

NOTE: When properly adjusted, the valve permits maximum release of steam pressure without causing violent agitation of the liquid.

CAUTION: Use care with the dial glass, when adjusting the jacket pressure gauge. The dial glass is not fastened to the rim. When the rim is unscrewed, the dial glass could drop out.

(1) Remove the right side panel for access to the valve if the sterilizer has a cabinet.

(2) Close the valve finger tight, then open 1/4 turn.

(3) Adjust the valve so that it takes 10 to 15 minutes in the exhaust phase of a liquids cycle to empty the chamber. Make the adjustment with an empty chamber.

(4) If sediment restricts the flow of steam through the valve, clean the valve and readjust it.

c. **Adjust the Jacket Pressure Gauge.** Adjust the jacket pressure gauge if the gauge does not read zero when there is no jacket pressure (unit is off and cool). Refer to figure 1-18.

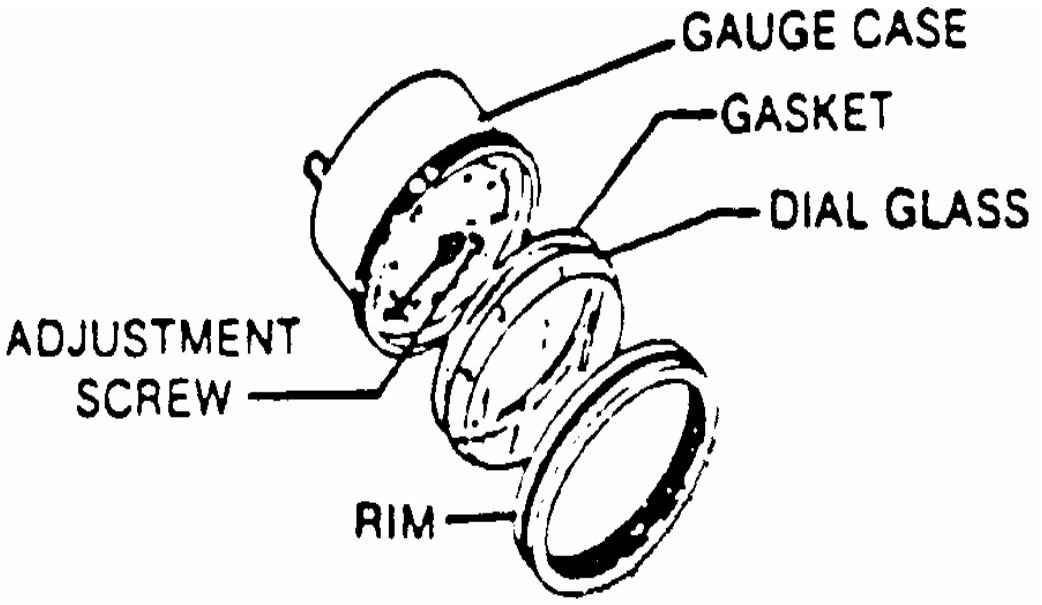


Figure 1-18. Jacket pressure gauge.

(1) Remove the top panel for access to the jacket gauge. The gauge is located on the piping above the sterilizer body.

(2) Remove the dial glass by unscrewing the rim from the gauge case. Use a strip of rubber to remove the dial glass to avoid hand pressure binding the rim.

(3) Adjust the gauge when there is no pressure in the jacket or chamber.

(a) Adjust a gauge that has the adjustment screw in the center of the pointer by holding the pointer and turning the adjustment screw slightly in the opposite direction to that which the pointer is to be moved.

(b) Repeat until the pointer is at zero. If the adjustment screw is on the face of the dial, do not hold the pointer; just turn the adjustment screw to set pointer at zero.

(4) Assemble the glass dial in the rim and place the rim in position against the gauge case.

(5) Turn the rim counterclockwise until you feel the threads drop into alignment. Then screw the rim clockwise into the gauge case.

d. **Adjust the Chamber Pressure Gauge.** Adjust the chamber pressure gauge when the chamber is at atmospheric pressure. The gauge is located at the right of the control head. Refer to figure 1-19.

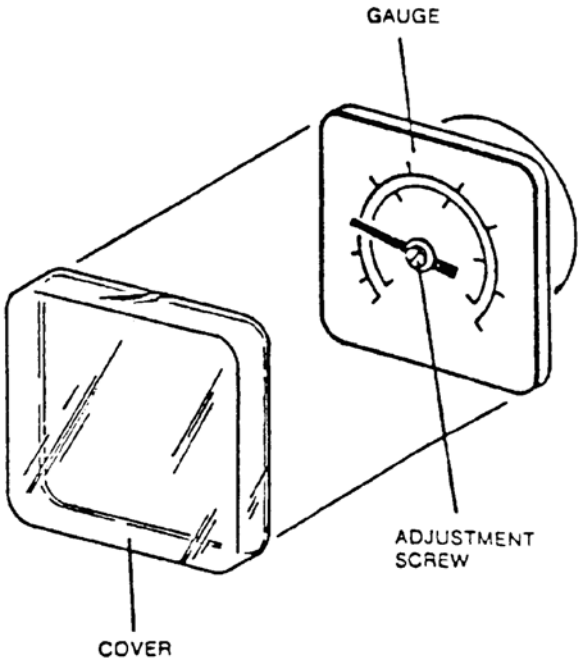


Figure 1-19. Chamber pressure gauge.

(1) Remove the plastic cover.

(2) Adjust the gauge as necessary using the procedures given for the jacket pressure gauge.

(3) Replace the plastic cover.

e. **Summary of Safety Precautions.** Observe the following calibration/verification safety precautions to ensure safe operation of the sterilizer.

(1) Do not use the door latch to support the weight of the door. Support the door by placing blocking under it before repair.

(2) When you adjust the door, ensure that the door lug bolts are secure. If they are loose, apply Lock-tite 242 to the bolts and torque to 75 foot pounds to ensure integrity of the door, maintain a sealed system, and prevent steam burns.

(3) When you adjust the jacket pressure gauge, use care with the dial glass. The dial glass is not fastened to the rim. When the rim is unscrewed, the dial glass could drop out.

Section IV. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

1-11. GENERAL

Now that you know how to operate and calibrate the sterilizer, you are ready to perform PMCS. You must conduct periodic PMCS on the sterilizer to ensure its continued operation. You need the following tools and equipment.

a. Sterilizer, Surgical Dressing, Castle 3333.

b. Medical Equipment Repairer's Tool Kit, NSN 5180-00-611-7923.

c. Medical Equipment Repairer's Tool Kit, NSN 5180-00-611-7924.

1-12. PREVENTIVE MAINTENANCE CHECKS AND SERVICES PROCEDURES

Use the following procedures to perform PMCS.

a. **Clean the Unit.**

(1) Clean all solenoid parts. Cleaning is required if the voltage to the coil is incorrect, valve operation is sluggish, or there is excessive leakage or noise.

(2) Clean the strainers when cleaning the solenoid valve.

b. **Check the Unit.**

(1) Ensure the valve is free from dirt and foreign matter.

(2) Operate the valve to ensure proper operation.

(3) Inspect the internal valve parts for damage or excessive wear. Clean all parts during the inspection.

(4) Check for a faulty control circuit.

(a) Energize the solenoid. Ensure there is a metallic click which indicates the solenoid is operating. If there is no click, there is a loss of power supply.

NOTE: You may not hear the click due to the wall between the control and solenoid, noise from other sterilizers, etc. If you do not hear the click, check the solenoid by placing a small screwdriver on top to see if it is magnetized. If it is magnetized, the coil is conducting, and the solenoid is energized.

(b) Check for loose or blown out fuses, an open-circuit or grounded coil, broken lead wires, or spliced connections.

(5) Check for a burned-out or open-circuited coil (refer to the procedures for checking the solenoid in the NOTE above). Replace the coil if necessary.

(6) Check the voltage across the coil leads. The voltage must be at least 85 percent of the nameplate rating.

(7) Check the pressure to the valve to ensure it is within the range specified on the nameplate.

(8) Check for damaged or worn valve parts which could cause excessive leakage. Disassemble the valve and clean all parts. Replace the parts that are worn or damaged.

(9) Check the plumbing for leaks.

(10) Check the steam traps for clogs and damage.

(11) Inspect the door gasket for nicks or tears.

(12) Check the chamber drain screen for clogs or damage.

(13) Check the air filter for cleanliness and serviceability.

Continue with Exercises

EXERCISES, LESSON 1

INSTRUCTIONS: Answer the following items by completing the statement or by writing the answer in the space provided at the end of the item.

After you have completed all of these items, turn to "Solutions to Exercises" at the end of the lesson and check your answers with the solutions.

1. You are sterilizing a linen pack. Which temperature, exposure, and drying time do you use for linen packs?

   a. 135ºC (275ºF), three minutes exposure, no minimum drying time.

   b. 135ºC (275ºF), three minutes minimum exposure, and three minutes minimum drying time.

   c. 100º-121ºC (212º-250ºF), exposure time as required, slow exhaust.

   d. 121ºC (250ºF), 20 minutes exposure, no minimum drying time.

2. You are checking the recorder chart to ensure it is accurately recording. You are adjusting the record's electrical measuring circuit to a related pen arm position. Which of the following do you use?

   a. Red pen.

   b. Blue pen.

   c. Span/null.

   d. Cycle counter.

3. You are running the vacuum leak test cycle. After you press the controls on switch on the control/display panel, which task do you perform?

   a. Select a cycle.

   b. Press the close door switch(es).

   c. Wait for the cycle complete indictor to come on.

   d. Press the open door switch on the control/display panel.

4. You are reviewing the functions of solid state relay (SSR) functions. The function of SSR 5 is to control the:

   a. Direction of door 1.

   b. Air/in/vent valve.

   c. Water to the ejector.

   d. Storage of exhaust water.

5. Each cycle goes through the same series of phases. These phases (in order) are:

   a. Ready, conditioning, exposure, exhaust, and complete.

   b. Ready, exposure, exhaust, conditioning, and complete.

   c. Ready, exhaust, exposure, conditioning, and complete.

   d. Ready, conditioning, exhaust, exposure, and complete.

6. You are performing operational checkout procedures. After you ensure that the power at the wall box is on, which task do you perform?

   a. Ensure that CB1 and CB2 are off by checking if the green lights above them are off.

   b. Ensure that CB1 and CB2 are on by checking if the green lights above them are on.

   c. Ensure that the door is open. If not, flip the control board to MANUAL and energize SSR number five.

   d. Ensure that the DS1 on the control board and DS18 on the display board are lit.

7. You are adjusting the sterilizer. Which item do you adjust to determine the length of time required for releasing chamber pressure during the liquids cycle?

   a. Chamber bleed valve.

   b. Jacket pressure gauge.

   c. Chamber pressure gauge.

   d. Door counterbalance weight.

8. You are performing PMCS procedures on the valve. After you ensure the valve is free from dirt and foreign matter, you should:

   a. Inspect the internal valve parts for damage.

   b. Check for a faulty control circuit.

   c. Ensure that there is no a metallic click.

   d. Operate the valve to ensure proper operation.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 1

1. b (para 1-1a(1))
2. c (para 1-2b(4))
3. b (para 1-4c(3))
4. c (Table 1-1)
5. a (para 1-5b)
6. b (para 1-8b)
7. a (para 1-10b, NOTE)
8. d (para 1-12b(2))

End of Lesson 1

LESSON ASSIGNMENT

LESSON 2	Isolate Malfunctions.
TEXT ASSIGNMENT	Paragraphs 2-1 through 2-2.
LESSON OBJECTIVES	After completing this lesson, you should be able to:
	2-1. Isolate causes of malfunctions of the sterilizer when codes appear on the related control panel digital indicator.
	2-2. Isolate causes of problems in the uncode troubleshooting guide.
SUGGESTION	After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 2

ISOLATE MALFUNCTIONS

2-1. TROUBLE ANALYSIS

Lesson one discussed the functions of the entire unit. In this lesson, you will use the troubleshooting guides in Appendixes A and B to isolate the cause of malfunctions. The troubleshooting guides outline the possible causes and remedies for malfunctions that may occur during sterilizer operation. If there is more than one possible cause, proceed in sequence down the list to troubleshoot for the cause of the malfunction. The following paragraphs discuss the two types of charts: coded and uncoded.

a. **Coded Troubleshooting Guide.** Use the coded troubleshooting guide in Appendix A to identify (isolate) causes of malfunctions when related codes appear on the control panel digital indicator. The following is an example of how to use the troubleshooting guide to isolate a malfunction.

SYMPTOM: A code of 79 appears on the control panel digital indicator.

(1) Refer to the coded troubleshooting guide in Appendix. A

(2) Locate 79 in the code column.

(3) Find the nature of the malfunction by looking in the malfunction column (leak test failure).

(4) Refer to the cause column and identify the possible cause of the malfunction.

(5) Finally, refer to the remedy column opposite the appropriate cause. The appropriate action you should take to remedy the malfunction is to clean or replace the valves.

b. **Uncoded Troubleshooting Guide.** Use the uncoded troubleshooting guide in Appendix B to troubleshoot problem areas not covered in the coded trouble analysis charts. The following is an example of how to use the troubleshooting guide to isolate a malfunction.

SYMPTOM: The recorder motor is not operating.

(1) Refer to the uncoded troubleshooting guide in Appendix B.

(2) Find the malfunction in the trouble column.

(3) Look in the cause column. Two possible causes are listed.

(4) For cause number one, you check the remedy column and turn on the supply circuit. You discover that the motor still does not operate. You conclude that cause number two is applicable.

(5) You determine that the appropriate remedy is to replace the motor.

2-2. SAFETY PRECAUTIONS SUMMARY

After isolating the cause of a malfunction using the troubleshooting guides, the recommended remedy may require you to remove or replace a component in the sterilizer. Observe the following safety precautions when removing and replacing components.

a. **Replacing the Transducers.** When replacing the transducers, follow these precautions:

(1) Shut off the main steam supply. Depressurize the steam in the system before removing the transducer probes to prevent steam burns. Ensure that all liquids are drained from the system. All steam lines will be hot.

(2) Depress the battery pack circuit breaker to OFF (O) to prevent accidental contact with the low voltage circuit that could damage the power board.

(3) Depress both MAINS circuit breakers in the power box to OFF (O) to prevent electrical hazards.

b. **Replacing the Chamber Pressure Transducer.** When removing the chamber pressure transducer, follow these precautions:

(1) Use Teflon liquid or paste pipe thread sealant to ensure a tight connection between the probe and the bulkhead connector.

(2) Do not use pipe tape. Tape shreds will imbed in the transducer and cause a malfunction.

(3) Do not use a pipe wrench on the round shank.

(4) Ensure that there is a still loop with a minimum of five loops in the pressure transducer line.

c. **Replacing the Solid State Relay.** When replacing the solid state relay, ensure that the correct SSR is installed for each position.

d. **Repairing the Solenoids.** When repairing the solenoids, follow these precautions:

(1) Disconnect the electrical supply to the sterilizer before making electrical repairs to prevent electrical shock.

(2) Shut off the main steam supply and depressurize the steam in the system before making plumbing repairs to prevent steam burns.

Continue with Exercises

EXERCISES, LESSON 2

INSTRUCTIONS: Answer the following items by marking the response that BEST completes the statement or BEST answers the question.

After you have completed all of these items, turn to "Solutions to Exercises" at the end of the lesson and check your answers with the solutions.

1. You are following the safety precautions before replacing the transducer. Which task do you perform to prevent accidental contact with the low voltage circuit board?

   a. Ensure there is a tight connection between the probe and the bulkhead connector.

   b. Depress the battery pack circuit breaker to OFF.

   c. Turn on the MAINS circuit breakers.

   d. Shut off the main steam supply.

Situation: You are isolating the causes of malfunctions. Use this situation and the troubleshooting guides that follow in Appendixes A and B to answer questions 2 through 6.

2. A code of 77 appears on the control panel digital indicator. You determined that the cause of the problem is with the wire connections between the control board and the display board. Which remedy do you recommend?

   a. Recycle power.

   b. Replace the display board.

   c. Replace the control board.

   d. Check the wiring between control and display board.

3. A code of 18 appears on the control panel digital indicator. The air-in flow is retarded (exceeds 2 minutes). You have recently replaced the air-in filter. What is a possible cause of this malfunction?

    a. Chamber drain screen is clogged.

    b. Exposure temperature setting is incorrect.

    c. Solenoid valve 3SOL is not opening properly.

    d. Solenoid valve 3SOL is not closing properly.

4. The positive pulse is retarded (exceeds 5 minutes), and a code 04 appears on the control panel digital indicator. The steam supply is shut off. What would you do to remedy the problem?

    a. Check to ensure the steam supply pressure is 40 to 50 pounds per square inch gravity (psig) dynamic.

    b. Reset exposure temperature.

    c. Turn on the steam supply.

    d. Repair the jacket trap.

5. There is a humming sound coming from the solenoid. What could be a possible cause of the problem?

    a. Door cable is broken.

    b. Coil housing is loose.

    c. Recorder motor defective.

    d. Power line had a malfunction.

6. The pen arms do not lift from the chart when the recorder door is opened. The pen arms are not bent or damaged in any way. What is a possible cause of the problem?

   a. Door cable is restricted by an object.

   b. Lifting rods are out of adjustment.

   c. Power line had a malfunction.

   d. Coil housing is loose.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 2

1. b (Para 2-2a(2))
2. d (Appendix A)
3. c (Appendix A)
4. c (Appendix A)
5. b (Appendix B)
6. b (Appendix B)

End of Lesson 2

APPENDIX A

Coded Troubleshooting Guide

WARNINGS		
CODE/MALFUNCTION	**POSSIBLE CAUSE**	**REMEDY**
71 Door controls	Refer to uncoded troubleshooting chart.	
73 Control board	1. Power line malfunction. 2. Control board.	1. Recycle power. 2. Replace control board.
77 Communication lines	1. Power line malfunction. 2. Wire connections between control board and display board. 3. Display board. 4. Control board.	1. Recycle power. 2. Check wiring between control board and display board. 3. Replace display board. 4. Replace control board.
79 Leak test failure (exceeds 2.7mm Hg/min) or a total of 0.783 psia	1. Door gasket. 2. Solenoid valve 1SOL not closing. 3. Solenoid valve 3SOL not closing. 4. Chamber drain check valve(s) not closed.	1. Clean or replace. 2. Clean or repair. 3. Clean or repair. 4. Clean or repair.

CAUTIONS		
CODE/MALFUNCTION	**POSSIBLE CAUSE**	**REMEDY**
02 Negative pulse retarded exceeds the following times: 16x16: 5 minutes 20x20: 8 minutes	1. Water supply shut off. 2. Water pressure inadequate. 3. Door gasket. 4. Chamber drain screen clogged. 5. Solenoid valve 2SOL not opening properly. 6. Solenoid valve 1SOL not closed. 7. Solenoid valve 3SOL not closed. 8. Solenoid valve 6SOL not opening properly.	1. Turn on water supply. 2. Check and ensure water supply pressure is 30-70 psig dynamic. 3. Clean or replace. 4. Clean screen. 5. Clean or repair. 6. Clean or repair. 7. Clean or repair. 8. Clean or repair.

Coded Troubleshooting Guide (continued)

CAUTIONS (continued)		
CODE/MALFUNCTION	**POSSIBLE CAUSE**	**REMEDY**
04 Positive pulse retarded (exceeds 5 minutes)	1. Exposure temperature setting incorrect. 2. Steam supply shut off. 3. Steam pressure inadequate. 4. Solenoid valve 2SOL not closed. 5. Solenoid valve 1SOL not opening properly. 6. Solenoid valve 8SOL not opening properly. 7. Steam supply strainer plugged. 8. Pressure release through jacket trap excessive. 9. Pressure release through chamber trap excessive.	1. Reset exposure temperature. 2. Turn on steam supply. 3. Check and ensure steam supply pressure is 40-50psig dynamic. 4. Clean or repair. 5. Clean or repair. 6. Clean or repair. 7. Clean strainer. 8. Repair jacket trap. 9. Repair chamber trap.
06 (16x16) Temperature retarded exceeds the following times: Wrapped goods – 4 minutes Unwrapped instruments - 6 minutes Liquids - 25 minutes	1. Exposure temperature setting incorrect. 2. Steam supply shut off. 3. Steam pressure inadequate. 4. Solenoid valve 2SOL not closing properly. 5. Solenoid valve 1SOL not opening properly. 6. Solenoid valve 8SOL not opening properly. 7. Steam supply strainer plugged. 8. Pressure release through chamber trap excessive.	1. Reset exposure temperature. 2. Turn on steam supply. 3. Check and ensure steam supply pressure is 40-50psig dynamic. 4. Clean or repair. 5. Clean or repair. 6. Clean or repair. 7. Clean strainer. 8. Repair chamber trap.

Coded Troubleshooting Guide (continued)

CAUTIONS (CONTINUED)		
CODE/MALFUNCTION	**POSSIBLE CAUSE**	**REMEDY**
06 (20x20)/ Temperature retarded exceeds the following times: Wrapped goods - 4 minutes Unwrapped instruments - 9 minutes Liquids - 30 minutes	1. Exposure temperature setting incorrect. 2. Steam supply shut off. 3. Steam pressure inadequate. 4. Solenoid valve 2SOL not closing properly. 5. Solenoid valve 1SOL not opening properly. 6. Solenoid valve 8SOL not opening properly. 7. Steam supply strainer plugged. 8. Pressure release through chamber trap excessive.	1. Reset exposure temperature. 2. Turn on steam supply. 3. Check and ensure steam supply pressure is 40-50psig dynamic. 4. Clean or repair. 5. Clean or repair. 6. Clean or repair. 7. Clean strainer. 8 Repair chamber trap.
10 Exposure temperature reset (set point -2^{O}C)	1. Steam supply shut off. 2. Steam pressure inadequate. 3. Solenoid valve 2SOL not closing properly. 4. Solenoid valve 1SOL not closing properly. 5. Solenoid valve 8SOL not closing. 6. Chamber drain screen clogged.	1. Turn on steam supply. 2. Check and ensure steam supply pressure is 40-50psig dynamic. 3. Clean or repair. 4. Clean or repair. 5. Clean or repair. 6. Clean screen.
14 Excessive exposure temperature (exceeds 6^{O}C over set point)	1. Exposure temperature setting incorrect. 2. Solenoid valve 1SOL not closing properly. 3. Solenoid valve 8SOL not closing properly.	1. Reset exposure temperature. 2. Clean or repair. 3. Clean or repair.
18 Air-in retarded (exceeds 2 minutes)	1. Air-in filter. 2. Solenoid valve 3SOL not opening properly.	1. Replace filter. 2. Clean or repair.

Coded Troubleshooting Guide (concluded)

CAUTIONS (CONTINUED)		
CODE/MALFUNCTION	**POSSIBLE CAUSE**	**REMEDY**
20 Pressure in chamber (Exceeds 2psi over or under atmospheric reading)	1. Solenoid valve 2SOL not opening. 2. Solenoid valve 1SOL not closing properly. 3. Solenoid valve 6SOL not opening properly. 4. If problem cycle was "Liquids," the chamber bleed valve may be clogged.	1. Clean or repair. 2. Clean or repair. 3. Clean or repair. 4. Clean bleed valve.
22	Vacuum leak test. In progress.	

End of Appendix A

APPENDIX B

Uncoded Troubleshooting Guide

MALFUNCTION	POSSIBLE CAUSE	REMEDY
Door does not rise easily when closing.	1. Door cable restricted by object. 2. Door cable broken. 3. Pulleys need lubrication. 4. Door gasket out of groove.	1. Remove object. 2. Replace cable. 3. Lubricate pulleys. 4. Lubricate and reassemble.
Door does not latch when fully closed.	1. Object under counterbalance weight. 2. Cables too loose. 3. Door latch out of adjustment.	1. Remove object. 2. Adjust cables. 3. Adjust door latch.
Recorder motor is not operating.	1. Power supply circuit is not turned on. 2. Recorder motor defective.	1. Turn on supply circuit. 2. Replace motor.
Pen arms do not lift from chart when recorder door is opened.	1. Lifting rods out of adjustment. 2. Pen arm bent, kinked, or damaged.	1. Extend the lifting rods to engage the pen arms. 2. Replace pen arms.
Recorder will not calibrate.	1. Power has been off.	1. Do not attempt calibration until the power has been on for at least 20 minutes.
Unlisted code appears.	1. Power line malfunction. 2. Wire connections between control board and display board. 3. Display board malfunction. 4. Control board malfunction.	1. Turn off power, wait one minute, and turn on power. 2. Check wiring between control board and display board. 3. Replace display board. 4. Replace control board.

Uncoded Troubleshooting Guide(concluded)

MALFUNCTION	POSSIBLE CAUSE	REMEDY
Random or erratic action of signals on the display board.	1. Battery pack circuit breaker turned on before MAINS circuit breakers were turned on. 2. Wire connections between control board and display board. 3. Display board malfunction. 4. Control board malfunction.	1. Turn off battery pack circuit breakers, turn on the MAINS circuit breakers, and then turn on battery pack circuit breaker. 2. Check wiring between control board and display board. 3. Replace display board. 4. Replace control board.
Solenoid hum.	1. Loose coil housing. 2. Buildup of foreign material on top of core assembly.	1. Bend housing to make firm contact with coil. 2. Repair the valve.

End of Appendix B