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June 28, 1984

Mr Harold R Denton
Office of Nuclear Reactor Regulation
Division of Licensing
US Nuclear Regulatory Commission
Washington, DC 20555

MIDLAND ENERGY CENTER PROJECT -
MIDLAND DOCKET NOS 50-329, 50-330
RESPONSE TO SUPPLEMENT 1 TO NUREG 0737: SAFETY PARAMETER DISPLAY SYSTEM
FILE J-280A SERIAL 29827

REFERENCES (1) CPCO LETTER, SERIAL 26468, DATED NOVEMBER 10, 1983
SUPPLEMENTAL RESPONSE TO GENERIC LETTER 82-33

(2) CPCO LETTER, SERIAL 21649, DATED APRIL 13, 1983
RESPONSE TO GENERIC LETTER 82-33

Attached is a copy of a report entitled, "Midland Energy Center Safety Parameter Display System." This report provides the safety analysis of the Safety Parameter Display System which Consumers Power Company committed to provide in response to Generic Letter 82-33.

The hardware and software described herein has been installed at the Midland Plant. The Safety Parameter Display System will be available for use in the control room during preoperational testing and initial fuel load of the Midland units. If there is any assistance we can offer to aid your review of our Safety Parameter Display System, such as a demonstration of the system at our Site, please do not hesitate to contact us.

James W. Cook

JWC/RMH/bjw

CC JGKeppler, Administrator, Region III
DSHood, Project Manager Licensing Branch #4, US NRC
Midland NRC Resident Office

OC0484-0177A-MP04

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CONSUMERS POWER COMPANY
Midland Units 1 and 2
Docket No 50-329, 50-330

Letter Serial 29897 Dated June 28, 1984

At the request of the Commission and pursuant to the Atomic Energy Act of 1954, and the Energy Reorganization Act of 1974, as amended and the Commission's Rules and Regulations thereunder, Consumers Power Company submits a report on the Midland Energy Center Safety Parameter Display System in response to related requirements identified in NRC Generic Letter 82-33.

CONSUMERS POWER COMPANY

By James W. Cook
James W Cook, Vice President
Projects, Engineering and Construction

Sworn and subscribed before me this 3rd day of July, 1984

Pamela J. Griffin
Notary Public
Jackson County, Michigan

My Commission Expires Sept 8, 1984

OC0484-0177A-MP04

MIDLAND ENERGY CENTER

SAFETY PARAMETER DISPLAY SYSTEM

MI0384-6450A-MP05

1. INTRODUCTION

This report provides a description of the Safety Parameter Display System (SPDS) developed for the Midland Project. The SPDS consists of computer driven displays which provide information to the operator regarding the current safety status of the plant. The displays are designed to support the Abnormal Operating Transient Guidelines developed for reactors provided by Babcock and Wilcox. Included in this report is a description of the computer system and CRT displays including the parameters utilized in the SPDS.

The SPDS CRT displays provide an integrated presentation of plant process information to the reactor plant operators. The information displayed on the SPDS is available at other locations in the control room. Emergency plant procedures address the location of instruments to be utilized in the event the SPDS is unavailable. As the operators will be capable and trained to handle emergency conditions without the SPDS present in the control room, the addition of the SPDS was determined to not result in a safety concern.

This report is intended to provide a description of the SPDS hardware and displays. It is not the intent of this report to cover all uses of these displays during normal or emergency conditions. For a more detailed description of how these displays can be used by the operator to ascertain and correct upset conditions, the reader is referred to the "Oconee

Nuclear Station, Unit 3, Abnormal Transient Operating Guidelines (ATOG)"[1].

2. COMPUTER HARDWARE DESCRIPTION

The SPDS for the Midland Plant is incorporated as a part of the plant computer system. The plant computer system is a non-safety grade device and is not seismically qualified. The plant computer does incorporate sufficient redundancy to assure high availability. In the description which follows, only those portions of the plant computer related to the SPDS function are described.

A functional block diagram of the Midland computer system is shown in Figure 1. The Midland computer system is a highly integrated multiprocessor system with redundant and interconnected components. The major subsystems of this facility are: the front-end preprocessors, the main Plant computers, the radiation monitoring computer, the Technical Support Center (TSC) computer, the Emergency Operations Facility (EOF) computer, and the functional displays and peripherals associated with each computer.

1 "Oconee Nuclear Station, Unit 3, Abnormal Transient Operating Guidelines (ATOG)," 74-1123297-00, Babcock and Wilcox Nuclear Power Generation Division, March 23, 1982; with revisions transmitted to Darrell G Eisenhut, Director, Division of Licensing, NRC, via letter from Daniel D Whitney, Chairman, Operator Support Subcommittee, Babcock and Wilcox Owners Group, June 15, 1982

Process inputs utilized by the SPDS are provided from both Class 1E and non-Class 1E devices. Inputs from Class 1E devices are provided through qualified isolaters located remote to the plant computer. The in-plant sensors are connected to the Plant Computer Process I/O which scans the data and performs A/D conversion of analog inputs.

The front-end preprocessors function to scan field inputs, convert inputs to engineering units and perform alarm checking of process variables. These processors also perform validity checks of inputs to verify that inputs are within expected ranges. Additionally, special calculations such as temperature compensation of levels and input validation routines are performed by these computers. Each front-end preprocessor serves as a backup to the other and automatically switches when a failure is detected.

One of the functions of the main plant computers is to format and update the SPDS displays. Each unit of the Midland plant has its own main computer. A third computer is provided which can replace either of the units computer in the event of failure. Switchover to the backup main computer is a manual operation requiring less than 15 minutes to accomplish.

The TSC computer receives data inputs from both main plant computers and from the radiation monitoring computer. This computer formats and drives displays including SPDS displays on the TSC and EOF CRT's. Additionally, the TSC computer supplies the main plant computers with radiation data used in the SPDS.

The Emergency Operations Facility (EOF) computer acts as a communication and display buffer. The EOF computer formats and updates displays including SPDS displays on the EOF CRT's.

3. DISPLAYS DESCRIPTIONS

The SPDS provides a concise display of critical plant variables to the control room operator to aid him in determining the safety status of the plant. The SPDS was designed to support the Abnormal Transient Operating Guidelines (ATOG) which serve as the basis for the plant emergency procedures. ATOG is a symptom-based guideline which emphasizes continuous surveillance of off-normal conditions. The four symptoms described in ATOG are:

a. Lack of adequate subcooled margin.

b. Lack of primary to secondary heat transfer (overheating).

c. Excessive primary to secondary heat transfer (overcooling).

d. Indications of steam generator tube rupture.

The information required to identify and track these symptoms is already available in the control room; however, it consists of discrete displays of reactor coolant system hot and cold leg temperature, reactor coolant system pressure and steam generator pressure. These discrete displays require mental integration on the part of the operator to quickly assess plant status using individual displays and the steam tables. The SPDS displays were designed to integrate this information on pressure-temperature curves to continuously show the primary subcooled margin and the dynamic relationship of the primary-to-secondary heat transfer.

The SPDS CRT display consists of three major areas on the screen. These areas are the title area, the pressure-temperature display area and the alert area. Each of these areas is described in detail in the following sections.

3.1 Title Area

Figure 2 shows a typical SPDS CRT screen. The section above the pressure temperature display is referred to as the Title Area. This area, common to all displays, consists of the display title (composed of time, date, display title and unit number) and the values of important plant parameters used elsewhere in the display. Parameters displayed in this area include containment pressure, reactor coolant system pressures and temperatures, core exit thermocouple temperatures and the steam generator saturation temperature. Dynamic data in the title area is updated every two seconds.

3.2 Display Area

The display area consists of the pressure-temperature curves upon which important operating limits are superimposed. Markers indicating the actual primary and secondary system operating points are also overlaid on the displays. Dynamic data in the display area is updated at two second intervals. There are four pressure-temperature base displays available to the operator which can be called up depending upon plant status.

RPS Trip Envelope

This display, which is shown in Figure 2, is utilized during normal power operations. The reactor protection system trip envelope, as well as a box defining normal operations, are superimposed on the pressure-temperature display.

ATOG-PT

This display, shown in Figure 3, is the primary display used by the operator to evaluate plant status during emergency conditions. Following a reactor trip, this display is placed on the SPDS CRT, automatically superceding any other display currently being viewed. The primary limits superimposed on this display are the saturation line, the variable subcooled margin (VSM) line (which accounts for instrument error) and the post-trip window used to define normal post-trip response of primary pressure and temperatures. The symptoms of loss of subcooling margin, overheating and overcooling are visually integrated on this display. Steam Generator saturation temperature as well as reactor coolant system pressure and temperature are dynamically displayed. The pressurizer level, in the form of a bar chart, is also provided in the lower right hand corner of the display.

Low Range P-T

This display, shown in Figure 4, is utilized during plant heatups and cooldown when greater resolution is required due to additional limitations being placed on control of primary system pressure and temperature. This display is applicable during low pressure/temperature conditions down to and including refueling conditions. In addition to the saturation and VSM curves, the decay heat removal system maximum pressure is superimposed on this display to indicate operating limits when this system is in operation or is to be placed in operation. The pressurizer level, in the form of a bar chart, is also provided in the lower right hand corner of the display.

Inadequate Core Cooling (ICC)

This display, shown in Figure 5, is utilized by the operator in the event the core is not adequately being cooled. Limit lines superimposed on this display include the saturation line and the 1400°F and 1800°F clad temperature lines. The marker in this display indicates the location of the average of the five highest incore thermocouples at the current reactor coolant system pressure. Procedure guidelines direct the operator to the actions to be taken in the event that system temperatures and pressures are in any region below the saturation curve. The pressurizer level and hot leg levels are also indicated on this display to provide the operator with information on reactor coolant system inventory.

3.3 Overlays

There are times during both normal and emergency operations when additional pressure temperature limits are applicable, and if left on the CRT display at all times would clutter the display and make it more difficult to interpret. To display these additional limits when applicable, the SPDS has been designed to allow these limits to be added through operator selected overlays. This section describes the overlay options available to the operator and indicates when they would be used.

Historical Trend

During the course of a transient or normal evolution, the operator may require information on the trend of the reactor coolant system pressure and temperature marker. The trend overlay allows the operator to display this trend information for the previous 30 minutes. Figure 6 show an example of the ATOG P-T display with the trend overlay selected. This overlay is applicable to all displays.

Thermal Shock Limits

During emergency conditions, when high pressure injection is initiated, maximum limits on reactor coolant pressure are imposed to minimize reactor vessel thermal shock. Figure 7 shows an example of the ATOG P-T display with the thermal shock limits overlay selected. This overlay is only applicable to the ATOG P-T and Low Range P-T displays.

Variable Subcooled Margin - 30°F (VSM-30°F)

During steam generator tube ruptures, the emergency procedure guidelines (ATOG) instruct the operator to maintain RCS pressure as low as possible to minimize the primary-to-secondary leak rate. The VSM-30°F overlay can be superimposed on the CRT displays to give the operator a target window for controlling primary pressure. Figure 8 shows an example of the ATOG P-T display with the VSM-30°F overlay selected. This overlay is only applicable to the ATOG P-T and Low Range P-T displays.

Low Temperature Overpressure Protection (LTOPP)

During normal plant heatups and cooldowns, the operator is directed to change the PORV setpoint and/or open the DHR isolation valves at various primary temperatures to provide overpressure protection of the RCS. The LTOPP overlay shows the operator the maximum allowable operating pressure based on PORV and DHR relief valve setpoints. Figure 9 shows an example of the ATOG-P-T display with the LTOPP overlay selected. This overlay is only applicable to the ATOG P-T and Low Range P-T displays.

Fuel Compression Limits (FCL)

During normal heatups and cooldowns, the operator is directed to maintain primary pressure above certain low pressure limits based on reactor coolant pumps seal staging, reactor coolant pump NPSH requirements and fuel pin in compression limits. A composite of these lower pressure limits can be superimposed on the CRT display to graphically depict these limits. These limits are based on the number of reactor coolant pumps running. The SPDS monitors pump status and automatically selects the correct limit when this overlay is selected. The FCL displayed is also dynamically changed on the screen if the pump status is changed while this overlay is selected. Figure 10 shows an example of the FCL overlay superimposed on the ATOG P-T display. The FCL overlay is only applicable to the ATOG P-T and the Low Range P-T displays.

Pressure vs Incore Temperature (INCORE)

There are times in the emergency procedure guidelines when the operator is instructed to control primary pressure and temperature based on incore thermocouple readings rather than T_{hot} and T_{cold}. The INCORE overlay allows the operator to replace the T_{hot} and T_{cold} markers on the ATOG P-T or Low Range P-T display with a marker showing the location of the average of the five highest incore thermocouple readings. Figure 11 shows an example of the INCORE overlay selected on the Low Range P-T display. Note that the marker symbol is changed to denote that incore temperature rather than T_{hot} or T_{cold} is being displayed. The INCORE overlay is only applicable to the ATOG P-T and the Low Range P-T displays.

The overlays superimposed on a particular display are identified as being selected in the upper left hand corner of the pressure-temperature display. Multiple overlays can be superimposed on the same display.

This allows the operator to overlay the LTOPP and FCL curves simultaneously and have maximum and minimum pressure limitations displayed on a single display for normal plant heatup or cooldown.

3.4 Alert Area

Alert signals appear in the area below the pressure-temperature display to key the operator to anomalies in areas not rigorously monitored in the display area. This area, common to all displays, directs the operator's attention to areas with unusual occurences. The alert section is normally blank; if an alert condition is detected, that alert is lit up in solid yellow with a red flashing block in front of the alert. This directs the operator to look at additional instrumentation to confirm and take action if necessary. There are nine alerts which are defined in the following paragraphs and which are shown activated in Figure 2.

Reactivity

This alert monitors control rod position and source range nuclear instrumentation. Approximately five seconds after a reactor trip all control rod positions are monitored. If any control rod is not on the bottom, the alert is activiated, indicating a stuck rod. Approximately 25 minutes following a reactor trip, the algorithm begins monitoring source range nuclear instrumentation. If the nuclear instrumentation indicates a count rate above a preset value, the alert is activated, indicating insufficient shutdown margin or a potential reactor restart and flags the operator to check other instruments. Monitoring of the source range instrumentation continues until Rod Groups 1 and 2 are 100% withdrawn, indicating a planned reactor start-up. The algorithm then resets, awaiting the next reactor trip signal.

Low Decay Heat Flow

This alert monitors decay heat removal flow and pump status when the RCS pressure and temperature are in the range where the decay heat removal system operation is required and the reactor coolant pumps are not operating. The alert activates upon indication of no decay heat removal pump running or decay heat removal flow less than required.

High Rad Auxiliary Building Vent

This alert monitors radioactivity at the discharge of the auxiliary building vent. Activation of this alert informs the operator that there is a leakage of radioactive material within the Auxiliary Building which is being released to the environment.

High Rad Air Ejector

This alert monitors radiation at the condensor air ejector. Activation of this alert indicates primary-to-secondary leakage and potential steam generator tube rupture.

High Rad Steam Line A

This alert monitors radiation in the steam from the A steam generator. Activation of this alert alone or in conjunction with an air ejector radiation alert indicates the potential for a steam generator tube rupture in steam generator A.

High Rad Steam Line B

This alert monitors radiation in the steam from the B steam generator. Activation of this alert alone or in conjunction with an air ejector radiation alert indicates the potential for a steam generator tube rupture in steam generator B.

CTMT Isolation

This alert monitors containment pressure and radiation. Activation of this alert implies that containment pressure or radiation is approaching the containment isolation setpoint. This alert is intended to allow the operator to attempt to correct the problem or manually perform the isolation function if required. Containment pressure is indicated in the title area of the SPDS to aid the operator in making this decision.

CTMT Spray

This alert monitors containment pressure. Activation of this alert implies that containment pressure is approaching the containment spray actuation setpoint. This alert is intended to allow the operator to attempt to correct the problem or manually initiate containment spray if required. Containment pressure is indicated in the title area of the SPDS to aid the operator in making this decision.

CTMT Hydrogen

This alert monitors containment hydrogen concentration. Activation of this alert informs the operator of the need to initiate the hydrogen recombiners in containment.

4. MAN MACHINE INTERFACE

Each unit of the Midland Plant has one CRT dedicated to the SPDS function. No other computer generated displays can be placed on these CRT's. This dedicated CRT is located immediately adjacent to the Safeguards control panel. This location was chosen to allow easy accessability to the information by all personnel within the control room. Figure 12 shows the location of the dedicated SPDS CRT in the control room.

Communication with the dedicated SPDS CRT is via a dedicated keypad located on the safeguards panel immediately adjacent to the SPDS-CRT. A graphical representation of the keypad arrangement is shown in Figure 13. The alphanumeric keys are utilized to select the base pressure-temperature display and to indicate which loop markers are requested. The function keys on the right hand side of the keypad are utilized to add and/or delete overlays from the base displays. The actual keypads are labeled similar to that shown in Figure 12; however, due to space constraints, acronyms are used under the function keys to describe the overlays. In the event the operator forgets the meaning of an acronym, the help key (function F4) can be pushed. Pushing the help key displays the SPDS keypad description shown in Figure 13. This display remains active for 30 seconds, at which time it is timed out and the CRT returns to the previously requested display.

In addition to the dedicated SPDS CRT, the SPDS can be displayed on other CRT's within the control room. The location of these backup CRT displays is shown on Figure 12. The display of SPDS information on the backup CRT's or at the TSC or EOF requires the use of a menu system through a standard keyboard. The information to be provided by the operator when requesting the SPDS from a standard keyboard is shown in Figure 14. After selecting the desired options, the SPDS is displayed on the requested CRT. Movement from base display to base display is then possible by utilizing page forward/page back pushbuttons. If the operator wants to change the selected loop or selected overlay, he must return to the menu to select these new options. Returning to the SPDS menu after the SPDS function has been selected requires only a single keystroke.

5. INPUT VALIDATION

To prevent misleading the operator, analog values displayed by the SPDS are extensively validated in real time prior to display. This validation is achieved by comparing redundant sensor readings and through other checks prior to display of the parameter to the operator. In the event that the computer is unable to ascertain a valid reading, the analog values in the title areas are filled with question marks, markers in the display area turn yellow and are moved to the valid parameter axis and bar charts turn yellow. These actions readily identify faulty data to the operator. Figure 15 provides an example of a display where parameters were determined to be invalid by the computer.

Table 1 is a listing of the analog values displayed to the operator by the SPDS. This table shows the number of inputs provided and the ranges of the inputs used to derive the displayed values. The number of inputs for a displayed value range from a minimum of 2 to a maximum of 6.

Validation of SPDS analog inputs begin by performing limit checks on each input signal. This check assures that the input is within its expected operating range. Inputs identified to be out of limits are flagged and alarmed through the non-SPDS portion of the computer. Following the limit check, those inputs which pass the limit check are further validated in a manner which is dependent on the number of inputs remaining. For parameters having four inputs, the displayed value is the average of the middle two inputs. For parameters having three inputs, the displayed value is the middle value. For parameters having two inputs, the displayed value is the average of the inputs. After determining the display value, each input to this value is compared against the display value. Any input deviating from the display value by a predetermined amount is flagged and alarmed through the non-SPDS portion of the computer system. If only two inputs make up the display value and if these inputs deviate from the display value by a predetermined amount, the display value is flagged as being invalid and is displayed as described earlier.

Some SPDS parameters are comprised of inputs covering several ranges of the same value. Each input range is validated as described above for the number of inputs included in that range. The SPDS then selects the range to be displayed. If the narrow range instrument is on scale and is valid, the narrow range value is selected for display. If the narrow range instrument is off scale or is determined to be invalid, the wide range value is selected for display.

6. COMPARISON TO NUREG-0737 SAFETY FUNCTIONS

Supplement 1 to NUREG-0737 states that information is to be provided to plant operators in five categories. This section lists each category and describes the information provided in each category by the Midland SPDS.

Reactivity Control

Information provided by the SPDS to monitor reactivity control includes reactor coolant system pressures and temperatures, control rod positions and source range nuclear instrumentation. Following a reactor trip demand, if not all rods are inserted, the reactor may not go subcritical. This condition would be indicated by increasing primary temperatures and pressures on the pressure-temperature diagram and by the reactivity alert which monitors control rod positions. For long term monitoring of reactivity when the reactor is shutdown, the SPDS monitors source range nuclear instrumentation. Events which add positive reactivity such as deboration events would result in increasing source range count levels which will be indicated by the reactivity alert.

Reactor Core Cooling and Primary Heat Removal

Indication of adequate primary heat removal and core cooling is provided by the primary and secondary pressure and temperature indications on the pressure-temperature diagrams. The direction and rate of motion of the markers on the pressure-temperature diagrams provide integrated information to continuously show the dynamic relationship of the primary heat transfer and the degree of primary subcooling.

Reactor Coolant System Integrity

Indication of reactor coolant system integrity is provided by monitoring reactor coolant system pressure, temperature, pressurizer level and hot leg level. A loss of RCS integrity would manifest itself by decreasing pressure as indicated on the pressure-temperature diagram, decreasing pressurizer level and, if severe enough, decreasing hot leg level. The pressure-temperature diagram with appropriate operating limits superimposed can also identify an approach to limits which challenge reactor coolant system integrity.

Radioactivity Control

Indication of radioactivity control is provided by monitoring containment radiation, Auxiliary Building vent stack radiation, air ejector radiation and steam line radiation. These radiation values are provided as alerts only. A separate radiation monitoring system computer exists in the Midland design. Containment radiation is monitored to alert the operator to potential leaks inside containment and the potential need to isolate containment. Auxiliary Building vent stack radiation is monitored to alert the operator of excessive releases to the environment and the potential need to isolate vent pathways. Air ejector and steam line radiation are monitored to alert the operator to potential steam generator tube ruptures.

Containment Integrity

Indication of containment integrity is provided by monitoring containment pressure and containment hydrogen concentration. Indication of containment pressure is provided in the SPDS title area; additionally, two alerts at different containment pressures are provided to alert the operator that containment pressure is increasing and that the containment may have to be isolated or containment spray actuated. Containment hydrogen is monitored to provide the operator an alert to start the hydrogen recombiners.

7. VERIFICATION AND VALIDATION

To assure that a high quality SPDS was implemented, a verification and validation program was conducted throughout the process of design, fabrication, installation and testing of the SPDS. A flow chart detailing the design steps in completing the SPDS is shown in Figure 16. This section discusses each major type of design verification performed on the Midland SPDS.

SPDS Functional Specification

A detailed specification was written to specify the CRT displays. The displays were designed to support the Abnormal Transient Operating Guidelines (ATOG) which are used as the basis for emergency operating procedures. The specification detailed the format, content, color and sources of data for the displays as well as the operator interaction requirements. The completed specification was provided to a software consultant for implementation on the existing plant computer system.

Control Specification

An additional specification was written which added additional requirements specified by the software consultant in consultation with Consumers Power Company. This control specification, which contained the original specification as an Appendix, became the vehicle for documenting the final design including any exceptions or deviations from the original specification.

Systems Requirement Review

The systems requirement review determined whether the system requirements as specified in the controlling specification were complete, feasible, testable and consistent with system purpose. The systems requirement review was performed by individuals not involved in formulation of the controlling specification.

Test Plan

The test plan established the detailed requirements for testing the hardware and software functionability.

Hardware Configuration Design Review

The existing computer hardware available at Midland was reviewed to assure that the configuration could support the SPDS functional requirements.

Preliminary Design Review

An independent review of the Architectual Documentation was performed to assure that the general design approach was technically adequate.

Critical Design Review

The critical design review was conducted on a subsystem basis to assure the acceptability of detailed software coding. The critical design review included validity testing of the software modules.

Validation Test

Validation testing of SPDS modules was performed on a development computer system at the factory prior to field installation of the software. The validation testing verified functionability of each module and design requirement which could be tested prior to actual field installation.

Field Validation Test

The field validation test was performed following field installation of the software. This testing, performed by individuals independent of the design effort, verified the functionability of each module and design requirement in accordance with the requirements of the test plan.

Validation Report

The total verification and validation of the SPDS subsystem is summarized in the Validation Report. Traceability of the verification and validation activities throughout the project, identification and resolution of descrepancies and reference to detailed documentation is provided in this report.

TABLE 1

SPDS VALIDATED INPUT LIST

Parameter	PTID(1)	Range	Comment
Containment Pressure	P043	0-27 psia	
	P044	0-27 psia	
	P045	0-27 psia	
	P046	0-27 psia	
	P079 (P127)	10-225 psia	
	P080 (P128)	10-225 psia	
RCS Pressure Loop A	P721	1500-2500 psig	
	P729	1500-2500 psig	
	P201	0-2500 psig	
	P202	0-2500 psig	
RCS Pressure Loop B	P722	1500-2500 psig	
	P730	1500-2500 psig	
	P203	0-2500 psig	
	P204	0-2500 psig	
Pressurizer Pressure	P120	0-600 psig	
	P129	0-3000 psig	
	P130	0-3000 psig	
T-Cold Loop A	T195	50-750°F	
	T197	50-750°F	
T-Cold Loop B	T196	50-750°F	
	T198	50-750°F	
T-Hot Loop A	T721	520-620°F	
	T730	520-620°F	
	T197	0-750°F	
T-Hot Loop B	T722	520-620°F	
	T731	520-620°F	
	T198	0-750°F	
Incore Thermocouples	24 Inputs	0-2300°F	Average of 5 highest of valid inputs
Steam Generator Pressure A	P047	0-1200 psig	Steam generator temperature calculated from validated steam generator pressure
	P048	0-1200 psig	
	P049	0-1200 psig	
	P050	0-1200 psig	

TABLE 1

SPDS VALIDATED INPUT LIST

Parameter	PTID[1]	Range	Comment
Steam Generator Pressure B	P093 P094 P095 P096	0-1200 psig 0-1200 psig 0-1200 psig 0-1200 psig	Steam generator saturation temperature calculated from validated steam generator pressure.
Pressurizer level	L772 L773 L774	0-400 in 0-400 in 0-400 in	Temperature compensated from pressurizer level and pressure inputs
Hot Leg Level Loop A	L111	488-610 in	Temperature compensated level calculated from hot leg level, temperature and reference leg temperature for each hot leg
Hot Leg Level Loop B	L112	488-610 in	Temperature compensated level calculated from hot leg level, temperature and reference leg temperature for each hot leg

(1) PTID - Point identifier used in computer. If PTID's differ between Unit 1 and 2, Unit 2 is shown in parenthesis.

FIGURE 2
MIDLAND PLANT COMPUTER
BLOCK DIAGRAM

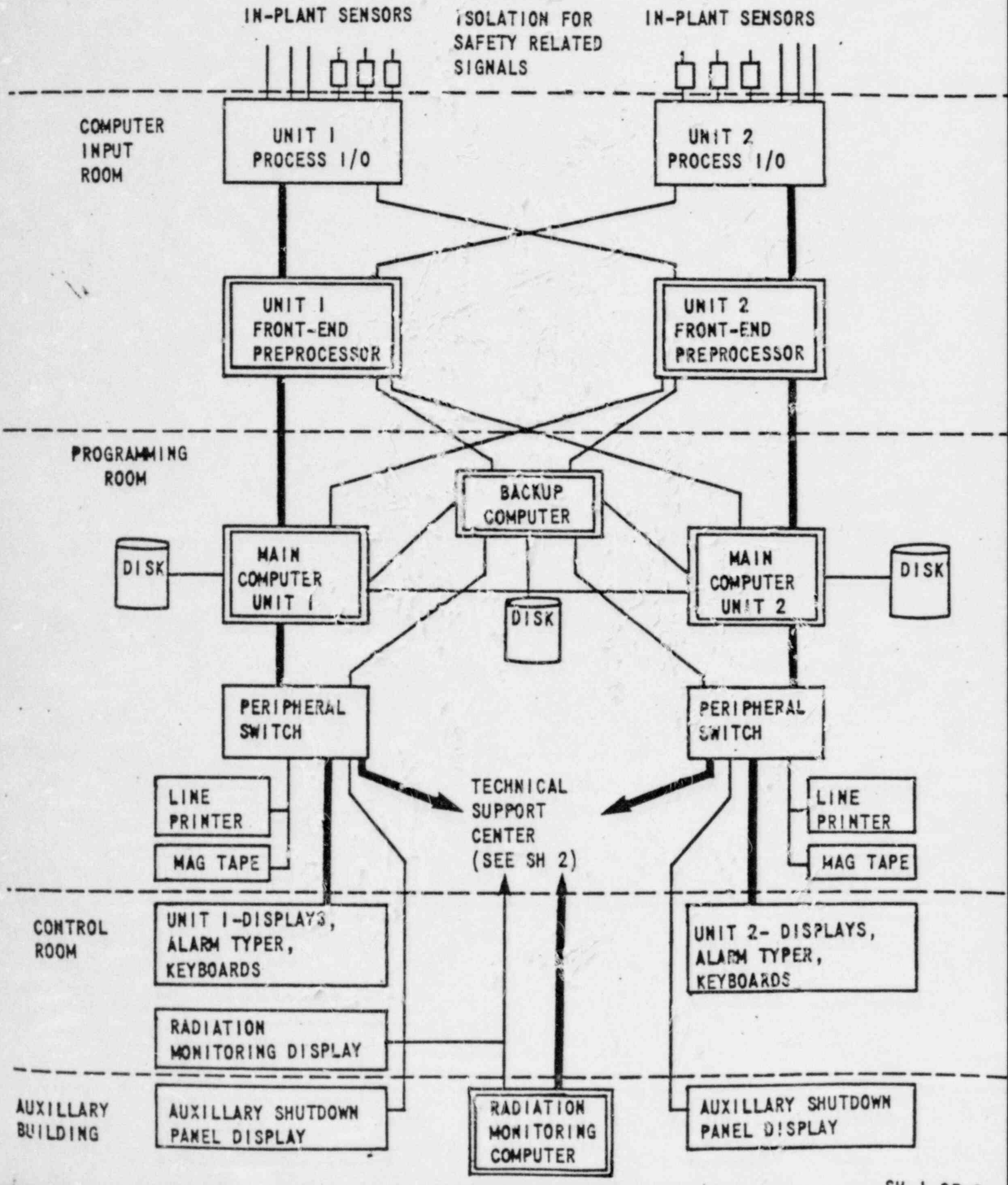


FIGURE 1 (Contd)
MIDLAND PLANT COMPUTER
BLOCK DIAGRAM

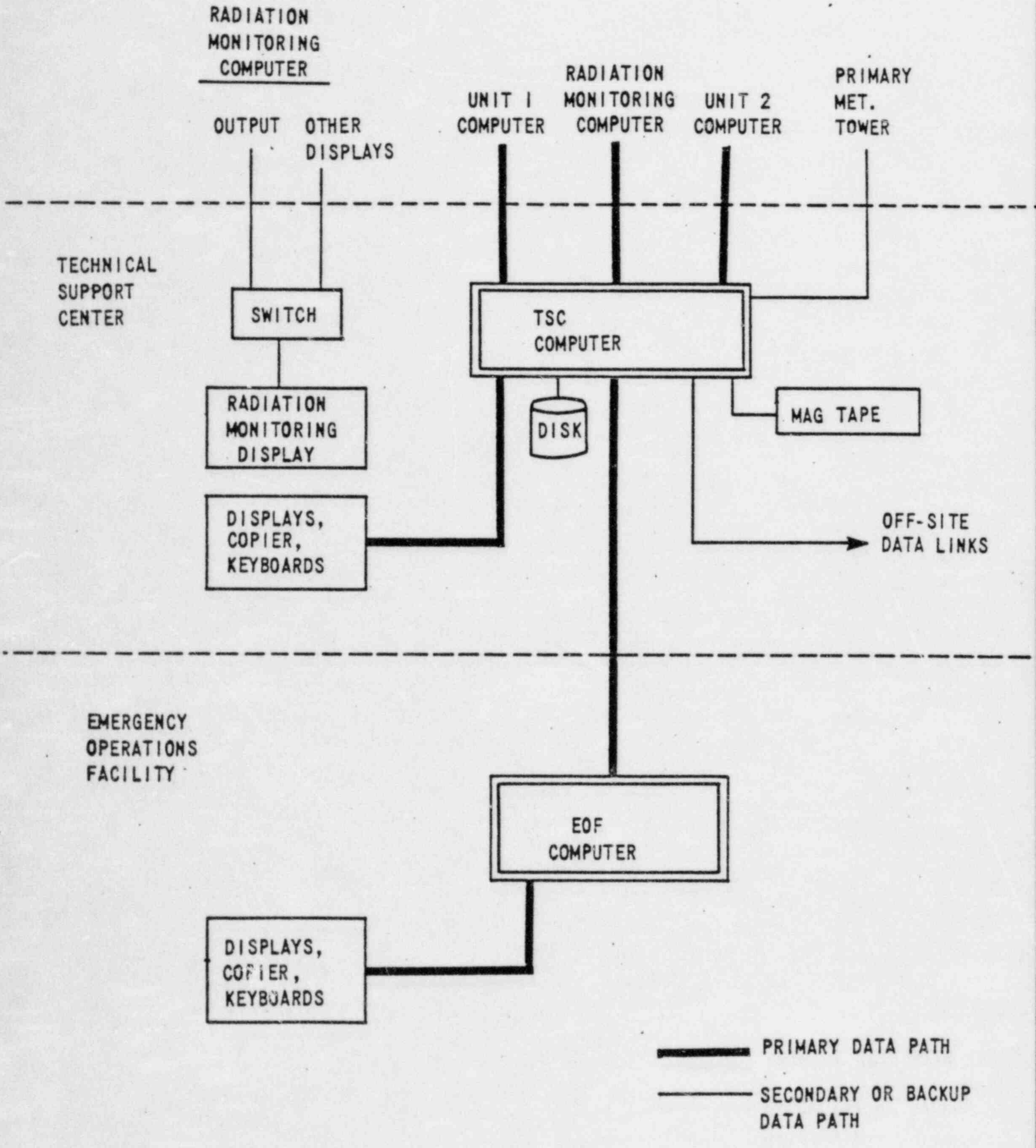


FIGURE 2
RPS TRIP ENVELOPE DISPLAY

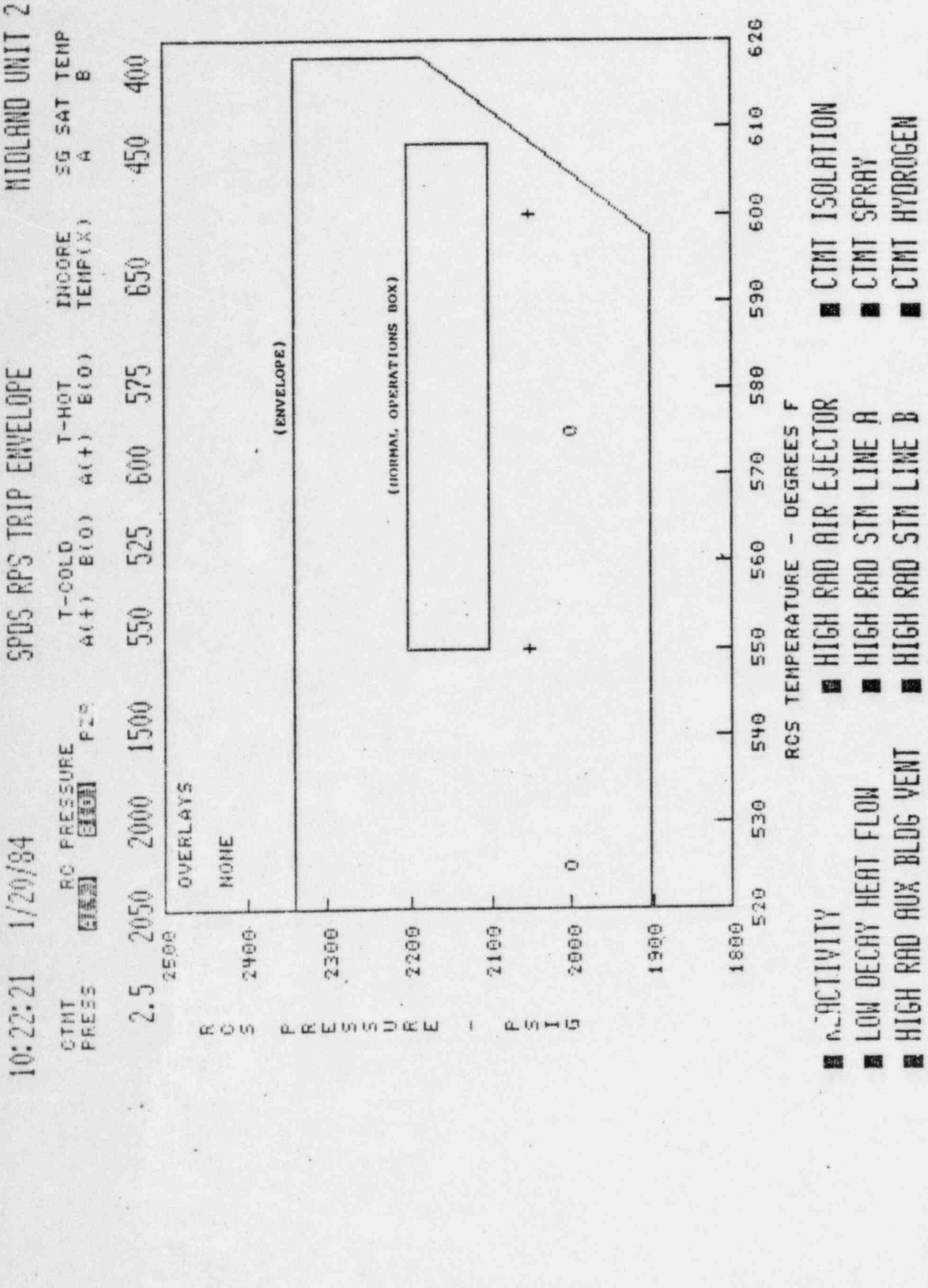


FIGURE 3
ATOG PRESSURE-TEMPERATURE DISPLAY

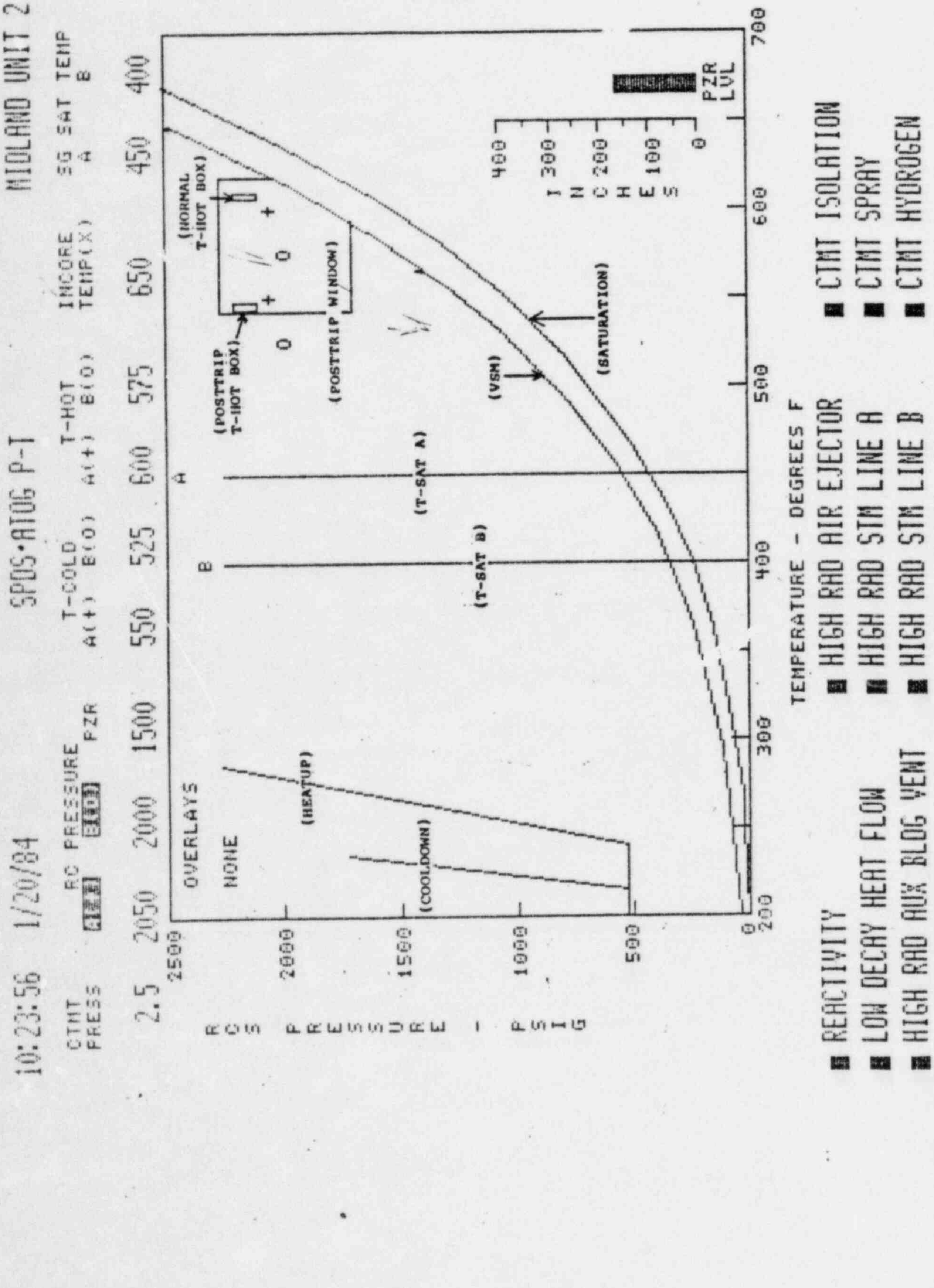


FIGURE 4
LOW RANGE PRESSURE-TEMPERATURE DISPLAY

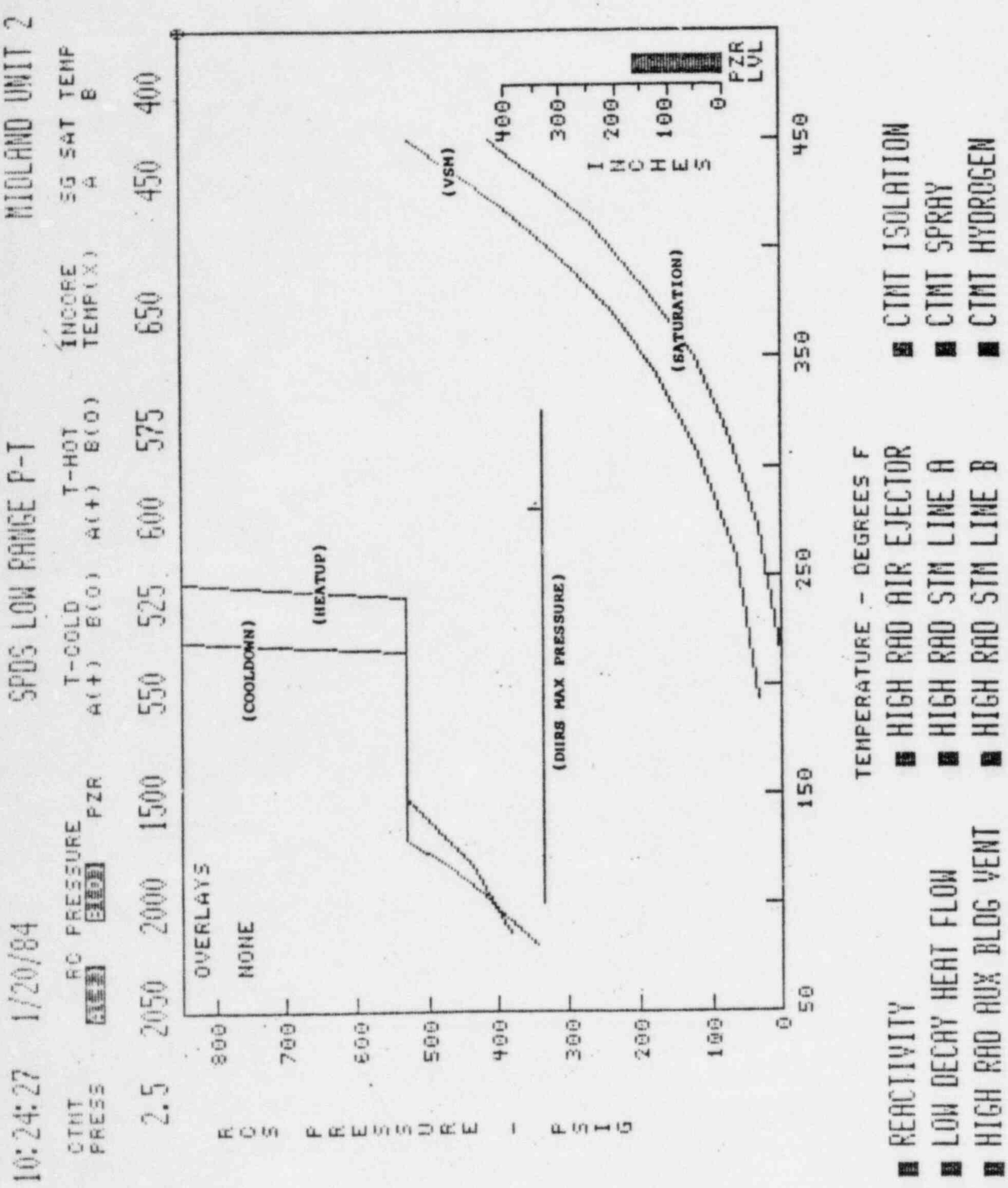


FIGURE 5
INADEQUATE CORE COOLING DISPLAY

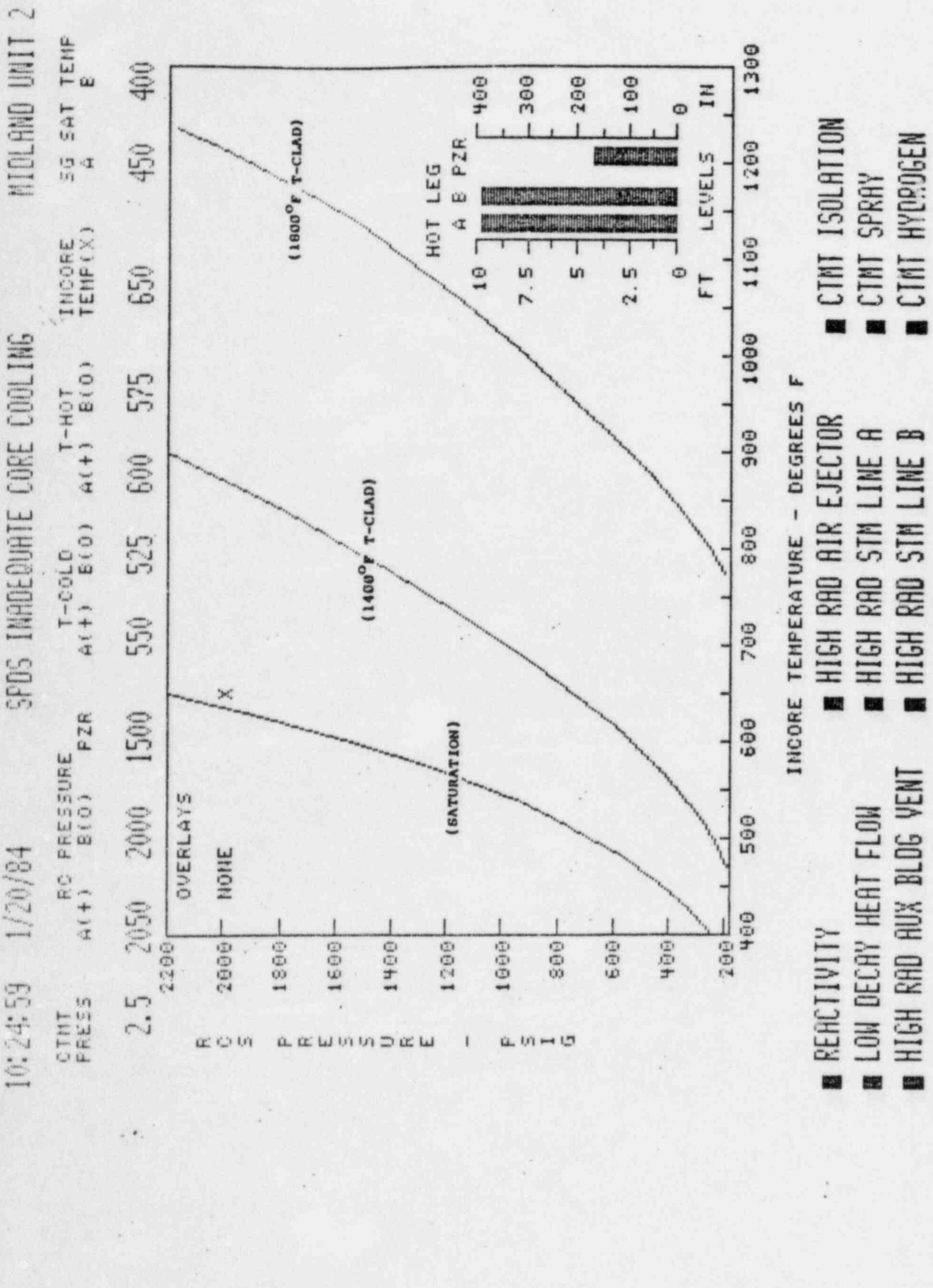


FIGURE 6
ATOG P-T DISPLAY WITH TREND

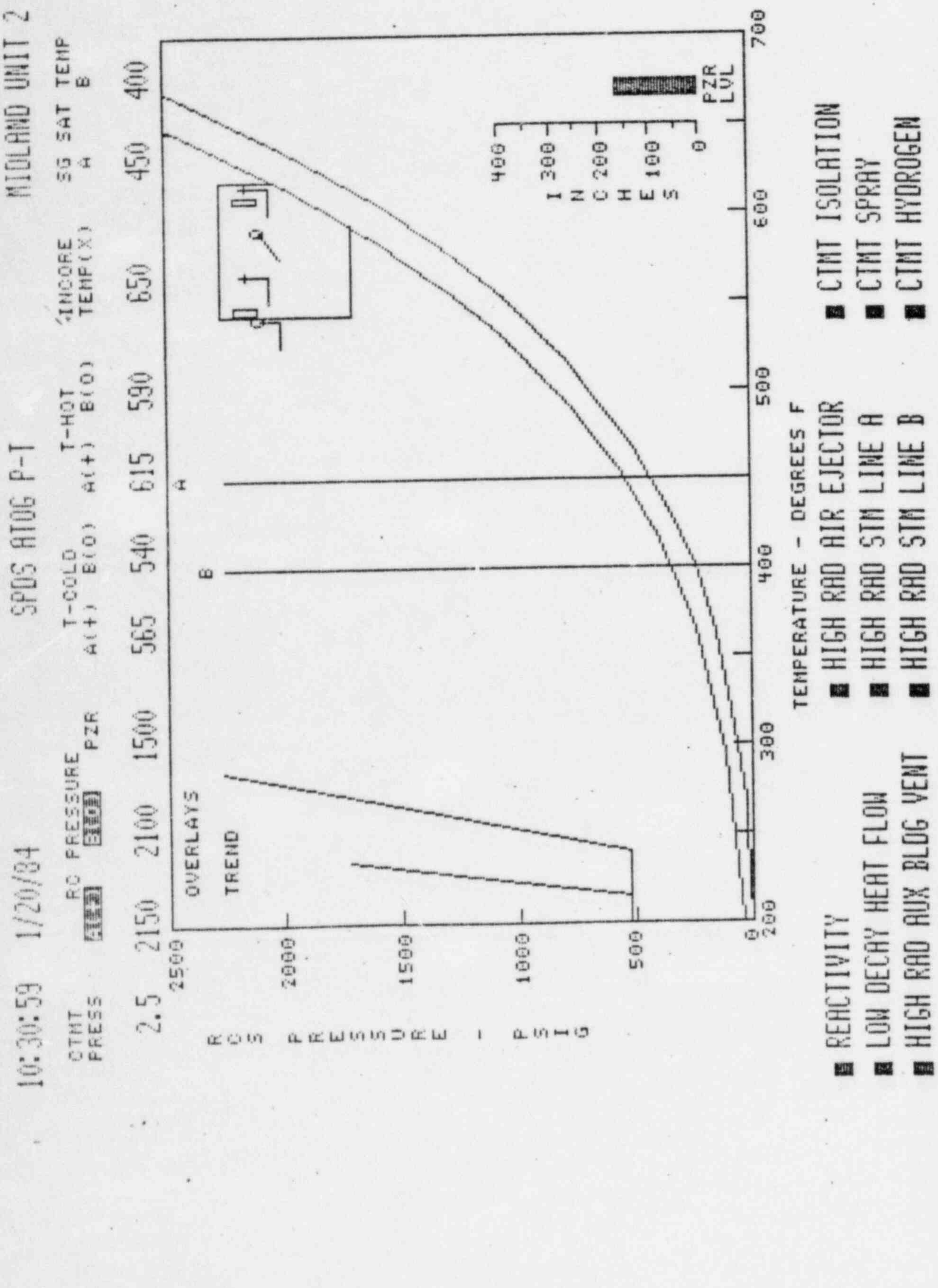


FIGURE 7
ATOG P-T DISPLAY WITH THERMAL SHOCK UNITS

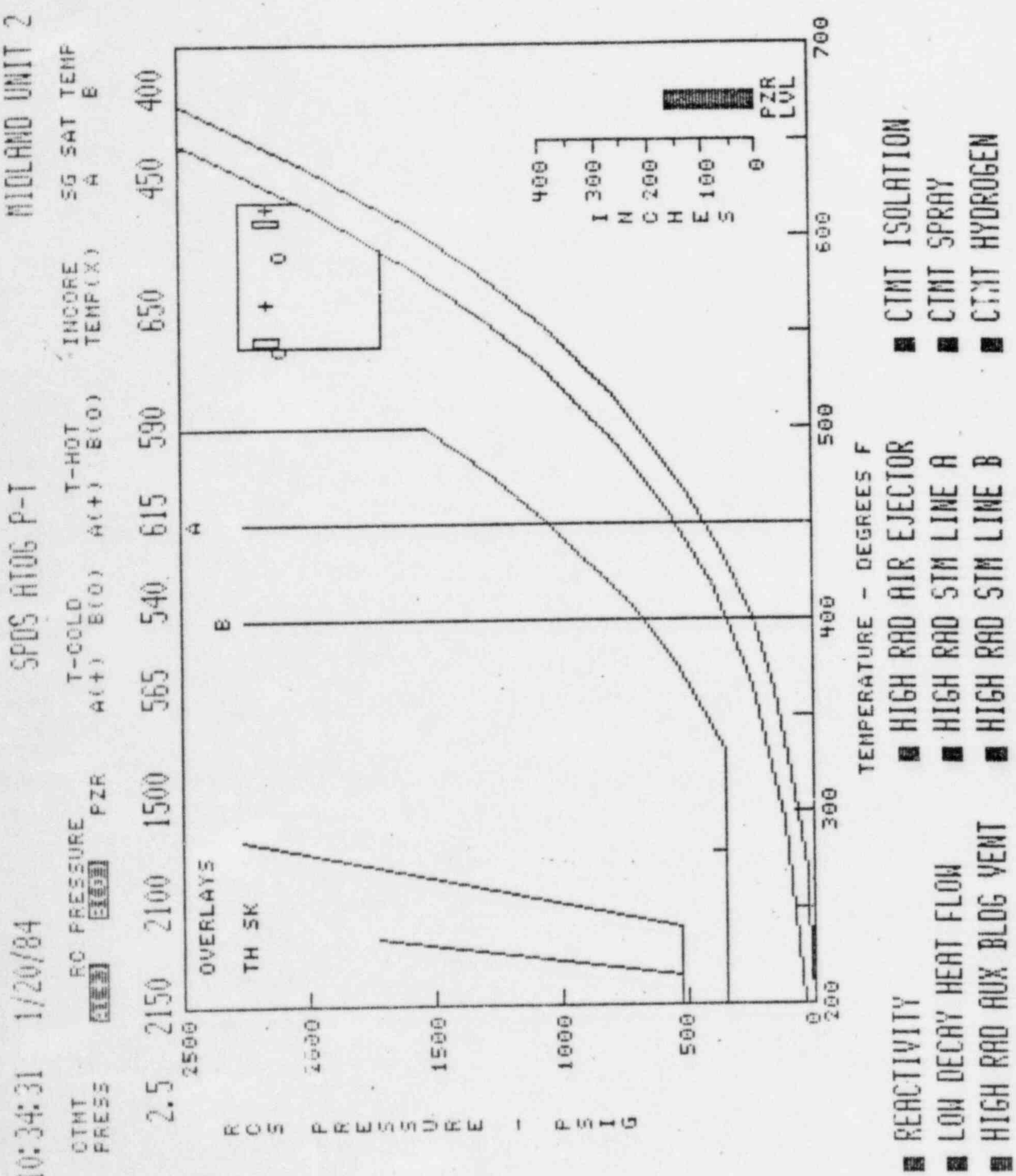


FIGURE 8
ATOG P-T DISPLAY WITH VARIABLE SUBCOOLING MARGIN - 30°F

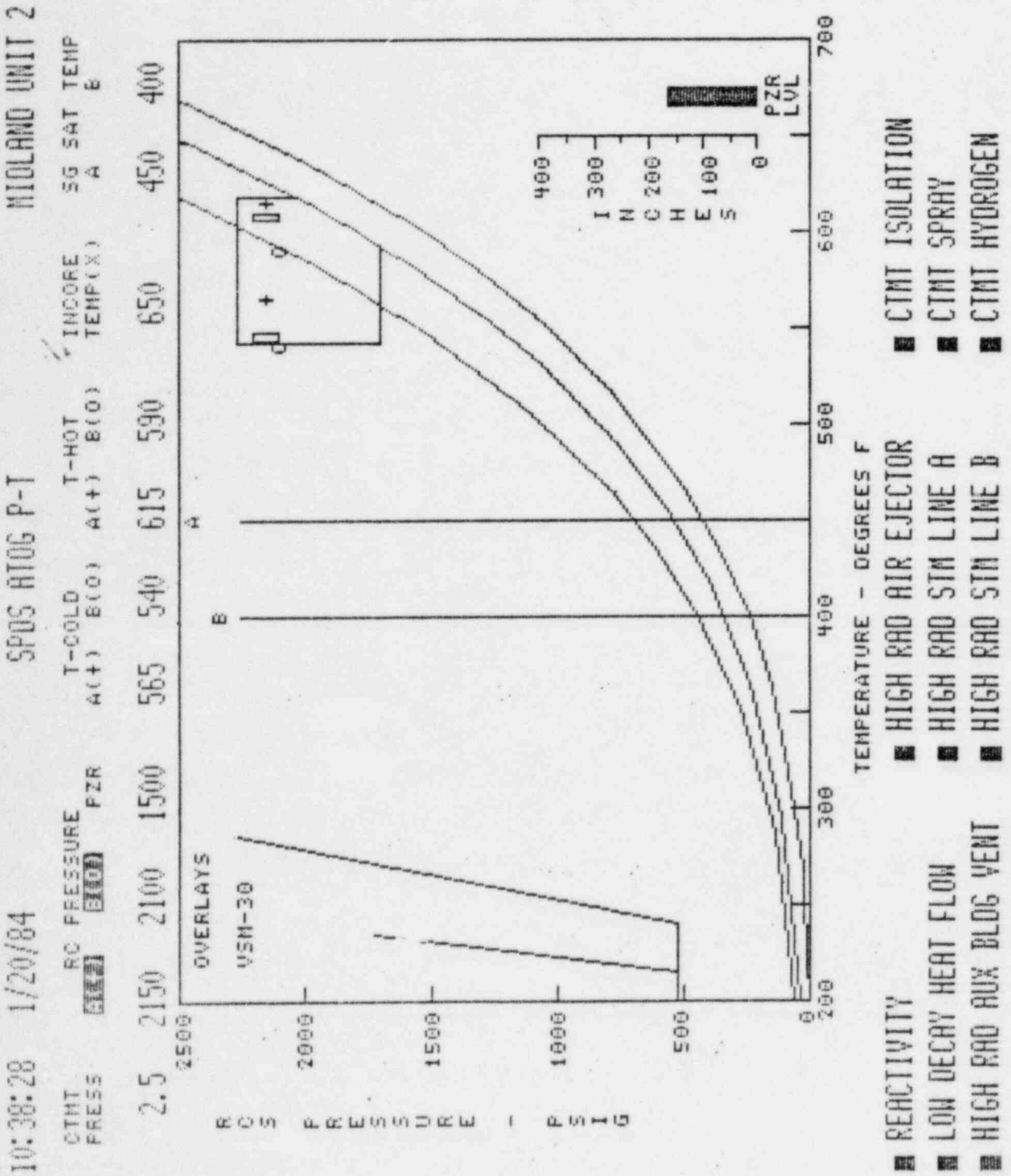


FIGURE 9
ATOG P-T DISPLAY WITH LOW TEMPERATURE
OVERPRESSURE PROTECTION LIMITS

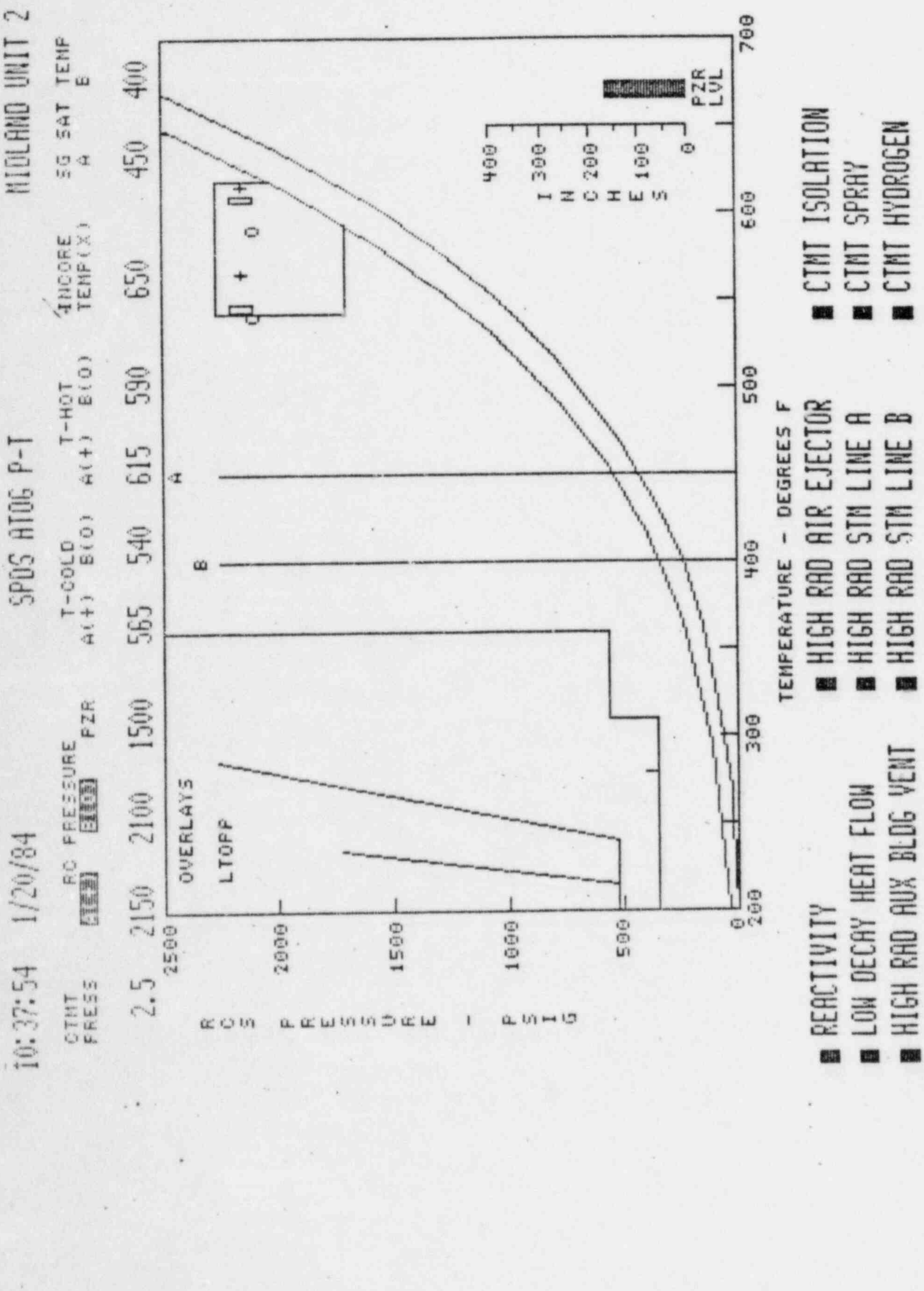


FIGURE 10
ATOG P-T WITH FUEL COMPRESSION LIMITS

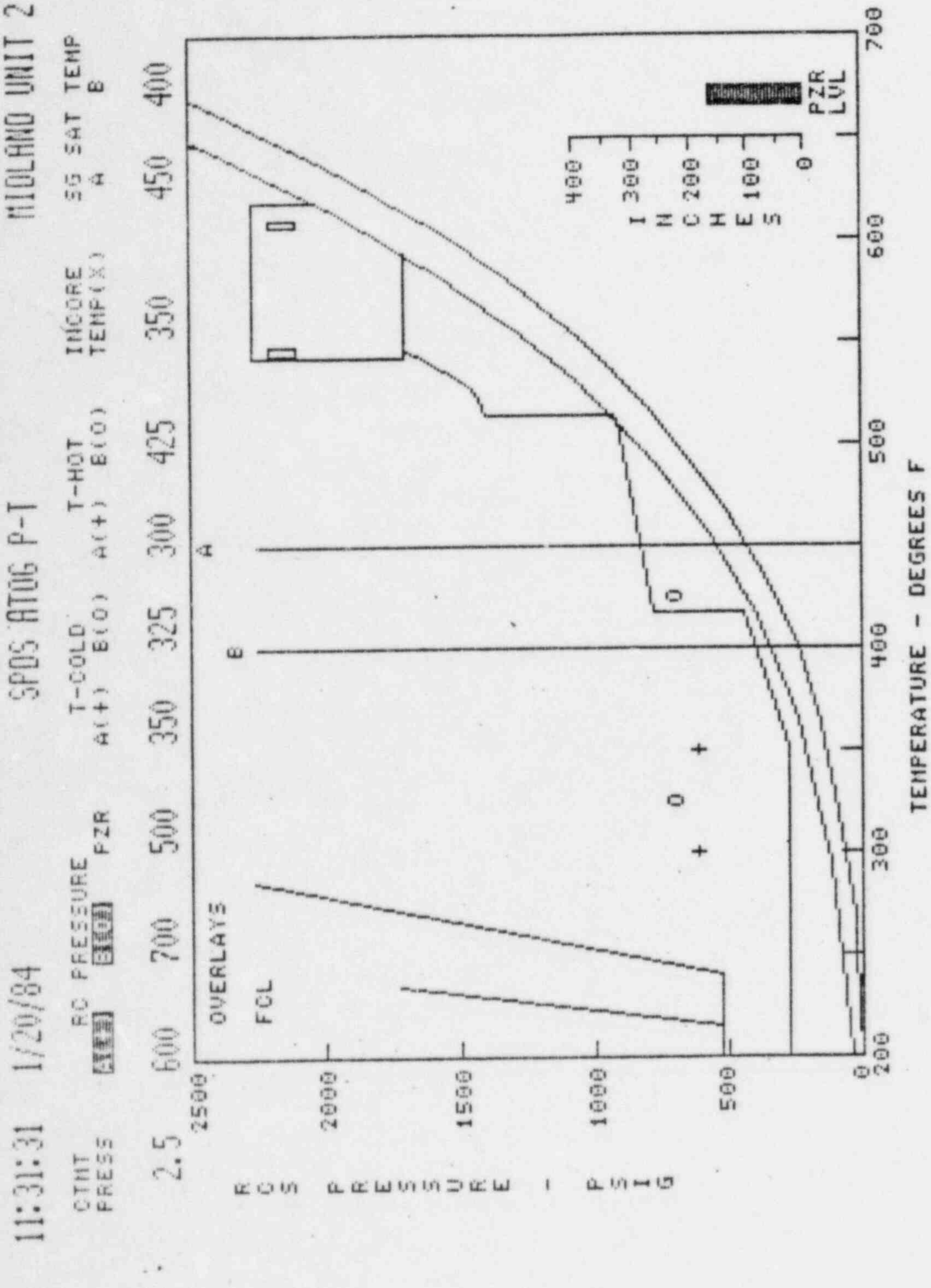
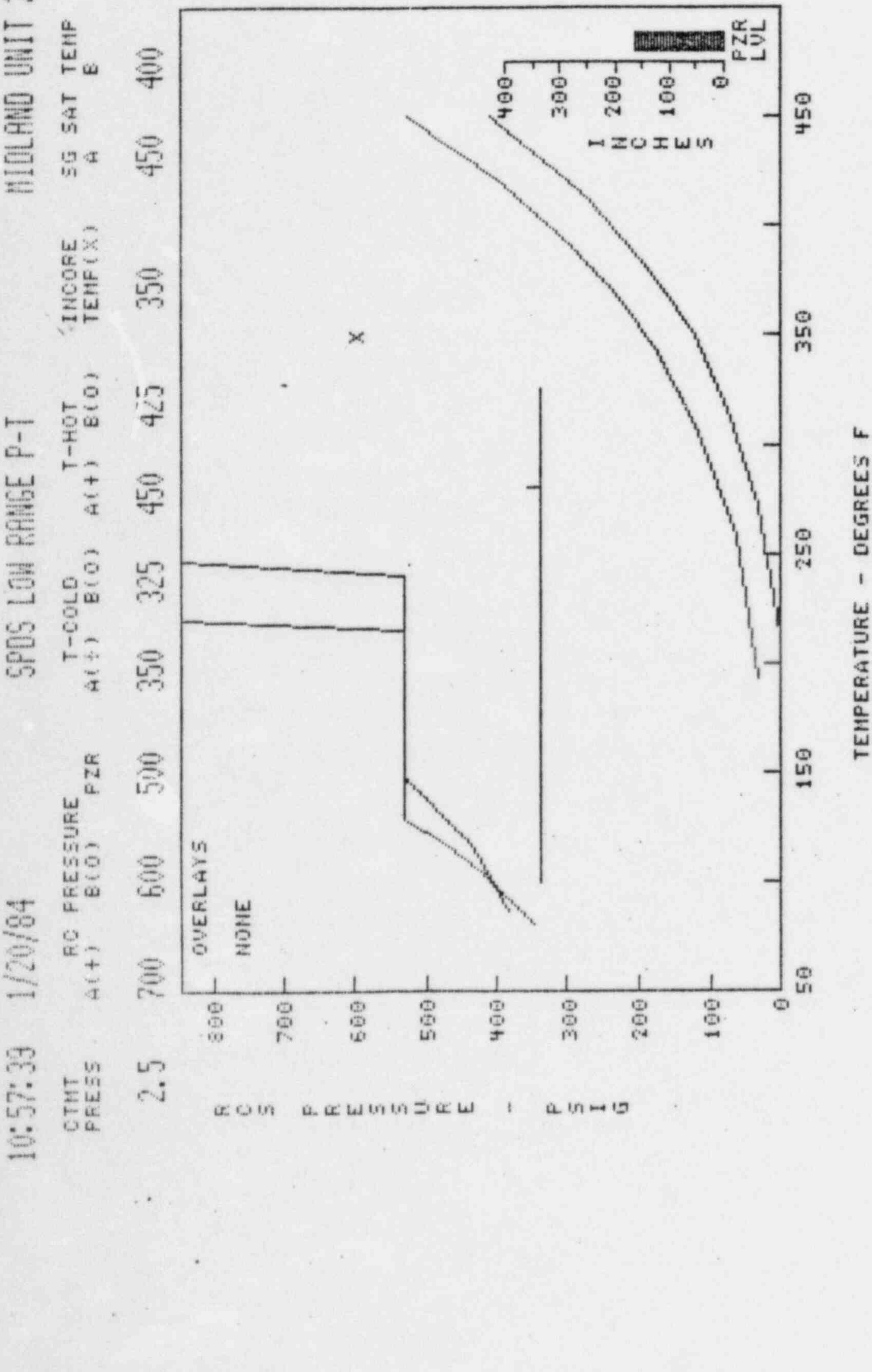


FIGURE 11
LOW RANGE P-T WITH INCORE TEMPERATURE SELECTED



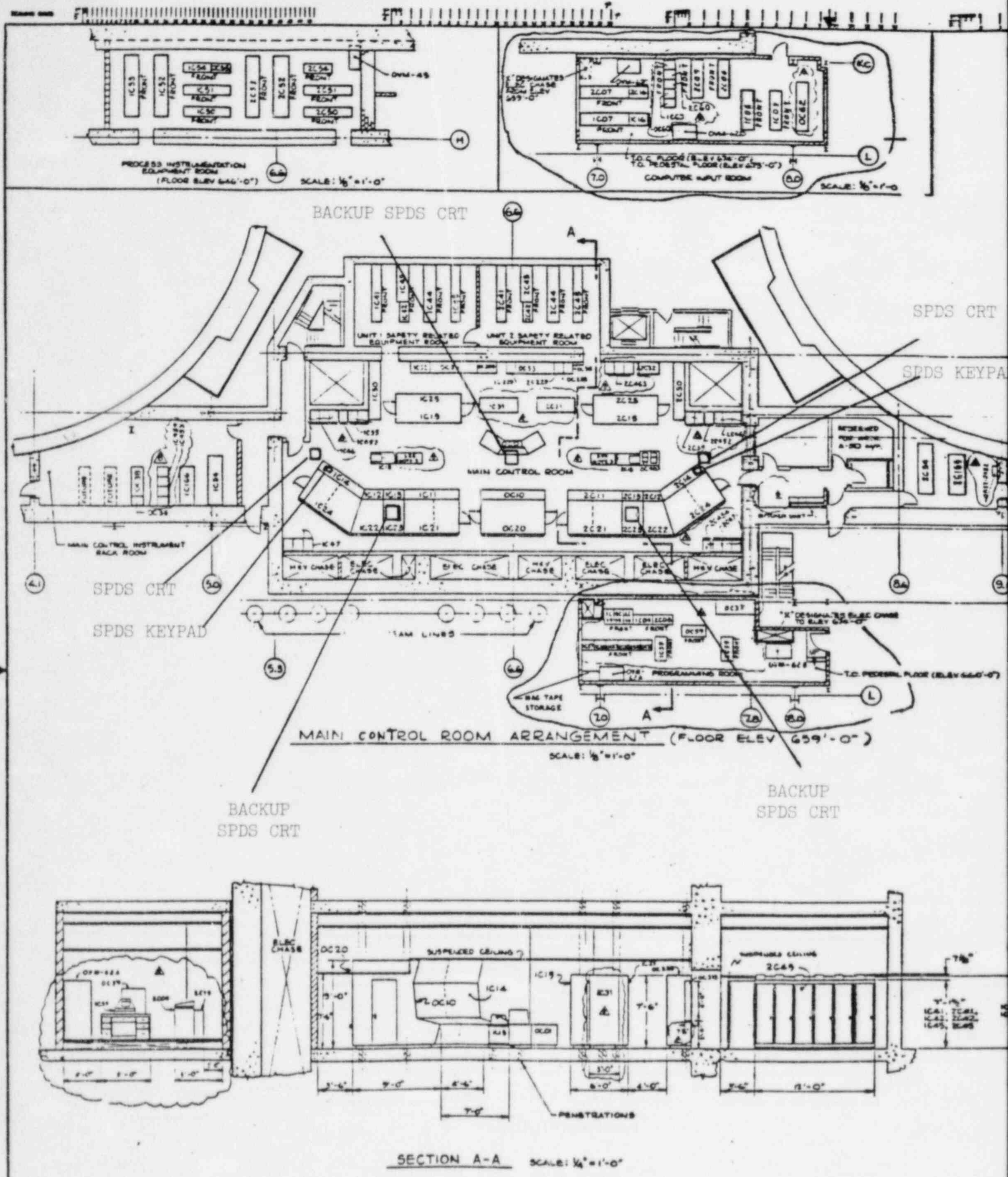


FIGURE 12
SPDS DISPLAY LOCATIONS

11:59:54 1/20/84 SPDS KEYPAD DESCRIPTION MIDLAND UNIT 2

NOTE: KEYS A THROUGH F NOT USED

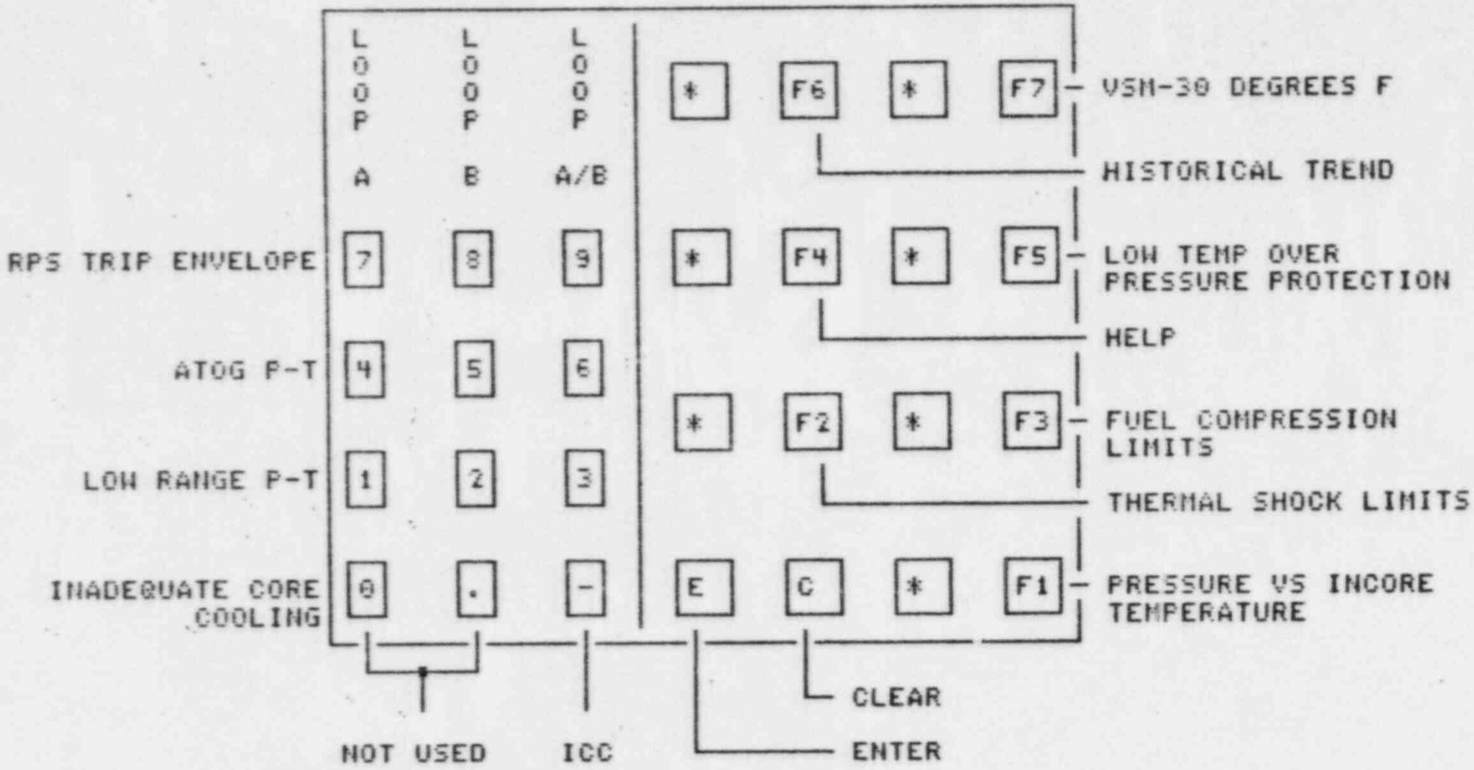


FIGURE 13
SPDS KEYPAD ARRANGEMENT

FIGURE 14
SPDS MENU FORMAT

11:56:16   1/20/84   FUNCTION 12 SPDS DISPLAY SELECT   MIDLAND UNIT 2

LOOP SELECT

: LOOP A   : LOOP B   : LOOP A/B *

BASE DISPLAY

: RPS TRIP ENVELOPE
: ATOG P-T *
: LOW RANGE P-T
: INADEQUATE CORE COOLING

OVERLAY SELECT

: PRESSURE VS INCORE TEMPERATURE	: THERMAL SHOCK LIMITS
: FUEL COMPRESSION LIMITS	: LOW TEMP OVER PRESSURE PROTECTION
: HISTORICAL TREND	: VARIABLE SUBCOOLED MARGIN - 30 DEGF

ENTER ANY CHARACTER IN TAB FIELDS TO SELECT
LOOP, BASE DISPLAY, AND OVERLAY OPTION(S)

NOTE: * INDICATES DEFAULT SELECTION

FIGURE 15
ATOG P-T DISPLAY WITH INVALID DATA

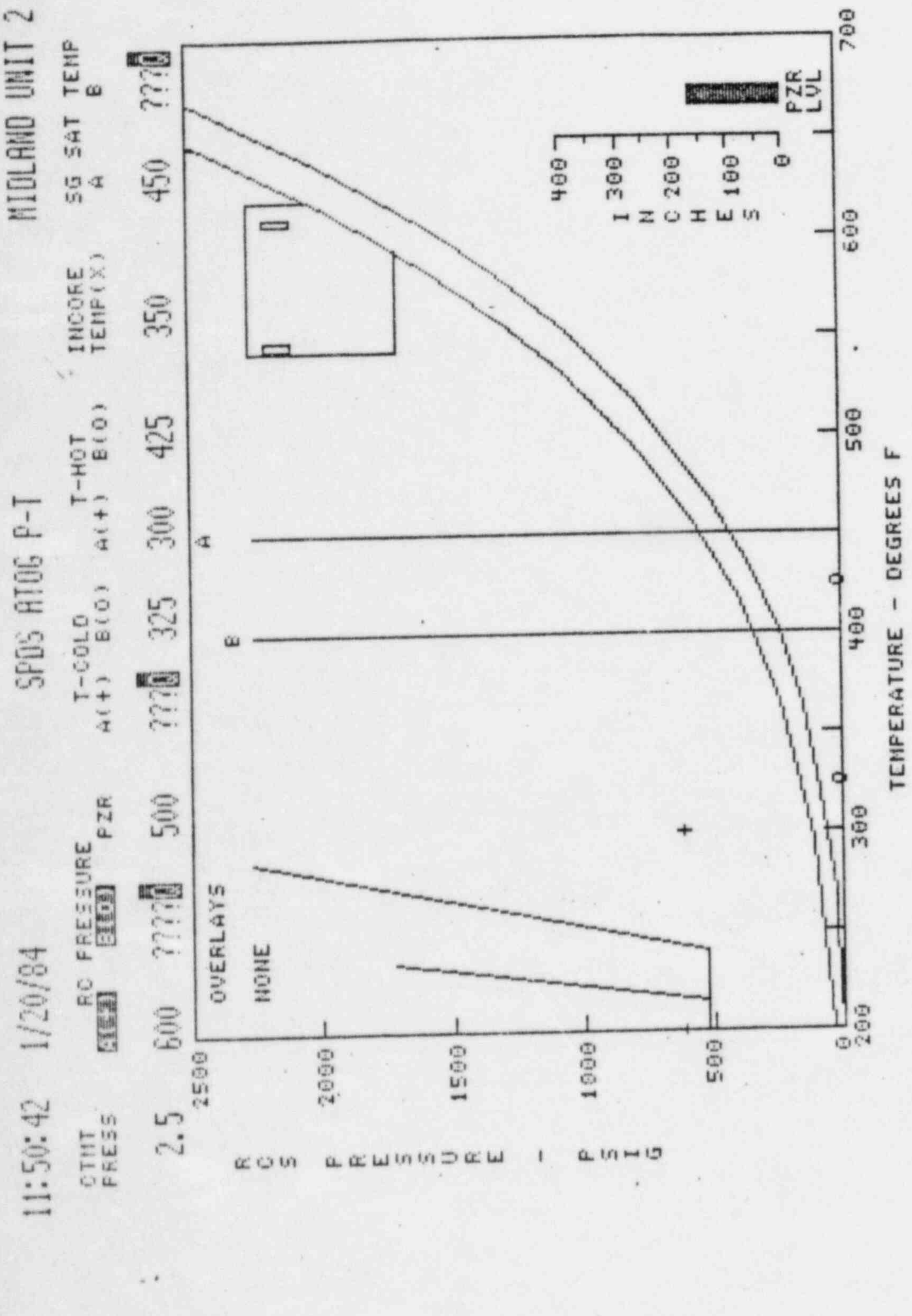
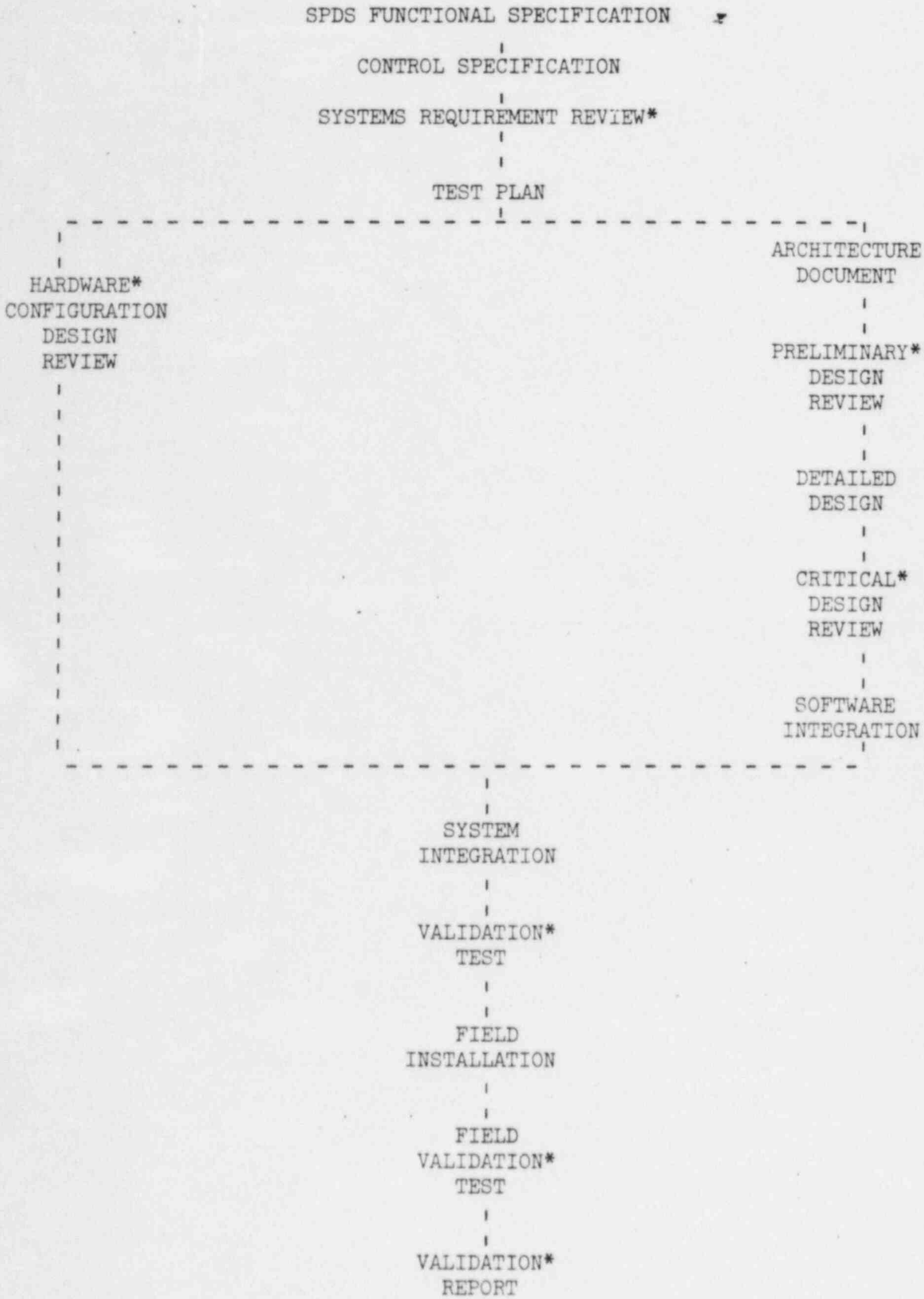


FIGURE 16
SPDS DESIGN FLOW CHART



*V&V Activity