ATTACHMENT #2

PTP

A FUNCTIONAL DESIGN SPECIFICATION

FOR THE

QSPDS DISPLAY

SPECIFICATION NO. NPROD-ICE-3202, REV. 00

Nuclear Power Systems
COMBUSTION ENGINEERING, INC.
Windsor, Connecticut

QA Status: Verified

The safety related design information contained in this document has been reviewed and satisfies (where applicable) the item contained on check list(s) 6a, ___, and ___ of the Quality Assurance of Design Manual. This review is so certified.

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LIST OF ABBREVIATIONS

CETC	Core Exit Thermocouples
CFMS	Critical Function Monitoring System
CNMT	Containment
HJTC	Heated Junction Thermocouples
ICC	Inadequate Core Cooling
PCM	Page Control Module
PDU	Plasma Display Unit
QSPDS	Qualified Safety Parameter Display System
RCS	Reactor Coolant System
RVL	Reactor Vessel Level
SATM	Saturation Margin

1.0 PURPOSE

The purpose of this document is to specify the functional design of the Qualified Safety Parameter Display System (QSPDS) display. These pages will describe:

1. The characteristics of the display hardware
2. How information is organized into pages
3. The format of pages
4. The behavior of the display during normal, alarm, and post-alarm states.
5. The behavior of the display in response to operator input.

2.0 SCOPE

This specification applies to the generic QSPDS developed to meet reference 1. Plant specific displays are designed from the plant specific QSPDS functional design specification (reference 3) and specified in the plant specific display document (reference 2).

3.0 DISPLAY CHARACTERISTICS

The Plasma Display Unit is a plasma dot matrix having the characteristics listed in Table 3.1.

The PDU has a limited capability for displaying blinking alphanumerics. This feature is achieved not in hardware but by a firmware routine that repeatedly plots the fields using modes write and inverse alternately.

Display rates for alphanumerics and graphics should be taken into consideration when designing plant specific page formats.

TABLE 3.1

DISPLAY CHARACTERISTICS

Size:	8.5 x 8.5 inches
Addressable Points:	512 x 512 = 262,144
Resolution:	60 dots per inch
Color:	Neon orange
Alphanumerics:	
Character Sets:	7 x 10 U.C. letters, numerals, punctuation, and special characters in 8 x 16 dot matrix. Height = 0.167 in (0.423 cm). 8 x 16 U.C. letters and numerals in 8 x 16 dot matrix. Height = 0.267 in (0.677 cm).
Locating:	any point
Modes:	write (pattern dots on, background dots off) erase (pattern dots off, background dots unchanged) overstrike (pattern dots on, background dots unchanged) inverse (pattern dots off, background dots on) blink (alternating write and inverse modes)
Screen Capacity:	64 characters per line x 32 lines
Rate:	Up to 270 characters per second
Graphics:	
Vector Plotting:	any length from/to any point
Modes:	write, erase
Rate:	up to 80 vectors per second

4.0 ORGANIZATION OF DATA

QSPDS data is organized into a hierarchy of pages compatible with the Critical Function Monitoring System (CFMS). Figure 4.1 shows the page hierarchy. The page layouts are shown in the Appendices.

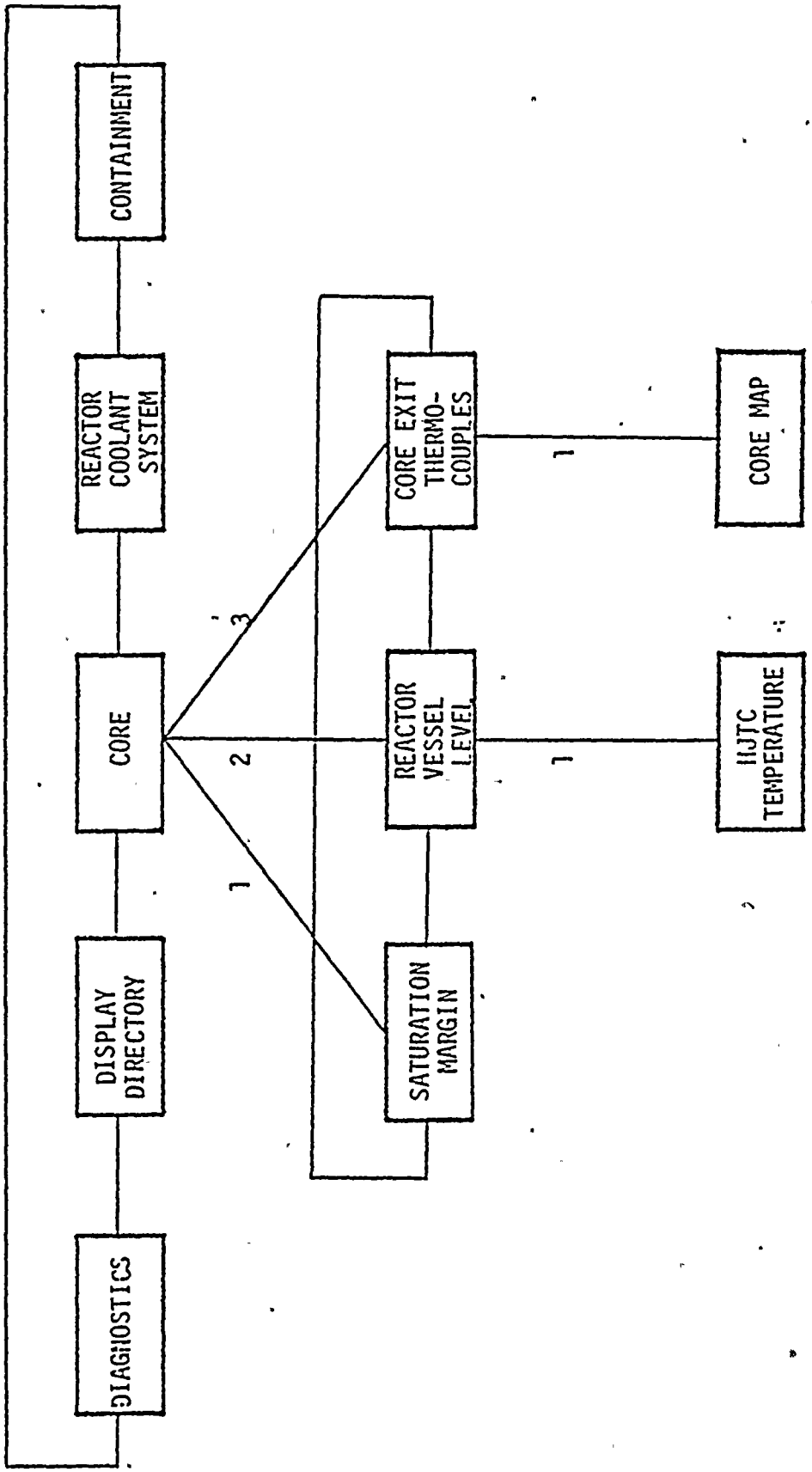
4.1 The QSPDS parameters are organized into three top level systems: Core, Reactor Coolant System (RCS), and Containment (CNMT). Three pages at the top of the hierarchy (level one) are dedicated to these systems. These pages display the minimum set of SPDS parameters as a backup to the CFMS for seismic conditions. The top level ICC parameters are displayed under the Core Heat Removal function on the Core page.

At level two, there are three sector pages which provide increased detail for the ICC variables on the Core page: Saturation Margin (SATM), Reactor Vessel Level (RVL), and Core Exit Thermocouples (CETC).

At level three, there are two sector pages which provide increased detail for the RVL and CETC pages: Heated Junction Thermocouples (HJTC) and Core Map.

4.2 Also at level one of the page hierarchy are a directory page and a diagnostic page. Additional pages may be added at any level to meet plant specific needs.

Figure 4.1 PAGE HIERARCHY



5.0 PAGE FORMATS

Display pages are designed to present information clearly and concisely. Page loading is low. The parameters displayed on each system page are organized into several groups with a subtitle and a surrounding frame for separation. The ICC supporting pages are specially designed to give the best presentation.

The display pages consist of two types of data: static and dynamic.

5.1 STATIC PAGE DATA

Static page data is written on the display when the page is initially selected and is unchanged when the page is updated. Static page data includes the following:

Page Title:	8 x 16 letters centered near the top
Page Number:	Three 7 x 10 digits in upper right corner
Frames:	Rectangular boxes framing parameters that are logically related.
Subtitles:	7 x 10 letters describing frames or tables
Column Headings:	7 x 10 letters labeling tables
Parameter Names or IDs:	7 x 10 letters describing parameters
Units:	7 x 10 letters and/or special characters describing measurement units
Graphics:	Fixed portion of a graph or drawing.

5.2 DYNAMIC PAGE DATA

Dynamic page data may be changed when a page is updated and includes the following:

1. Heartbeat: 8 x 8 rectangle in upper left corner is redrawn solid or clear (alternately) each time the page is updated.

2. System Alarm Indicators: Legends for the three systems (consisting of 7 x 10 letters and page numbers) are enclosed by small frames at bottom center of each page. The legends are rewritten each time the page is updated. The mode indicates the alarm status of each system.

3. Parameter Values: 7 x 10 alphanumerics representing analog or binary parameter values are rewritten each time the page is updated. The mode indicates the alarm status of each parameter. Table 5.2.1 shows the formats used for parameter values.

4. Sector Numbers: 8 x 16 numerals indicating relevant sector pages (if any) are rewritten each time the page is updated. The mode indicates the alarm status of each sector.

5. Graphics: Variable portions of a graph or a drawing are redrawn each time the page is updated.

6. System Error Message: 7 x 10 alphanumerics indicating a current QSPDS malfunction are rewritten in the lower right corner of the display in blink mode each time the page is updated.

7. Operator Error Message: 7 x 10 alphanumerics indicating a current operator error are written in the lower left corner of the display in inverse mode each time the page is updated.

TABLE 5.2.1
PARAMETER VALUE FORMATS

Integer	- 0000
Real	-000.0 -00.00 -0.000 -.0000
Exponential	-0.000 ± 00
Actuation/Initiation Parameter	ACTUATED - OFF
Valves, closed limit switch	CLOSED - NOT CLOSED
Valves, open limit switch	OPEN - NOT OPEN
Valves, closed and open limit switch	OPEN - THROTTLED - CLOSED
Reactor Trip	YES - NO
Breaker Position	OPEN - CLOSED

Note: Minus sign (-) appears only for negative values. No sign appears for non-negative values.

6.0 ALARM BEHAVIOR

The display is modified to attract and direct the attention of the operator when any of the following conditions occur:

1. Parameter Alarm
2. System Error
3. Operator Error

These conditions are described in the following paragraphs.

6.1 PARAMETER ALARMS

There are two types of parameter alarms: setpoint and bad data. The setpoint alarm occurs when a parameter value exceeds its high or low setpoint. (Note that not all parameters have setpoints.) The bad data alarm occurs when a parameter value exceeds its allowable range. This may be the result of an out-of-range sensor, a failed sensor, an electrical failure, or a software error.

When a parameter alarm occurs, the relevant* top level system enters the alarm state and the corresponding system alarm indicator on the current display page is shown in blink mode. If the parameter is shown on a lower level sector page, higher level pages will show the relevant sector numbers in blink mode. In the case of a setpoint alarm, the parameter value is shown in inverse mode with an adjacent asterisk. In the case of a bad data alarm, the parameter value field is filled with question marks in write mode with an adjacent asterisk.

* Some parameters may be shared by several systems but each parameter is considered to be essential to only one relevant system.

When the operator acknowledges a parameter alarm, the relevant system alarm indicator and sector numbers remain in inverse mode and a second asterisk is shown next to the parameter value field.

A summary of display behavior for parameter alarms is shown in Table 6.1.

6.2 SYSTEM ERROR

When a system hardware or software error is detected, the message "SYSTEM ERROR" is shown in blink mode in the lower right hand corner of the display. The diagnostic page gives a description of the system error. The system error message is displayed until the error is no longer detected.

6.3 OPERATOR ERROR

When an error is made at the PCM keyboard, a message is shown in write mode at the lower left corner of the current display page. The operator error messages include:

ENTER PAGE OR SECTOR FIRST
ILLEGAL EXECUTE
ILLEGAL PAGE NUMBER
ILLEGAL SECTOR NUMBER
NO SECTOR ZERO FROM HERE

An operator error message is shown for several seconds and then erased.

TABLE 6.1

ALARM BEHAVIOR

PAGE ELEMENTS	ALARM STATUS	ACK STATUS	MECHANISMS	EXAMPLES
System Alarm Indicators and Sector Numbers	Normal or Return to Normal	---	Write Mode	CORE PPP 2
	Parameter Alarm on Associated Page	UNACK	Blink Mode	CNMT PPP 2
		ACK	Inverse Mode	CNMT PPP 2
Parameter Value Fields	Normal or Return to Normal	---	Write Mode	123.4
	Setpoint Alarm	UNACK	Inverse Mode, 1 Asterisk	123.4*
		ACK	Inverse Mode, 2 Asterisks	*123.4*
	Bad Data Alarm	UNACK	Write Mode, Questions Marks, 1 Asterisk	??????*
		ACK	Write Mode, Questions Marks, 2 Asterisks	*??????*

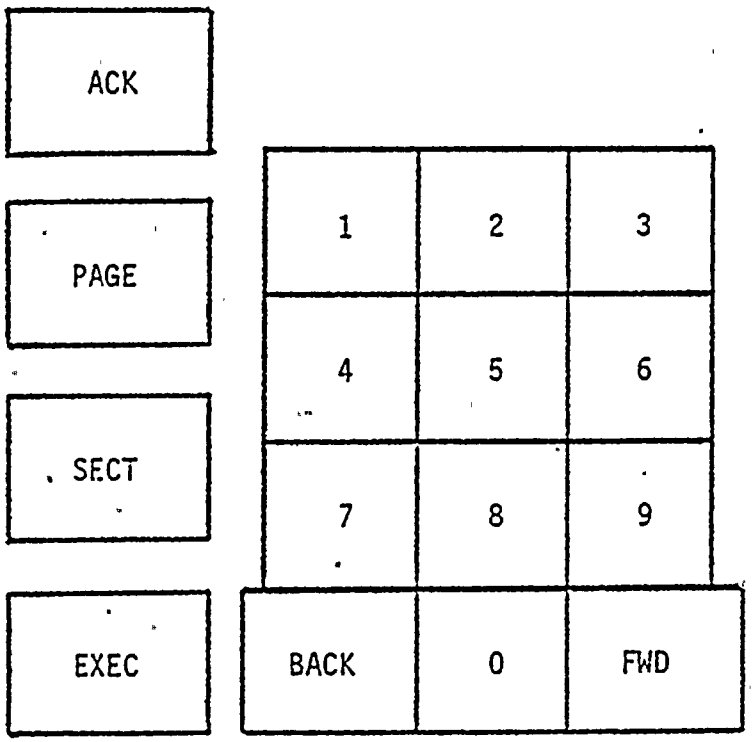
7.0 OPERATOR INTERFACE

The operator selects display pages and acknowledges alarm conditions via the Page Control Module (PCM) keyboard. Figure 7.1 shows the PCM keyboard layout. Table 7.1 describes the operation of the PCM keyboard.

TABLE 7.1
PCM KEYBOARD OPERATION

Operation	Keystrokes
Acknowledge any and all alarm conditions	ACK
Select an adjacent page at the current level	BACK or FWD
Select sector n relevant to current page	SECT n EXEC
Select any page by its 3-digit number	PAGE p p p EXEC
Select the relevant higher level page from a sector	SECT 0 EXEC

Figure 7.1 PCM Keyboard Layout



8.0 REFERENCES

1. Functional Design Specification for a Qualified Safety Parameter Display System, NPROD-ICE-3201.

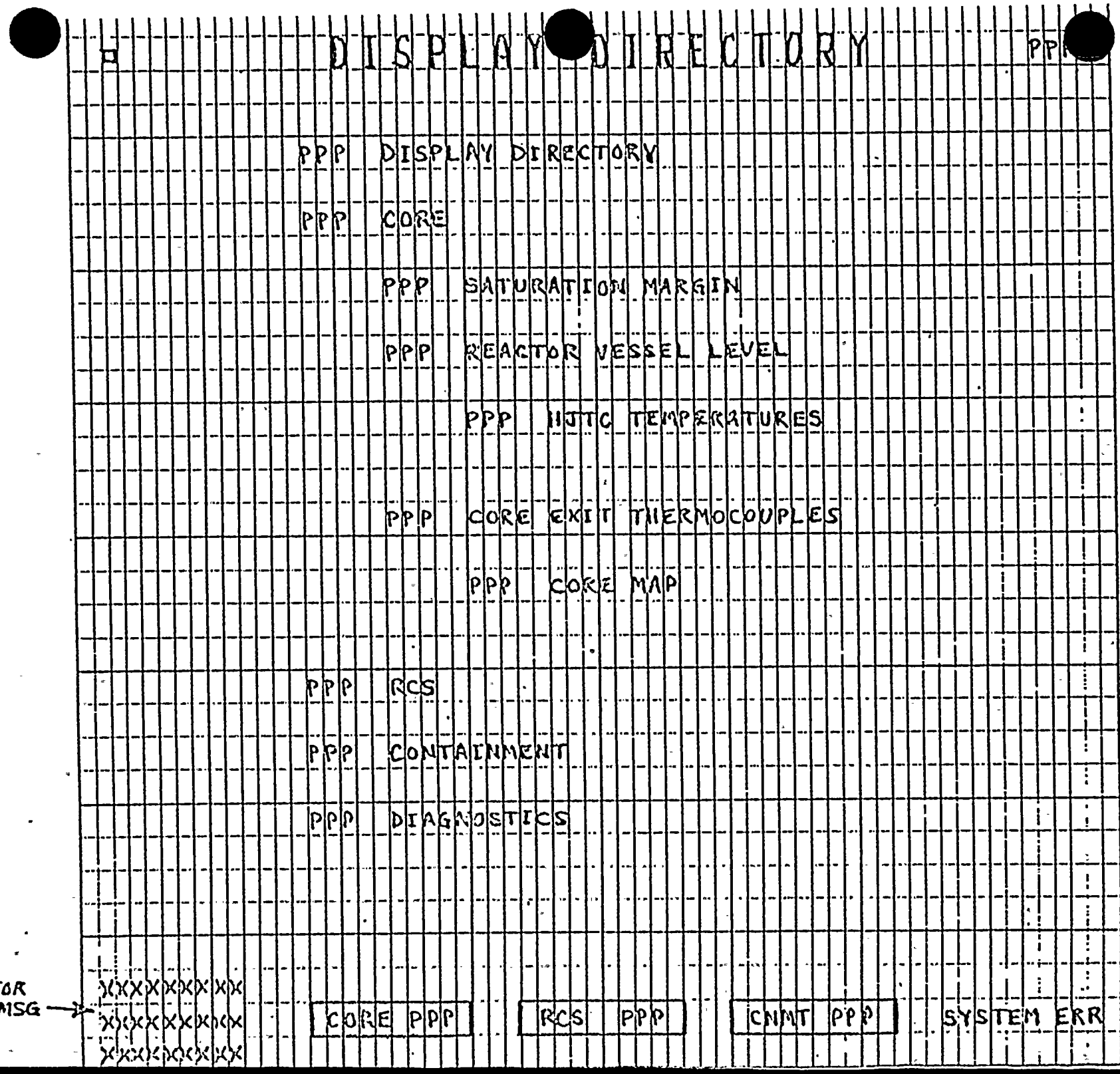
2. Functional Design Specification for the QSPDS Display for (specific plant), XXXXX-ICE-3220.

3. Functional Design Specification for a Qualified Safety Parameter Display System for (specific plant), XXXXX-ICE-3218.

4. QSPDS Data Base Document for (specific plant), XXXXX-ICE-3219.

APPENDIX

The Appendix contains the formats for QSPDS Channel A display pages. Channel B pages are identical to Channel A except for plant specific parameter identification differences.


DISPLAY DIRECTORY
PPP
PPP DISPLAY DIRECTORY
PPP CORE
PPP SATURATION MARGIN
PPP REACTOR VESSEL LEVEL
PPP HJTC TEMPERATURES
PPP CORE EXIT THERMOCOUPLES
PPP CORE MAP
PPP RCS
PPP CONTAINMENT
PPP DIAGNOSTICS
OPERATOR ERROR MSG
CORE PPP
RCS PPP
CNMT PPP
SYSTEM ERR

□ CORE PPP

REACTIVITY CONTROL

NEUTRON POWER ± 0.000±00 % POWER

CORE HEAT REMOVAL CONTROL

RCS/UPPER HD SATURATION MAR 1 ± 0000 DEG F XXXXXXXXX

REACTOR VESSEL LEVEL 2 ± 0000 % ABOVE CORE

CET SATURATION MAR 1 ± 0000 DEG F XXXXXXXXX

REP CET TEMP 3 ± 0000 DEG F

XXXXXXXXX
XXXXXXXXX | CORE PPP | RCS PPP | CNMT PPP | SYSTEM ERR

SUPERHEAT OR SUBCOOLED

SATURATION MARGIN

PPP

SATURATION MARGIN

	DEG F		PSI	
UPPER HEAD	± 0000	XXXXXXXXXX	±0000	XXXXXXXXXX
RCS	± 0000	XXXXXXXXXX	±0000	XXXXXXXXXX
CET	± 0000	XXXXXXXXXX	±0000	XXXXXXXXXX

SUPERHEAT OR SUBCOOLED

INPUTS

UPPER HEAD	TEMP	± 0000	DEG F
HOT LEG SG XXXX	TEMP	± 0000	DEG F
COLD LEG XX	TEMP	± 0000	DEG F
COLD LEG XX	TEMP	± 0000	DEG F
REP CET	TEMP	± 0000	DEG F
PRESSURIZER	PRESS	± 0000	PSIA

XXXXXXXXXX

REACTOR VESSEL LEVEL

PPP

RVL SENSOR INDICATION

UNHEATED T/C 1

'VOID' WHEN UNCOVERED, SOLID WHEN COVERED

TOP OF HEAD	1	VOID	± 0000	DEG F
	2		± 0000	DEG F
	3		± 0000	DEG F
	4		± 0000	DEG F
	5		± 0000	DEG F
	6		± 0000	DEG F
	7		± 0000	DEG F
	8		± 0000	DEG F
FUEL ALIGN PLATE				

REACTOR VESSEL LEVEL ± 0000 % ABOVE CORE

XXXXXXXXXX
XXXXXXXXXX

CORE PPP | RCS PPP | CNMT PPP | SYSTEM ERR

HJTC TEMPERATURE PPP

HJTC TEMPERATURES (DEG F)

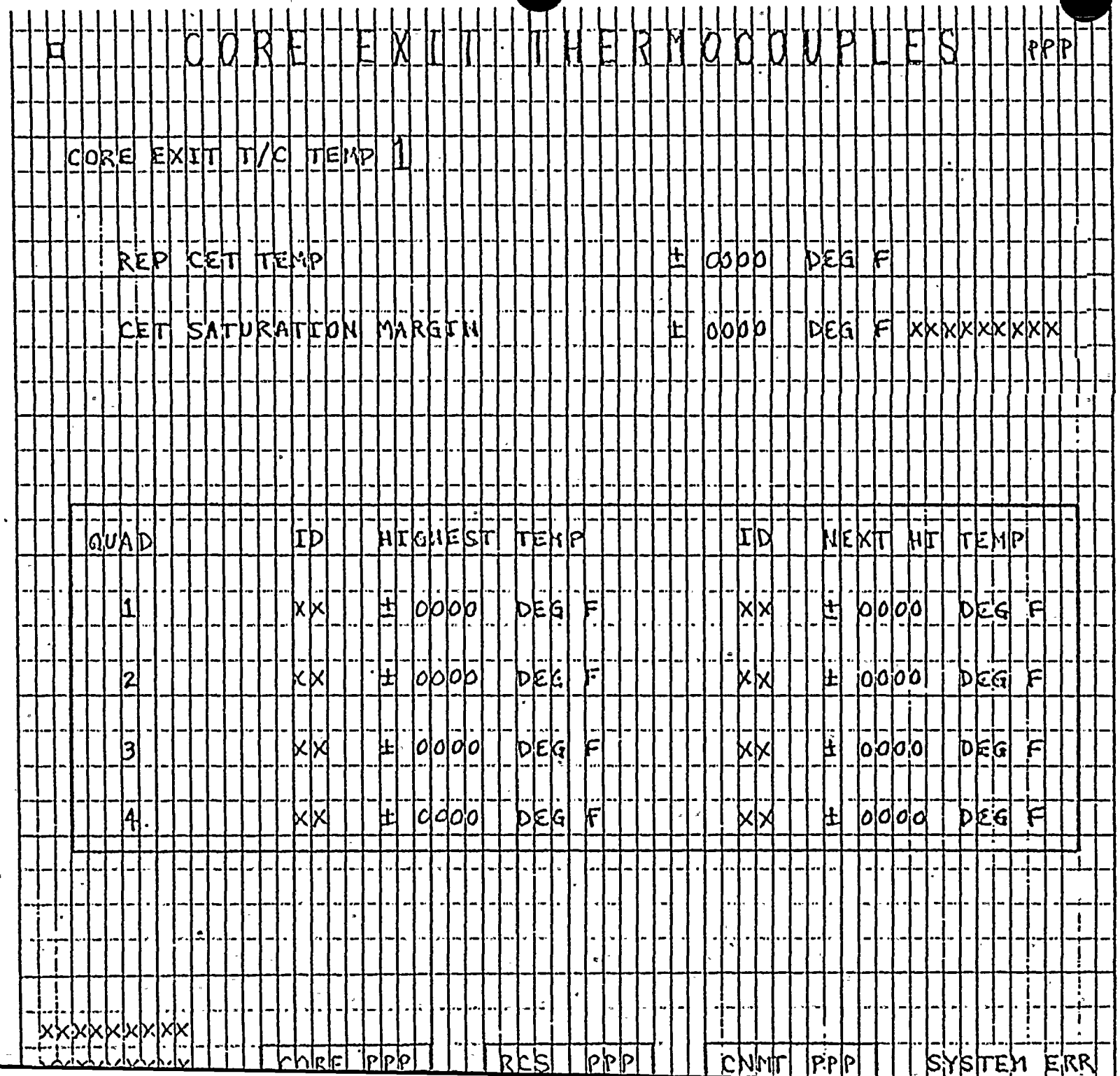
	UNHEATED	HEATED	DIFFERENTIAL
1	± 0000	± 0000	± 0000
2	± 0000	± 0000	± 0000
3	± 0000	± 0000	± 0000
4	± 0000	± 0000	± 0000
5	± 0000	± 0000	± 0000
6	± 0000	± 0000	± 0000
7	± 0000	± 0000	± 0000
8	± 0000	± 0000	± 0000

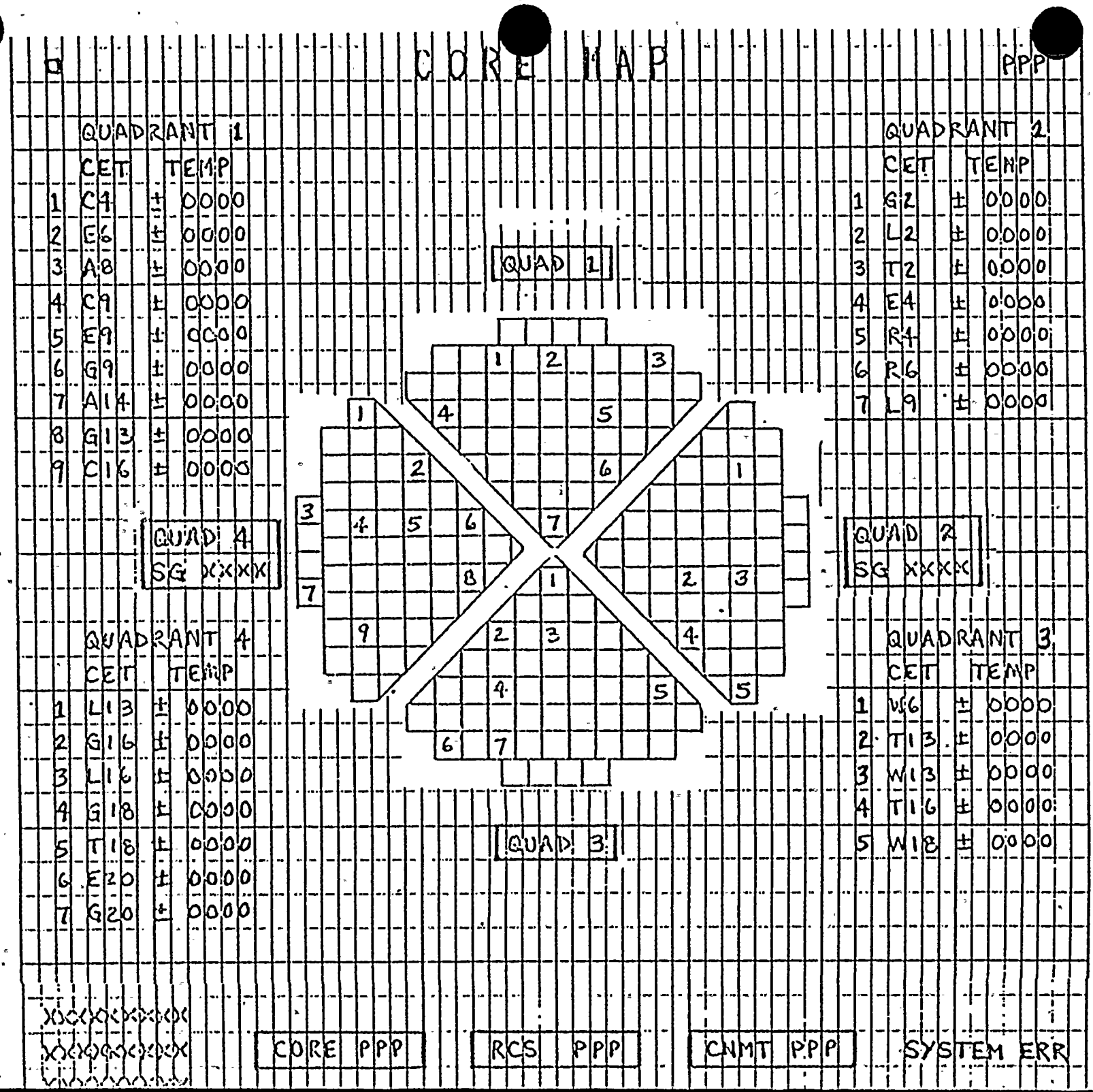
HEATER CONTROL SIGNAL 1 ± 0000 % FULL POWER
HEATER CONTROL SIGNAL 2 ± 0000 % FULL POWER

REACTOR VESSEL LEVEL ± 0000 % ABOVE CORE

XXXXXXXXXX
XXXXXXXXXX
XXXXXXXXXX

CORE PPP RCS PPP CNMT PPP SYSTEM ERR


E CORE EXIT THERMOCOUPLES PPP
CORE EXIT T/C TEMP 1
REP CET TEMP ± 0000 DEG F
CET SATURATION MARGIN ± 0000 DEG F XXXXXXXXX
QUAD ID HIGHEST TEMP ID NEXT HI TEMP
1 XX ± 0000 DEG F XX ± 0000 DEG F
2 XX ± 0000 DEG F XX ± 0000 DEG F
3 XX ± 0000 DEG F XX ± 0000 DEG F
4 XX ± 0000 DEG F XX ± 0000 DEG F
XXXXXXXXX
CORE PPP
RCS PPP
CNMT PPP
SYSTEM ERR



THIS IS A PLANT-SPECIFIC EXAMPLE OF A CORE MAP

□ **RCS** PFF

RCS HEAT REMOVAL CONTROL

HOT LEG SG XXXX TEMP	±	0000	DEG F
COLD LEG XX TEMP	±	0000	DEG F
COLD LEG XX TEMP	±	0000	DEG F
REACTOR VESSEL LEVEL	±	0000	% ABOVE CORE
STEAM GEN XXXX LEVEL	±	0000	%
STEAM GEN XXXX LEVEL	±	0000	%

RCS PRESSURE CONTROL

PRESSURIZER PRESS	±	0000	PSIA
RCS/UPPER HD SATURATION MAR	±	0000	DEG F XXXXXXXXX

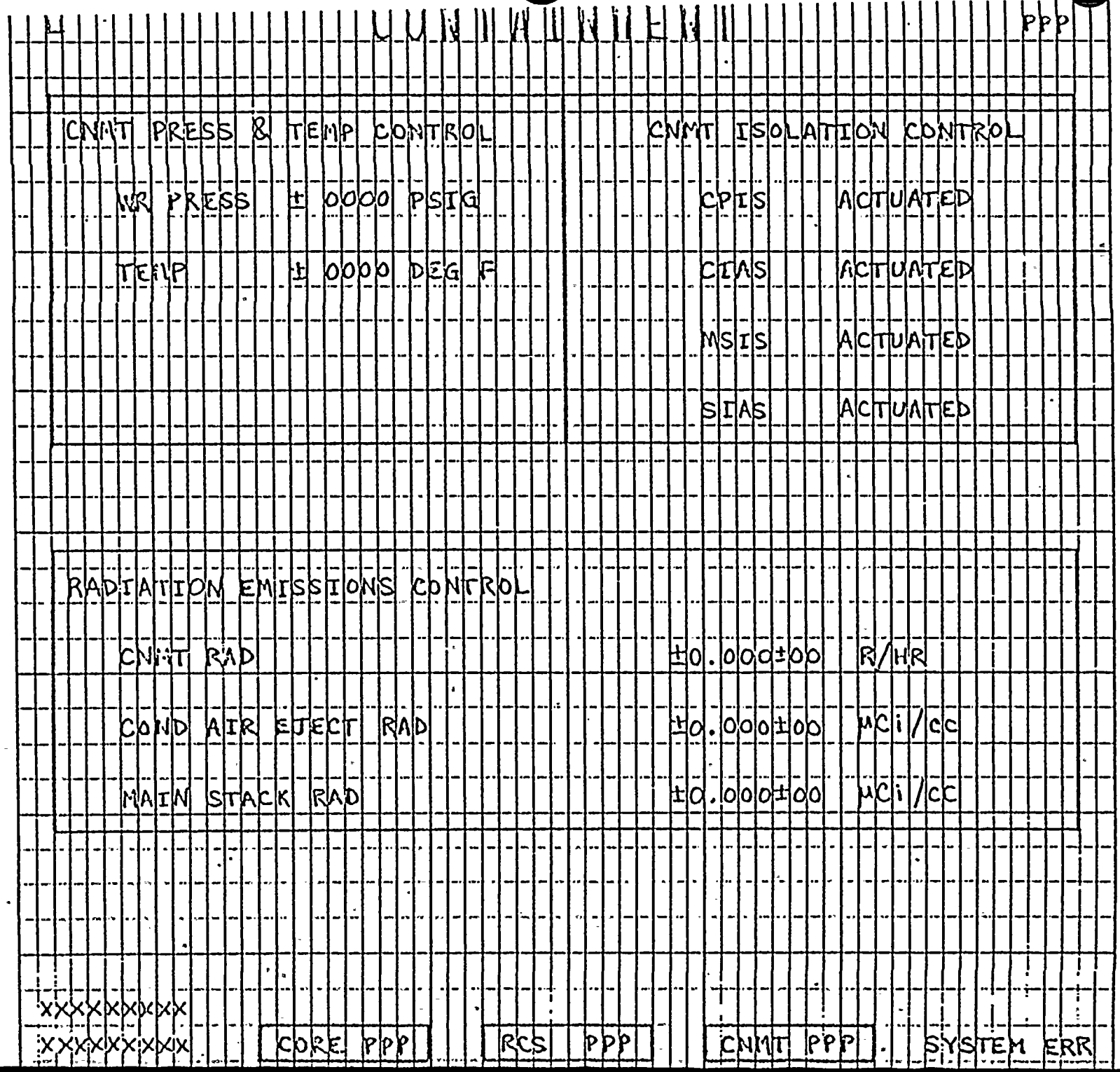
SUPERHEAT OR SUBCOOLED

RCS INVENTORY CONTROL

PRESSURIZER LEVEL	±	0000	%
REACTOR VESSEL LEVEL	±	0000	% ABOVE CORE

XXXXXXXXX

SYSTEM ERR


PPP
CNMT PRESS & TEMP CONTROL
WR PRESS ± 0000 PSIG
TEMP ± 0000 DEG F
CNMT ISOLATION CONTROL
CPIS ACTUATED
CIAS ACTUATED
MSIS ACTUATED
SIAS ACTUATED
RADIATION EMISSIONS CONTROL
CNMT RAD ±0.000±00 R/HR
COND AIR EJECT RAD ±0.000±00 µCi/cc
MAIN STACK RAD ±0.000±00 µCi/cc
XXXXXXXXX
XXXXXXXXX
CORE PPP
RCS PPP
CNMT PPP
SYSTEM ERR

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

XXXXXXXXX

XXXXXXXXX | CORE PPP | RCS PPP | CNMT PPP | SYSTEM ERR

XXXXXXXXX