Attachment 5

# DETAILED DESCRIPTIONS OF THE DISPLAYS FOR THE COOPER NUCLEAR STATION SAFETY PARAMETER DISPLAY SYSTEM (SPDS)

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# 1. INTRODUCTION

## 1.1 RELATIONSHIP BETWEEN THE PLANT MANAGEMENT INFORMATION SYSTEM (PMIS) AND THE SAFETY PARAMETER DISPLAY SYSTEM (SPDS)

The Cooper Nuclear Station (CNS) Safety Parameter Display System (SPDS) is a subsystem of an integrated computer system called the Plant Management Information System (PMIS). The PMIS is comprised of: (a) a modular, intelligent, multiplexed, front-end data acquisition subsystem, (b) redundant preprocessors, (c) modern, high-speed, real-time, multi-user, multi-tasking central processors coupled with operator-interactive software, and (d) color graphic display equipment. The PMIS incorporates the following functions: (a) all functions of the existing GE/PAC 4020 Plant Process computer, (b) the Safety Parameter Display System, (c) ability to characterize and predict radiological plumes, (d) the functions of the transient recording and analysis system, and (e) additional plant management systems. The PMIS will provide improvements in the ability of the plant operators and support staff to determine the status of the plant, avoid abnormal events, and react promptly to recover from adverse conditions. Human-factored CRT displays will assist the operators in assessing the plant status and will guide them in the response to abnormal plant conditions. Appropriate sample rates and on-line, long-term data storage and retrieval capabilities are provided to support post-transient analysis and core performance calculations. An overview of the various PMIS functions, including the SPDS, is shown in Figure 1-1.

The major hardware components of the PMIS are shown in Figure 1-2. The SPDS display terminals interface with the PMIS via rack-mounted modems, as shown in Figure 1-3; therefore, the SPDS is dependent on the PMIS data acquisition subsystem, preprocessors, and central processors.

To the extent practical, the SPDS utilizes available capabilities of the PMIS software. Special software is needed, however, for the following unique SPDS functions:

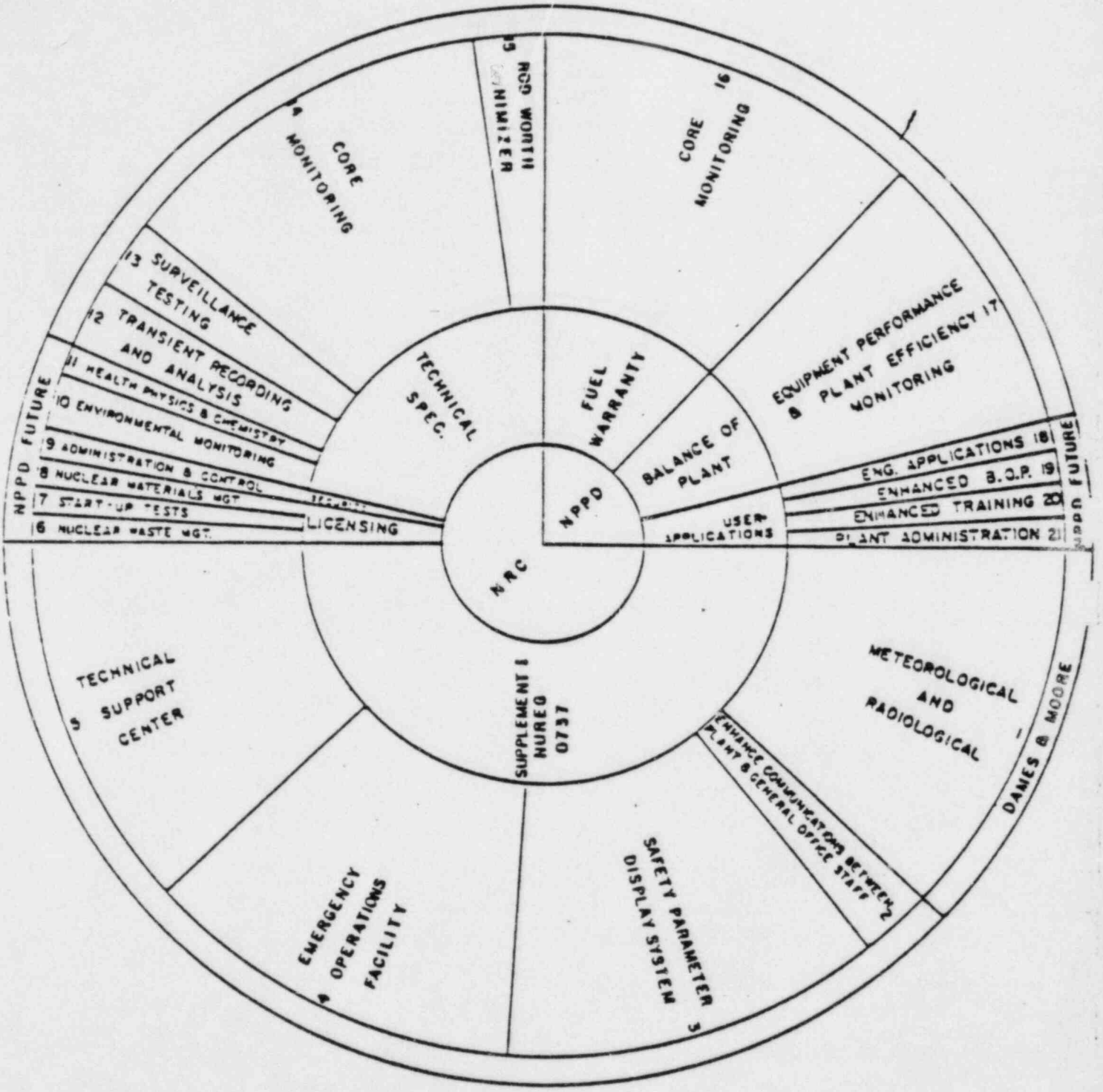


Figure 1-1. Functions of the CNS Plant Management Information System (PMIS).

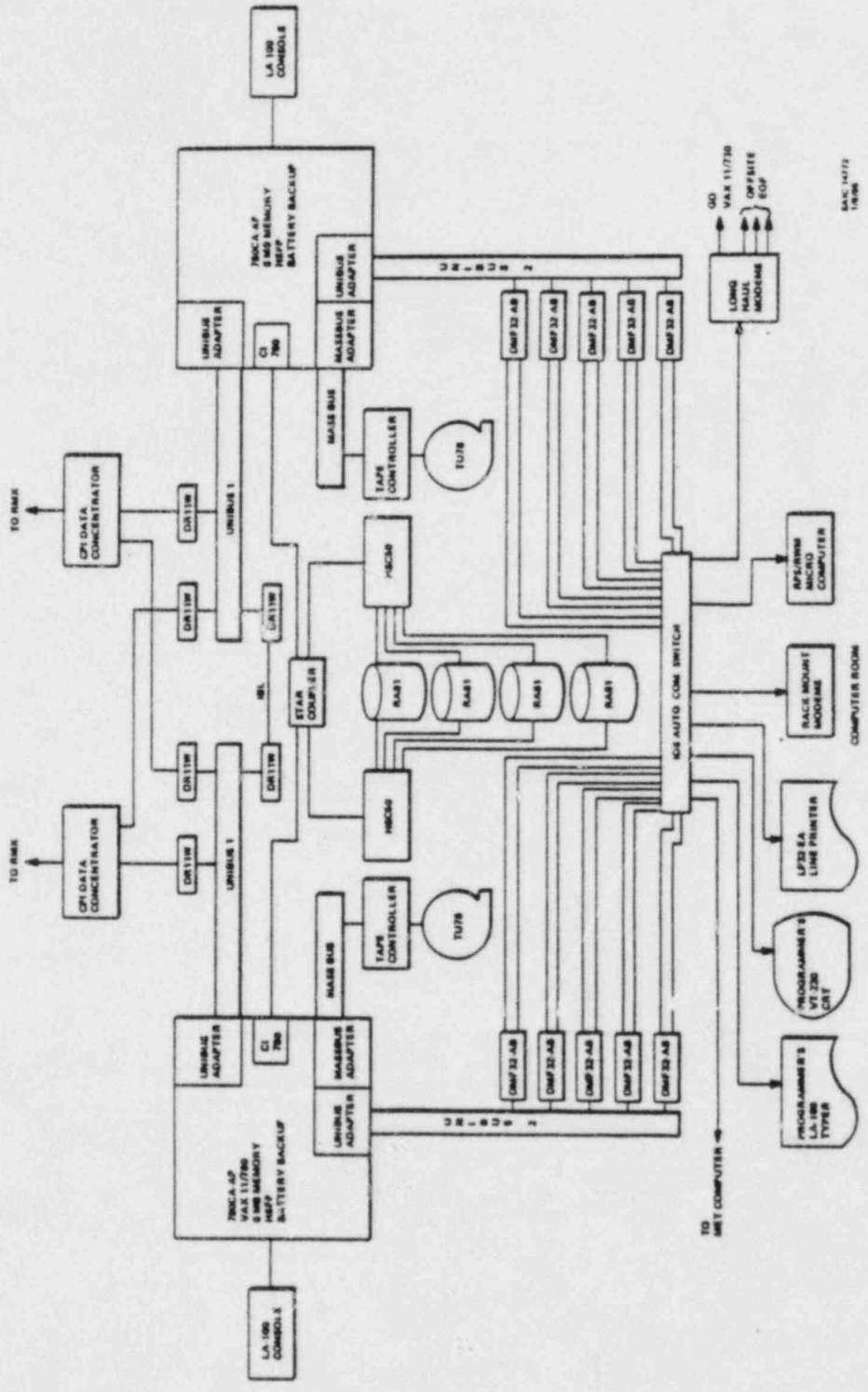


Figure 1-2. PMIS Hardware Configuration.

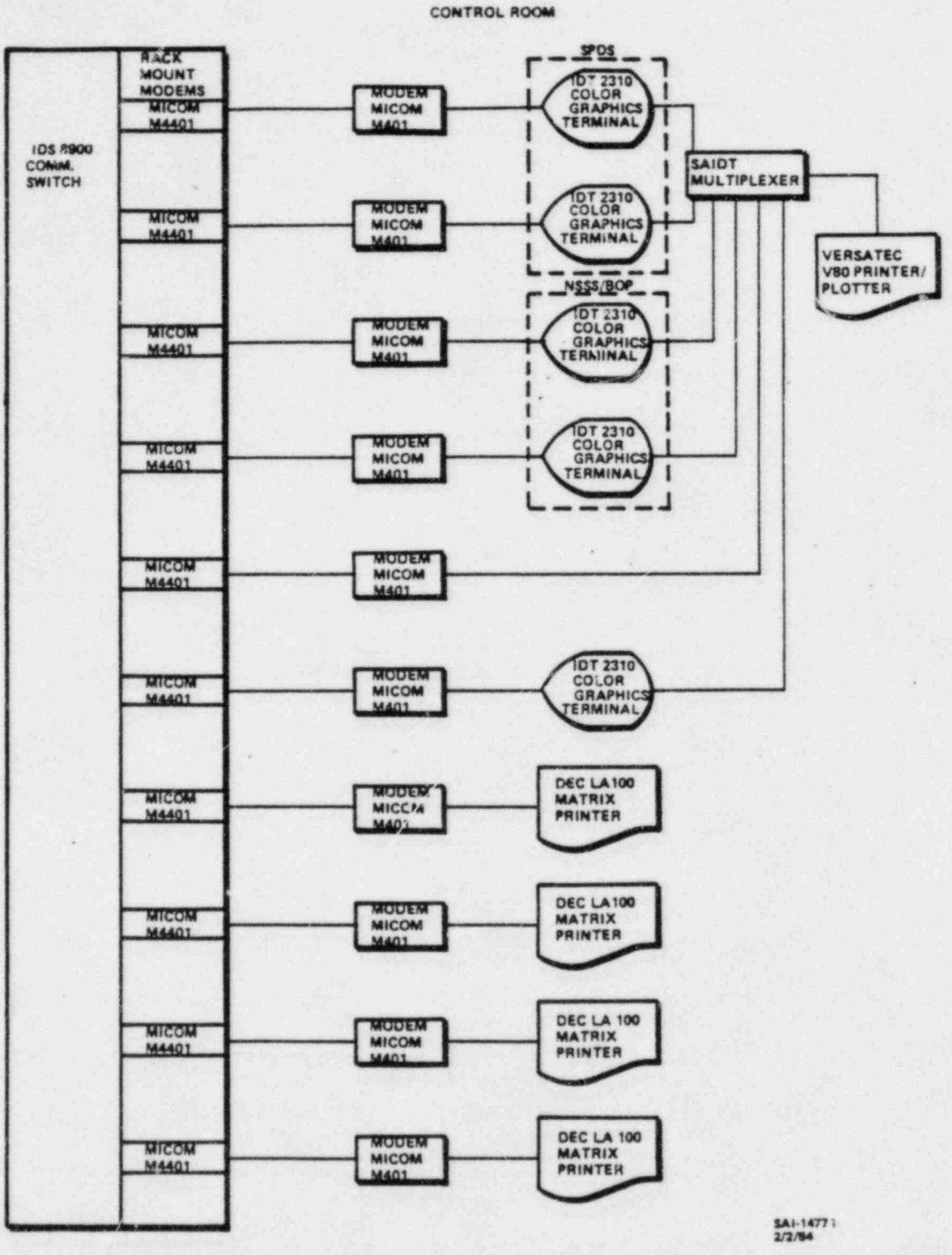


Figure 1-3. Control Room Input/Output Devices Supported by PMIS.

- Routines to support external (real) data points
  - Calculation of current value
  - Alarm/limit checking
  - Assignment of quality code
  - Interfacing with PMIS routines for updating the current value table

- Routines to drive displays or display features not supported by the PMIS display compiler

- Routines to support data validation features of the SPDS that supplement those performed by the PMIS

PMIS hardware and software must be viewed as an integral part of the SPDS. The role of the SPDS, however, is unique among PMIS subsystems.

## 1.2 PURPOSE OF THIS REPORT

This report contains a detailed description of the Safety Parameter Display System developed for the Cooper Nuclear Station. It defines SPDS data requirements, display format and content, and the manner in which the individual displays and specific display features are expected to operate. Also described in this report are external calculations and data validation functions that are performed separately by the SPDS. Separate documentation is provided for: (a) PMIS hardware and software needed to support the SPDS, (b) human factors guidelines, (c) SPDS safety analysis, and (d) special SPDS software. See Section 1.4 for a list of references to these other documents.

## 1.3 OVERVIEW OF THE SPDS DISPLAYS

The SPDS subsystem of the PMIS consolidates important plant parameters into unique displays that provide information: (a) on the status of plant safety functions, and (b) to support the use of symptom-oriented Emergency Operating Procedures (EOPs). The information presented to the control room operators via the SPDS is structured into a three-level hierarchy of color graphic displays as shown in Figure 1-4. In summary, the three levels of the SPDS display hierarchy are the following:

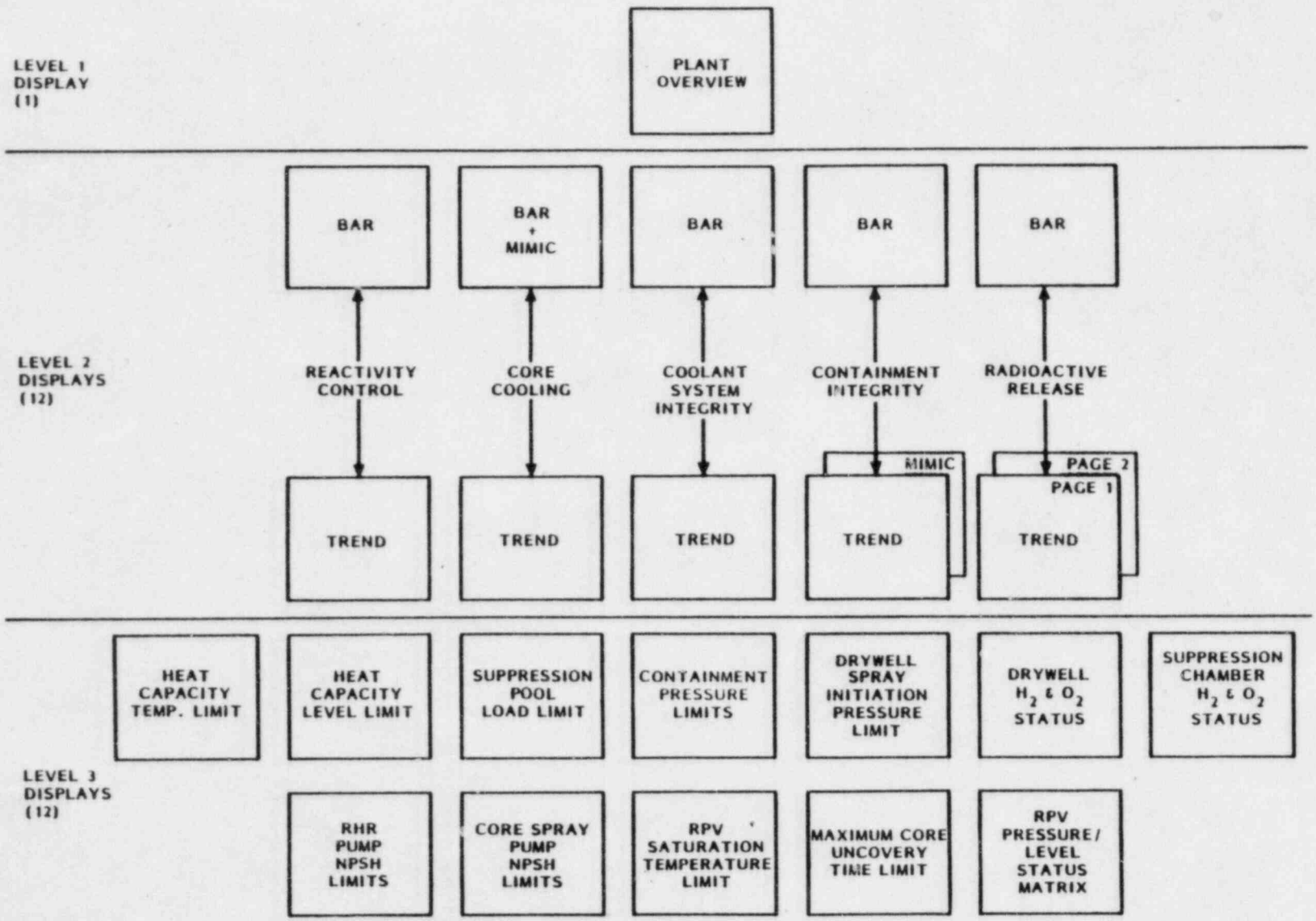


Figure 1-4. Hierarchy of SPDS Displays for the Cooper Nuclear Station.

- Level 1 display (Plant overview)
- Level 2 displays (Safety functions)
- Level 3 displays (EOP support)

The basic CRT screen format used in the CNS SPDS is shown in Figure 1-5. The detailed format, content and operation of each SPDS display was developed with careful consideration of the guidance in the Human Factors Plan (document 503-8500000-77). A general description of the CNS SPDS display hierarchy follows.

### 1.3.1 Level 1 Display (Plant Overview)

A key feature of the CRT layout shown in Figure 1-5 is the SPDS Status Area (SSA) which includes five rectangular blocks, or Safety Function Indicators (SFIs) that show, at a glance, the current status of the following five safety functions:

- Reactivity control
- Core cooling (and heat removal from the primary system)
- Coolant system integrity
- Containment integrity
- Radioactive release

Level 2 displays provide more detailed information on plant variables related to each safety function.

Each SFI block in the SSA is color- coded to indicate the current status of the safety function. Each SFI is controlled by an external (real) data point that is calculated by SPDS software using appropriate plant variables associated with the corresponding Level 2 displays. For example, during normal power operation, all Safety Function Indicators will be GREEN. An SFI block will change to display YELLOW (warning condition), RED (alarm condition), or MAGENTA (data validation problem) as dictated by the current value of the external (real) data point which drives the SFI. A complete description of the operation of the five Safety Functions Indicators is contained in Section 5.

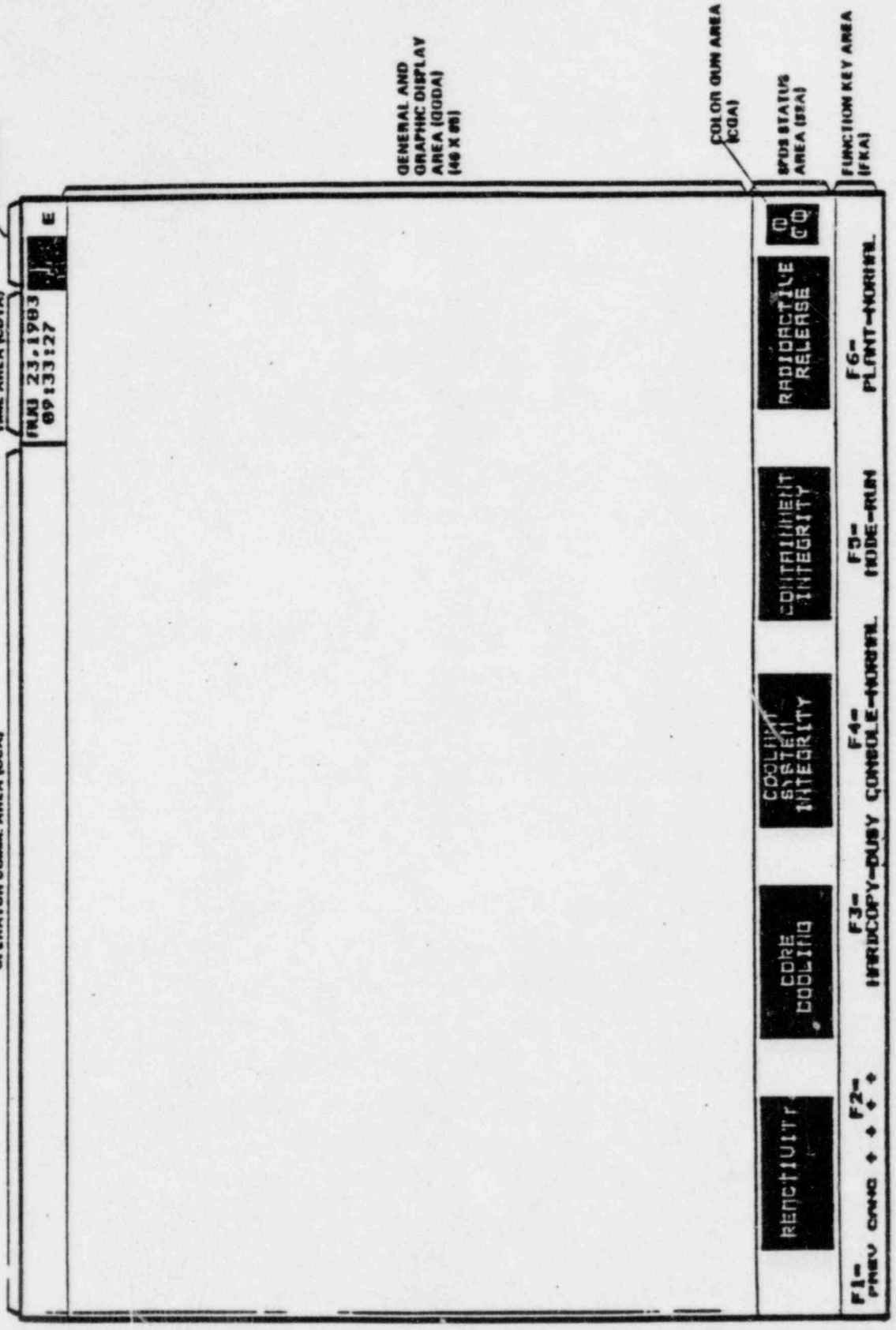


Figure 1-5. Basic CRT Layout for the Cooper Nuclear Station SPDS.

The Level 1 display for the CNS SPDS is actually the SPDS Status Area, which appears in the same location on all SPDS displays. Regardless of which SPDS display is being viewed, the operator is constantly appraised of the current status of plant safety functions. The Level 1 display is therefore linked directly to all other displays in the three-level hierarchy of SPDS displays.

To provide additional information of an overview nature, the following plant variables are displayed in the General and Graphic Display Area (GGDA, see Figure 1-5) of the Level 1 (L1.0) display:

- Average Power Range Monitor (APRM, average)
- Reactor Pressure Vessel (RPV) pressure
- RPV water level (narrow range)
- Drywell pressure (narrow range)

These variables are displayed as horizontal bar charts. Also included in the GGDA are two Equipment Status Indicators (ESIs) and an EOP Limit Status Indicator (EOPSI) that are intended to extend the usefulness of this display. Characteristics of the Level 1 display are discussed in detail in Section 7.

### 1.3.2 Level 2 Displays (Safety Functions)

The Level 2 displays consist of bar charts, trends plots, and mimics, as appropriate to indicate the current value and trend of key variables related to each of the safety functions identified previously. The Level 1 Safety Function Indicators appear in the SPDS Status Area of every Level 2 display. In addition, a variety of Equipment Status Indicators (ESIs) and Emergency Operating Procedure Limit Status Indicators (EOPSIs) are included in the General and Graphic Display Area of selected Level 2 displays. The EOPSIs provide a communications link from the Level 3 displays up to the appropriate Level 2 displays. There are twelve Level 2 displays, as follows:

- L2.1.1, Reactivity control (bar)
- L2.1.2, Reactivity control (trend)
- L2.2.1, RPV water level (bar/RPV mimic)

- L2.2.2, Core cooling (trend)
- L2.3.1, Coolant system integrity (bar)
- L2.3.2, Coolant system integrity (trend)
- L2.4.1, Containment integrity (bar)
- L2.4.2, Containment integrity (trend)
- L2.4.3, Suppression chamber mimic
- L2.5.1, Radioactive release (bar)
- L2.5.2, Radioactive release (trend page 1/2)
- L2.5.3, Radioactive release (trend page 2/2)

Characteristics of the Level 2 displays are discussed in detail in Section 8.

### 1.3.3 Level 3 Displays (EOP Support)

The Level 3 displays are at the lowest level of the SPDS display hierarchy. These displays consist of graphic plots that show the proximity of the plant to multiple-parameter limits curves or decision points that are specified in the plant Emergency Operating Procedures (EOPs). In addition, the Level 1 Safety Function Indicators appear in the SPDS Status Area of every Level 3 display. The following limit curves defined in the EOPs are included in twelve Level 3 displays in the CNS SPDS:

- L3.1, Heat capacity temperature limit
- L3.2, Heat capacity level limit
- L3.3, Suppression pool load limit
- L3.4, Containment pressure limits (3 superimposed limit curves)
  - Pressure suppression pressure limit
  - Primary containment pressure limit
  - Primary containment design pressure
- L3.5, Drywell spray initiation pressure limit
- L3.6, Drywell hydrogen and oxygen status
- L3.7, Suppression chamber hydrogen and oxygen status
- L3.8, RHR pump NPSH limits
- L3.9, Core spray pump NPSH limits
- L3.11, RPV saturation temperature limit

- L3.12, Maximum core uncovery time limit
- L3.15, RPV pressure/level status matrix

Proximity to these limits determines the status of the EOPSIs which are included in the Level 1 and Level 2 displays. Another important linkage among SPDS displays is provided by the System Alarm Area Indicator which displays a MAGENTA "E" in the System Alarm Area (SAA, see Figure 1-5) of all SPDS displays whenever any EOPSI is in a warning or alarm state. This indicator is "blank" when all EOPSIs are in a normal state. Characteristics of the Level 3 displays are discussed in detail in Section 9.

## 1.4 OTHER PMIS AND SPDS DOCUMENTATION INCORPORATED BY REFERENCE

As stated in Section 1.2, the scope of this document is limited, and it is not intended to be a stand-alone design document for the SPDS. This document implements or interfaces with the following other reference documents that were generated in support of the NPPD Plant Management Information System project:

- Functional Specification, 501-8500109-26,
- Detailed Design Volume I - Software, 502-8500110-1
- Detailed Design Volume II - Interface, 502-8500110-2
- Point I/O Summary, 501-8500103-27
- Human Factors Plan, 503-8500000-77
- Safety Parameter Display System Safety Analysis, 503-8500000-76

# 2. DATA QUALITY, DATA VALIDATION AND GENERAL DISPLAY CHARACTERISTICS DESIGN GUIDELINES

## 2.1 DATA QUALITY

Each time a field input point is sampled by the PMIS, a data quality code is appended to the current value. The PMIS data quality codes are listed in Table 2-1. The quality and limit checks are performed in the order listed in Table 2-1 (i.e., from 00 to 18). If all checks are satisfactory, the point is assigned a quality of GOOD, otherwise it is assigned the quality of the first check that is failed. Sensor and alarm zones that are considered when establishing data quality are illustrated in Figure 2-1. The following information needed to perform the relevant quality checks is specified in the PMIS data base definition of each data point:

- Processing control logicals
- Warning limits (high, low)
- Alarm limits (high, low)
- Engineering limits (high, low)
- Redundant point ID and tolerance (if applicable)
- Initialization data quality (if desired)
- Alarm cutout point and alarm cutout status (if applicable)

The quality code of a calculated data point can be determined by propagating the worst quality code of any of the inputs to the calculation. To the extent practical, the SPDS calculations are performed using "healthy" inputs as described below.

### 2.1.1 Definition of "Healthy" Data

In many cases, a valid result can be calculated even when one or more "poor" quality input points are rejected from the calculation. To take advantage of this, the quality code of any rejected input point is not considered in a "healthy" calculation, and the quality code assigned to the

Table 2-1. Data Quality Codes*

| No. | Code | Description | PMIS Default Color |
|---|---|---|---|
| 00 | UNK | Unknown, point not yet processed | White |
| 01 | DEL | Point deleted from processing (first processing control logical = N) | Magenta |
| 02 | NCAL | Could not calculate a software computer point (insufficient healthy inputs to calculation) | Magenta |
| 03 | INVL | Data acquisition system front-end hardware error (assigned by data acquisition system) | Magenta |
| 04 | RDER | Sensor read error (assigned by data acquisition system) | Magenta |
| 05 | OTC | Open thermocouple detection (assigned by data acquisition system) | Magenta |
| 06 | BAD | Input counts out of sensor range (assigned by data acquisition system) | Magenta |
| 07 | HRL | Point above high reasonable limit (EU high) in PMIS data base | Magenta |
| 08 | LRL | Point below low reasonable limit (EU low) in PMIS data base | Magenta |
| 09 | REDU | Redundant point check alarm based on redundant point definition and tolerance in PMIS data base | Magenta |
| 10 | HALM | Point above high alarm limit in PMIS data base | Red |
| 11 | LALM | Point below low alarm limit in PMIS data base | Red |
| 12 | HWRN | Point above high warning limit in PMIS data base | Yellow |
| 13 | LWRN | Point below low warning limit in PMIS data base | Yellow |

Table 2-1. Data Quality Codes*

| No. | Code | Description | PMIS Default Color |
|---|---|---|---|
| 14 | ALM | Logical change-of-state alarm on digital or logical points | Red |
| 15 | SUB | Substitute value assigned to point (assigned by PMIS based on operator input of substitute value via man-machine interface) | Blue |
| 16 | DALM | Point deleted from alarm processing (second processing control logical = N, no quality or limit checks are performed on the point) | Green |
| 17 | INHB | Alarm inhibited by an alarm cut-out point specified in PMIS data base (data is good, but the alarm function has been inhibited by a prescribed plant or system condition that can be defined in terms of the status of a digital alarm cutout point) | Green |
| 18 | GOOD | Good | Green |

*Note that the first 9 quality codes, (UNK to LRL) are considered to represent "not-healthy" data. Quality codes from REDU to GOOD are considered to represent "healthy" data, and are used in "healthy" calculations.

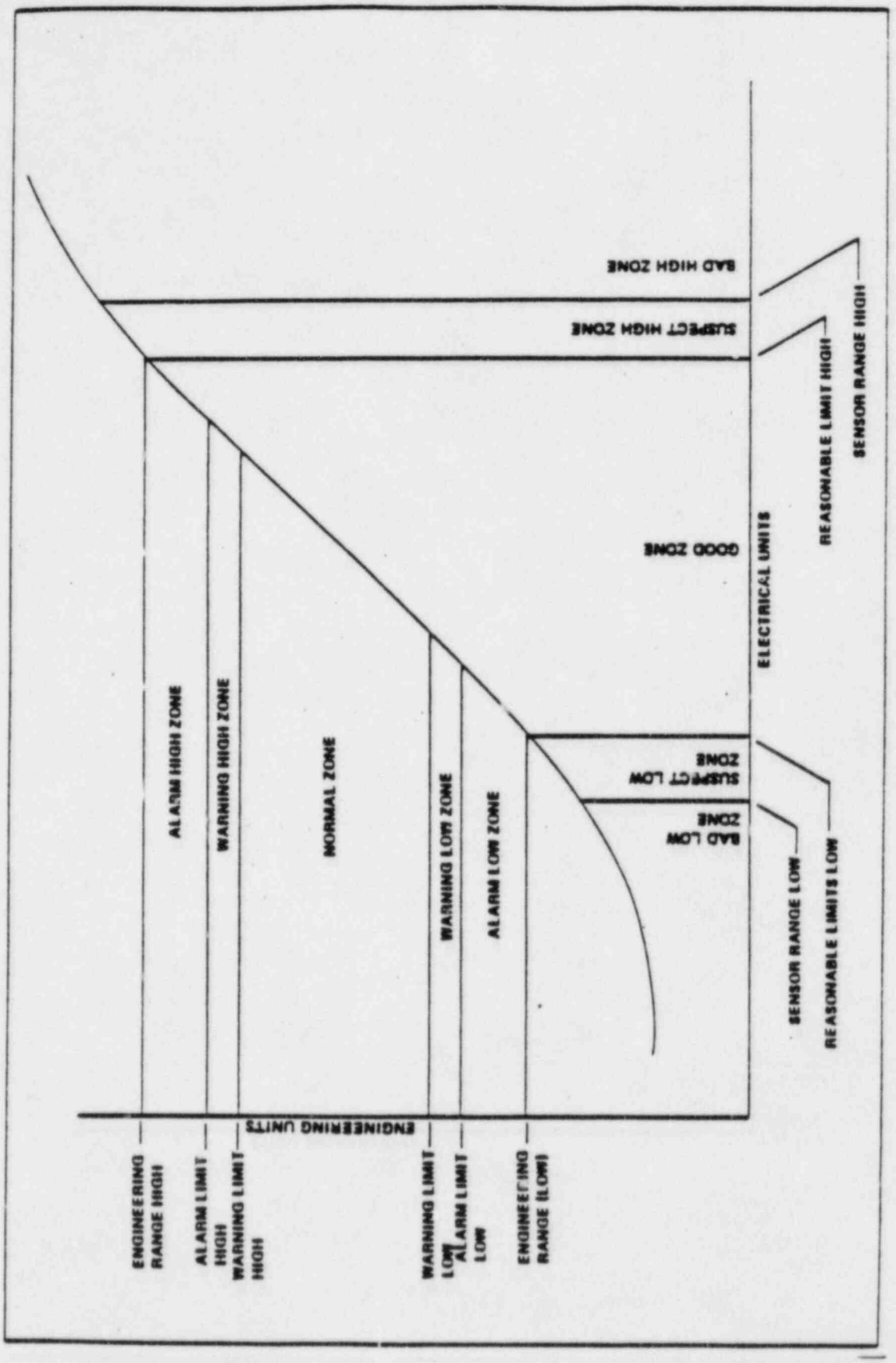


Figure 2-1. Sensor and Alarm Zones.

result is the worst quality code of the remaining inputs. This approach is taken in the following cases: (a) the "healthy average" and "healthy maximum" pseudo-analog calculations that can be performed by the PMIS, (b) the "healthy OR" and "healthy AND" Boolean operations that can be performed by the PMIS, and (c) special calculations that are performed for external (real) data points used by the SPDS.

An SPDS "healthy" calculation will only include input points whose quality code is one of the following:

REDU HALM LALM HWRN LWRN ALM SUB DALM INHB GOOD

Points with the following quality codes should be excluded from "healthy" calculations.

UNK DEL NCAL INVL RDER OTC BAD HRL LRL

Healthy calculations are described in Section 3.2. When a healthy result cannot be calculated because of the unavailability of an adequate number of healthy inputs, a quality of NCAL is assigned to the result.

2.1.1.1 Basis for Treating REDU Quality Data as Healthy Data

The PMIS data base allows an analog point to be designated as the redundant counterpart of one other analog point. When these two points differ by more than a specified tolerance, and all prior quality and limit checks have been satisfactory, both points are assigned a quality of REDU. In this case, the SPDS cannot judge which data point, if any, is at fault. For this reason REDU quality data is assumed to be healthy, and further resolution by the operators is needed.

It is possible that an REDU quality will be assigned simply because the PMIS redundant tolerance limit was set too small. Operating experience with the SPDS will identify this type of problem. The corrective actions needed are to: (a) determine more appropriate redundant tolerance limits for the points in question, and (b) update the PMIS data base to reflect the revised tolerances.

An REDU quality also will be assigned when equipment or instrumentation associated with one of the two redundant points experiences excessive drift or a fault of some type. The corrective actions needed in this case are to: (a) determine which point is at fault, and (b) restore the faulted point to normal operation, or (c) delete the faulted point from scan if b, above cannot be accomplished in a timely manner. When the faulted point is deleted from scan, its quality is set to DEL, and the redundant point check is not performed on the redundant counterpart point.

2.1.1.2 Basis for Treating HALM, LALM, HWRN and LWRN Quality Data as Healthy Data

The quality codes HALM, LALM, HWRN and LWRN are assigned based on a comparison of the current value of an analog, pseudo-analog, transform or external (real) point with warning and alarm limits specified in the PMIS data base. One of these quality codes can be assigned only if all prior quality and limit checks have been satisfactory. It therefore is expected that the point represents healthy data.

2.1.1.3 Basis for Treating ALM Quality Data as Healthy Data

The qualify code ALM is assigned based on a comparison of the current value of a digital, Boolean or external (logical) point with alarm states specified in the PMIS data base. This quality code is assigned only if all prior quality and limit checks have been satisfactory. It therefore is expected that the point represents healthy data.

2.1.1.4 Basis for Treating DALM and SUB Quality Data as Healthy Data

All SPDS rate-of-change (ROC) variables are assigned a quality code of DALM because the second processing control logical for these variables has been set to 'N' in the PMIS data base. Quality and limit checking has been suppressed for all SPDS ROC data because of the following considerations:

- No warning of alarm limits are specified in the PMIS data base for any SPDS ROC variables
- All ROC data is displayed in CYAN. (i.e., conventional GREEN, YELLOW, RED color coding is not used).

- All ROC data is displayed in conjunction with the current-value data from which the ROC is computed. This current value data is subject to PMIS and SPDS validation (see Section 2).
- With nly one exception, ROC data are not used in subsequent calculations. (The exception is the calculation of source range monitor reactor period, see Section 8.)

It should be noted that rate-of-change, by itself, is seldom an accurate measure of the "goodness" or "badness" of the current plant state (i.e., low but increasing RPV water level may be a "good" situation, while high RPV water level, increasing at the same rate, may be a "bad" situation. This example points to the fact that warning and alarm limits for ROC variables may be a function of the current value of the variable from which the ROC is calculated. This type of dependency cannot be represented in the PMIS data base. Displaying ROC data in CYAN avoids having to consider this type of dependency. Use of the CYAN color code should have no adverse impact on the use of the SPDS because ROC data is provided in the SPDS as supplementary information. The SPDS Safety Analysis* did not identify any ROC data that was directly related to safety function status or EOP entry conditions.

A substituted value (quality code SUB) is considered to be healthy because it is assumed that a substitute value will only be assigned for specific, controlled purposes such as: (a) SPDS testing, or (b) when PMIS data acquisition problems render an SPDS data point unavailable, but the value of the data point is known from another, reliable source. In both of these cases, it is necessary to treat a substitute value as a healthy data value in order to use it in any of the SPDS healthy calculations. If a substitute value were treated as not healthy, it would not be usable in determing the value of healthy SPDS composed points.

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*Safety Parameter Display System Safety Analysis, 503-8500000-76

It is the responsibility of the utility to control the use of the SPDS capabilities to delete a point from quality and limit checking and assign substitute values. With simple controls, it is expected that the operation and testing of the SPDS actually should be enhanced by considering, DALM and SUB quality data as healthy data.

2.1.1.5 Basis for Treating INHB Quality Data as Healthy Data

The quality code INHB is assigned to an analog, pseudo-analog, transform or external (real) point when a digital alarm cutout point changes states as specified in the PMIS data base description of the "analog" point. The digital alarm cutout point provides information on a plant or equipment state that negates the need for warnings and alarms from a particular "analog" point. This quality code can be assigned only if: (a) a digital alarm cutout point has been specified, (b) the alarm cutout point in the correct state, and (c) all prior quality checks have been satisfactory. It therefore is expected that the data point represents healthy data.

2.1.2 Relationship Between Quality Code and Color Fill

To the extent practical, the SPDS utilizes the PMIS default color assignments listed in Table 2-1 to define color fill based on data quality. For example, a bar chart generally will have a GREEN color fill when the associated data point has a quality code of GOOD or INHB. The bar color fill becomes YELLOW when the quality code is LWRN or HWRN (i.e., the current value is in a warning zone), and becomes RED when the quality code is LALM or HALM (i.e., the current value is in an alarm zone).

The following exceptions to the PMIS default color assignments are made in the SPDS displays: (a) color conventions for indicating pump and valve operating status are dictated by existing control room conventions (i.e., RED = ON/OPEN, GREEN = OFF/CLOSED, as described in Section 2.3), and (b) all rate-of-change data has a quality of DALM and is displayed in CYAN.

It should be noted that quality code color assignments are parameterized in a file named QUALITY.D. The color assignments can easily be changed if SPDS operating experience indicates that there is a better approach to relating data quality to color fill than the approach listed in Table 2-1.

## 2.2 DATA VALIDATION

### 2.2.1 PMIS Data Validation Techniques

A normal function of the PMIS is to check the validity of all data points by performing the quality and limit checks listed in Table 2-1. There are many redundant data points used by the SPDS. These points are identified in Table 2-2. To check the validity of redundant input points, the PMIS uses the technique of comparative analysis. The PMIS data base defines the redundancy relationships between pairs of input points, and specifies the allowable tolerance between their current values. When the allowable tolerance is exceeded, the redundant point check is failed, and each member of the pair of redundant input points is assigned a quality code of "REDU". As listed in Table 2-1, this quality code will cause the respective data points to be displayed in MAGENTA.

Note that Table 2-2 specifies how redundant points should be defined as pairs in the PMIS data base for the purpose of performing the PMIS redundant tolerance checks.

Operating experience with the SPDS may indicate that the redundant tolerance declared in the PMIS data base is too small for some data points and is creating "nuisance" validation failures. If this situation occurs, the redundant tolerance for the affected data points should be reset to a more appropriate value. That will minimize nuisance validation failures while still providing a meaningful check of the consistency between redundant points.

### 2.2.2 Supplementary SPDS Data Validation Techniques

In addition to the PMIS redundant tolerance check, the SPDS provides the following supplementary validation for selected plant variables:

- Not-valid indicators (NVIs)
- Downscale indicators (DNSCIs)
- Safety function indicator (SFI) validation
- Equipment status indicator (ESI) validation
- EOP limit status indicator (EOPSI) validation

Table 2-2. Identification of Redundant Input Points Used by the Cooper SPDS.(1)

| Variable(2) | Reference Input Point(3) | Redundant Input Point(3) | 2nd Redundant Input Point(3) |
|---|---|---|---|
| APRM Flux | B000<br>B002<br>B004 | B001<br>B003<br>B005 | |
| Average APRM | SPDS0006 | SPDS0007 | |
| SRM Log Count Rate | N040<br>N042 | N041<br>N043 | |
| RPV Water Level, NR | B021 | N011 | N012 |
| WR | G032 | G033 | |
| FZ | N009 | N010 | |
| RPV Pressure | N013 | N014 | |
| Drywell Pressure, NR | N017 | N018 | |
| MR | F084 | F085 | |
| Drywell Temperature(4) | M161<br>N276 | M162<br>N277 | M163 |
| Supp Pool Temp, Sector A | N023 | N031 | |
| B | N024 | N032 | |
| C | N025 | N033 | |
| D | N026 | N034 | |
| E | N027 | N035 | |
| F | N028 | N036 | |
| G | N029 | N037 | |
| H | N030 | N038 | |
| Supp Pool Level, WR | N019 | N020 | |
| Containment Water Level, WR | N021 | N022 | |

Table 2-2. Identification of Redundant Input Points Used by the Cooper SPDS.(1)

| Variable(2) | Reference Input Point(3) | Redundant Input Point(3) | 2nd Redundant Input Point(3) |
|---|---|---|---|
| Safety Valve A Tailpipe Temp. | M186 | T139 | |
| Safety Valve B Tailpipe Temp. | M187 | T140 | |
| Safety Valve C Tailpipe Temp. | M188 | T141 | |

Notes:

(1) Field input points have four-digit IDs, and SPDS-composed points have eight-digit IDs with the preface "SPDS".

(2) Following abbreviations are used to identify instrument ranges: NR=narrow range, WR=wide range, FZ=fuel zone range, MR=mid-range.

(3) In this table, a data point listed in the "Reference Input Point" column generally is the "A" channel for the respective variable. The "Redundant Input Point" generally is the "B" channel. The "2nd Redundant Input Point" is the "C" channel of those instruments that have only three like channels. To use this table, start in the "Reference Input Point" column and read across to identify its redundant point(s). If a reference input point only has one redundant input point (i.e., the "2nd Redundant Input Point" column is blank), each point should be identified in the PMIS data base as being redundant to the other. If there is a "2nd Redundant Input Point" listed, the PMIS data base should define redundancy of the three channels as a chain (i.e., A is redundant to B, which is redundant to C, which is redundant to A).

(4) Five points are used in the SPDS to compute a maximum drywell temperature. Sensors associated with points M161 to M163 are a different type than the sensors used for N276 and N277.

A summary of the validation criteria for SPDS composed points is presented in Table 2-3, and SPDS data validation techniques are discussed in detail in this section.

2.2.2.1 Not-Valid Indicators

To assist the operator in recognizing a "not-valid" situation, the characters "NV" appear in MAGENTA near the affected bar chart, trend or x-y plot, whenever the associated composed point fails to meet its respective validation criteria in Table 2-3. The presence of this Not-Valid Indicator (NVI) provides an unambigious indication that a question exists regarding the validity of input data. It is expected that the operator will investigate this situation and determine if an input data fault actually exists. Actions that may be taken by an operator include: (a) delete a faulty input data point from processing, (b) substitute a value for the faulty input data point, or (c) determine that no fault exists and continue to operate with the NVI present in the SPDS displays.

With regard to the data validation criteria in Table 2-3, please note the following:

- The average source range monitor (SRM) reading (SPDS0014) is validated by first verifying that the SRMs are in the "inserted" position as indicated by digital point A519. The SRMs must be inserted in order to properly correlate SRM detector output with a source range power level.

- The proximity to the RPV saturation temperature limit, as indicated by composed point SPDS028B, is not explicitly considered in the validation of RPV water level data. If drywell temperature exceeds the RPV saturation temperature limit, flashing may occur in the cold reference leg RPV level instruments. When flashing occurs, the RPV level indication derived from these instruments must be considered as unreliable. The saturation temperature limit at normal operating RPV pressure is about 545°F. CNS containment temperature instrumentation used by the SPDS provides a monitoring capability up to 400°F, therefore, the usefulness of the RPV saturation temperature limit is somewhat restricted. The

Table 2-3. Summary of Validation Criteria for Composed Points Associated with SPDS Displays.

| Composed Point ID | Name | Input Point IDs | Validation Criteria for Composed Point ID* | NVI Point ID |
|---|---|---|---|---|
| SPDS0008 | Average APRM | B000<br>B001<br>B002<br>B003<br>B004<br>B005 | PMIS redundant point checks on all field inputs to intermediate points SPDS0006 and SPDS0007 are OK | SPDS01NV |
| SPDS0010 | MSIV Status ESI | N797<br>N798<br>N799<br>N800<br>N801<br>N802<br>N803<br>N804 | See Section 6 | None |
| SPDS0014 | Average SRM | N040<br>N041<br>N042<br>N043 | SRMs inserted (A519 = 0) and PMIS redundant point check for all inputs is OK | SPDS02NV |
| SPDS0015 | SRM reactor period | SPDS0087 | None, but SPDS0014 was validated and it is input to simple rate-of-change transform to calculate SPDS0087 | None |
| SPDS0019 | Average narrow range RPV level | B021<br>N011<br>N012 | PMIS redundant point check for all inputs is OK** | SPDS03NV |
| SPDS0023 | Average wide range RPV level | G032<br>G033 | PMIS redundant point check on inputs is OK** | SPDS04NV |
| SPDS0027 | Average FZ range RPV level | N009<br>N010 | PMIS redundant point check on inputs is OK** | SPDS05NV |
| SPDS0029 | RPV mimic level | G032<br>G033<br>N009<br>N010 | None. Individual RPV water level bar charts are subject to PMIS redundant point checks in display containing mimic bar chart** | None |

Table 2-3. Summary of Validation Criteria for Composed Points Associated with SPDS Displays (continued).

| Composed Point ID | Name | Input Point IDs | Validation Criteria for Composed Point ID* | NVI Point ID |
|---|---|---|---|---|
| SPDS0030 | Average RPV pressure | N013<br>N014 | PMIS redundant point check on inputs is OK | SPDS07NV |
| SPDS0039 | Reactor scram ESI | SPDS0080<br>SPDS0083 | See Section 6 | None |
| SPDS0040 | Safety Valve A tailpipe temp | M186<br>T139 | PMIS redundant point check on inputs is OK | None |
| SPDS0041 | Safety Valve B tailpipe temp | M187<br>T140 | PMIS redundant point check on inputs is OK | None |
| SPDS0042 | Safety Valve C tailpipe temp | M188<br>T141 | PMIS redundant point check on inputs is OK | None |
| SPDS0043 | Avg narrow range drywell pressure | N017<br>N018 | PMIS redundant point check on inputs is OK | SPDS08NV |
| SPDS0045 | Avg mid-range drywell pressure | F084<br>F085 | PMIS redundant point check on inputs is OK | SPDS09NV |
| SPDS0050 | SRV and SV status ESI | SPDS0040<br>SPDS0041<br>SPDS0042<br>SPDS0089<br>SPDS0093<br>SPDS0094<br>SPDS0095<br>SPDS0096<br>SPDS0097<br>SPDS0098<br>SPDS0099 | See Section 6 | None |
| SPDS0051 | Maximum drywell temperature | M161<br>M162<br>M163<br>N276<br>N277 | PMIS redundant point check on inputs is OK | SPDS06NV |
| SPDS0054 | Drywell sump pump ESI | N059<br>N060 | See Section 6 | None |

Table 2-3. Summary of Validation Criteria for Composed Points Associated with SPDS Displays (continued).

| Composed Point ID | Name | Input Point IDs | Validation Criteria for Composed Point ID* | NVI Point ID |
|---|---|---|---|---|
| SPDS0055 | Supp. pool temp healthy avg 1A, 2A | N023<br>N031 | PMIS redundant point check on inputs is OK | SPDS10NV |
| SPDS0056 | Supp. pool temp healthy avg 1B, 2B | N024<br>N032 | PMIS redundant point check on inputs is OK | SPDS11NV |
| SPDS0057 | Supp. pool temp healthy avg 1C, 2C | N025<br>N033 | PMIS redundant point check on inputs is OK | SPDS12NV |
| SPDS0058 | Supp. pool temp healthy avg 1D, 2D | N026<br>N034 | PMIS redundant point check on inputs is OK | SPDS13NV |
| SPDS0059 | Supp. pool temp healthy avg 1E, 2E | N027<br>N035 | PMIS redundant point check on inputs is OK | SPDS14NV |
| SPDS0060 | Supp. pool temp healthy avg 1F, 2F | N028<br>N036 | PMIS redundant point check on inputs is OK | SPDS15NV |
| SPDS0061 | Supp. pool temp healthy avg 1G, 2G | N029<br>N037 | PMIS redundant point check on inputs is OK | SPDS16NV |
| SPDS0062 | Supp. pool temp healthy avg 1H, 2H | N030<br>N038 | PMIS redundant point check on inputs is OK | SPDS17NV |
| SPDS0063 | Overall avg supp pool water temp | SPDS0055<br>SPDS0056<br>SPDS0057<br>SPDS0058<br>SPDS0059<br>SPDS0060<br>SPDS0061<br>SPDS0062 | None. Substantial spatial variation in suppression pool water temperature may occur | None |
| SPDS0065 | Avg supp. pool wide range level | N019<br>N020 | PMIS redundant point check on inputs is OK | SPDS18NV |

Table 2-3. Summary of Validation Criteria for Composed Points Associated with SPDS Displays (continued).

| Composed Point ID | Name | Input Point IDs | Validation Criteria for Composed Point ID* | NVI Point ID |
|---|---|---|---|---|
| SPDS0067 | Avg cont. wide range level | N021<br>N022 | PMIS redundant point check on inputs is OK | SPDS19NV |
| SPDS0069 | Calculated torus oxygen | N061<br>N062<br>N065<br>N630<br>N631<br>N632<br>N633 | See Section 9 | None |
| SPDS0078 | Calculated SJAE effluent | N082<br>N083<br>N084<br>N085 | See Section 8 | None |
| SPDS0080 | All APRM downscale ESI | B000<br>B001<br>B002<br>B003<br>B004<br>B005 | See Section 6 | None |
| SPDS0084 | Delta T heat capacity | SPDS0030<br>SPDS0064 | See Section 9 | None |
| SPDS0085 | HPCI Pump ESI | N002 | See Section 6 | None |
| SPDS0086 | RCIC Pump ESI | N003 | See Section 6 | None |
| SPDS0089 | SRV "A" ESI | D556<br>T142 | See Section 6 | None |
| SPDS0090 to SPDS0092 | Calculated drywell oxygen Points 1 to 3 | N061<br>N062<br>N065<br>N627<br>N628<br>N629<br>N631<br>N632<br>N633 | See Section 9 | None |

Table 2-3. Summary of Validation Criteria for Composed Points Associated with SPDS Displays (continued).

| Composed Point ID | Name | Input Point IDs | Validation Criteria for Composed Point ID* | NVI Point ID |
|---|---|---|---|---|
| SPDS0093 to SPDS0099 | SRV "B" to "H" ESIs | D557<br>T143<br>D558<br>T144<br>D559<br>T145<br>D560<br>T146<br>D561<br>T147<br>D562<br>T148<br>D563<br>T149 | See Section 6 | None |
| SPDS0100 | Maximum drywell oxygen | SPDS0090<br>SPDS0091<br>SPDS0092 | None. Long instrument dwell time at each sampling point may cause substantial variations among input point readings during some plant conditions. | None |
| SPDS000B | Heat capacity temp limit EOPSI | SPDS0030<br>SPDS0063 | See Section 9 | None |
| SPDS001B | Heat capacity level limit EOPSI | SPDS0065<br>SPDS0084 | See Section 9 | None |
| SPDS002B | Suppression pool load limit EOPSI | SPDS0030<br>SPDS0065 | See Section 9 | None |
| SPDS004B | Containment pressure limit EOPSI | SPDS0045<br>SPDS0067 | See Section 9 | None |
| SPDS006B | Drywell spray initiation pressure limit EOPSI | SPDS0045<br>SPDS0063 | See Section 9 | None |

Table 2-3. Summary of Validation Criteria for Composed Points Associated with SPDS Displays (continued).

| Composed Point ID | Name | Input Point IDs | Validation Criteria for Composed Point ID* | NVI Point ID |
|---|---|---|---|---|
| SPDS007B | Drywell $H_2$ concentration EOPSI | T122<br>SPDS0045 | See Section 9 | None |
| SPDS009B | Drywell $O_2$ concentration EOPSI | SPDS0045<br>SPDS0053<br>IGL_MODE | See Section 9 | None |
| SPDS010B | Supp. chamber $O_2$ concentration EOPSI | SPDS0045<br>SPDS0069<br>IGL_MODE | See Section 9 | None |
| SPDS011B | NPSH Limit EOPSI | N000<br>N001<br>N004<br>N005<br>N861<br>N862<br>N863<br>N864<br>SPDS0045<br>SPDS0063 | See Section 9 | None |
| SPDS023B to SPDS027B | RPV pressure/ level status matrix | SPDS0024<br>SPDS0030<br>SPDS021B<br>SPDS022B | See Section 9 | None |
| SPDS028B | RPV saturation temperature limit EOPSI** | SPDS0030<br>SPDS0051 | See Section 9 | None |
| SPDSBOX1 | Reactivity control SFI driver | B000<br>B001<br>B002<br>B003<br>B004<br>B005<br>SPDS0083 | See Section 5 | None |
| SPDSBOX2 | Core cooling SFI driver | B021<br>N011<br>N012<br>G032<br>G033 | See Section 5 | None |

Table 2-3. Summary of Validation Criteria for Composed Points Associated with SPDS Displays (continued).

| Composed Point ID | Name | Input Point IDs | Validation Criteria for Composed Point ID* | NVI Point ID |
|---|---|---|---|---|
| SPDSBOX3 | Coolant system integrity SFI driver | N013<br>N014<br>N017<br>N018<br>N063<br>N806<br>N807<br>SPDS0010<br>SPDS0032<br>SPDS0050<br>IGL_MODE | See Section 5 | None |
| SPDSBOX4 | Containment integrity SFI driver | N013<br>N014<br>SPDS0051<br>SPDS0053<br>SPDS0063<br>SPDS0065<br>SPDS0069 | See Section 5 | None |
| SPDSBOX5 | Radioactive release SFI driver | N069<br>N073<br>N074<br>N079<br>SPDS0078 | See Section 5 | None |

* The PMIS performs redundant point checks on data points that are designated as being redundant in the PMIS data base. An important validation criterion for a composed point is that all redundant input points pass their respective redundant point check. A second important validation criterion is to verify that input data has a healthy data quality.

** The RPV saturation temperature limit status indicator is included in all displays presenting RPV water level indication. This status indicator provides further validation of the RPV water level indication.

EOP limit status indicator (EOPSI) for the RPV saturation temperature limit is included in all SPDS displays which present RPV water level information. Validation of this EOPSI is described in Section 9.

General guidelines for locating the NVI in the SPDS displays are presented in Section 2.3.

In the PMIS data base, Not-Valid Indicators are defined as external (real) points with a normal value of "0" (i.e., Table 2-3 validation check passed) and a value of "1" when the Table 2-3 validation check is failed. Not-Valid Indicators are assigned eight-character point identifiers beginning with "SPDS" and ending with "NV" (see Section 3 for a listing of NVIs). The Not-Valid Indicators associated with each display are identified in the display descriptions in Sections 7, 8 and 9.

2.2.2.2 Downscale Indicators

In a bar chart, the current value is shown by means of an appropriate color fill in the bar, and by a digital display of the current value. When a data point is "pegged high", the bar will be completely filled, and the color of the bar will change to MAGENTA because of the quality of the point driving the bar (i.e., a quality of HRL or NCAL). In contrast, when a data point is "pegged low", there is no color fill in the bar and a quality code of LRL or NCAL cannot cause the bar to change color to identify the existence of a downscale condition.

To assist the operator in recognizing a downscale situation, the characters "DNSC" are displayed in MAGENTA at the "low" end of affected bar chart whenever the current value of the data point driving the bar reaches the engineering limit low specified in the PMIS data base. General guidelines for locating this Downscale Indicator (DNSCI) in the SPDS displays are presented in in Section 2.3.

In the PMIS data base, Downscale Indicators are defined as external (real) points, with a normal value of "0" (i.e., not downscale), and a value of "1" when the current value of the associated data point drops to the engineering limit low (i.e., downscale condition exists). Downscale Indicators are assigned eight-character point identifiers, beginning with

"SPDS" and ending with "DS" (see Section 3 for a listing of DNSCIs). The Downscale Indicator associated with each bar chart is identified in the bar chart descriptions in Sections 7 and 8.

Downscale Indicators are not used in trend plots or x-y plots. In these types of displays, a moving cursor will track along one axis of the display during a downscale condition. These displays also include a ten-minute history of the associated data point(s), so the operator will be able to see the value of the data point as it approaches, reaches, and recovers from a downscale condition. Adequate information is thus available in these displays for the operator to be alerted to the existence of a downscale condition.

2.2.2.3 Safety Function Indicator Validation

An SFI normally will have a GREEN color fill, and will change to YELLOW when a warning condition exists, and to RED when an alarm condition exists. Each SFI is driven by a specific external (real) data point, as listed below:

| Point ID | SFI |
|---|---|
| SPDSBOX1 | Reactivity control |
| SPDSBOX2 | Core cooling |
| SPDSBOX3 | Coolant system integrity |
| SPDSBOX4 | Containment integrity |
| SPDSBOX5 | Radioactive release |

The validation criteria for each of these external (real) points is defined in Section 6. A validation failure causes the SFI to be displayed in MAGENTA. In spite of a validation failure, it may still be possible for a valid warning or alarm condition to be generated, therefore, these conditions take precedence over a validation failure. As a result, a valid SFI warning condition will cause a YELLOW color fill to replace a GREEN or MAGENTA color fill in the respective SFI block. Similarly, a valid SFI alarm condition will cause a RED color fill to replace a GREEN, MAGENTA, or YELLOW color fill.

The Not-Valid Indicators (NVI) described previously are not used with safety function indicators.

2.2.2.4 Equipment Status Indicator Validation

In general, ESIs are displayed in MAGENTA when: (a) insufficient healthy input data is available for determining system or equipment status, (b) input points have failed a PMIS redundant point check, or (c) conflicting data exists regarding equipment status. The specific validation criteria for each ESI is integrated with the ESI processing logic described in Section 6. The Not-Valid Indicators (NVIs) described previously are not used with ESIs.

2.2.2.5 EOP Limit Status Indicator Validation

In general, an EOPSI is displayed in MAGENTA when one or both of the input variables needed to drive the cursor in the associated Level 3 x-y plot is: (a) not healthy, or (b) has failed a PMIS redundant point check (i.e., healthy, but assigned a quality code of REDU). The specific validation criteria for each EOPSI is integrated with the EOPSI processing logic described in Section 9. The Not-Valid Indicators (NVIs) described previously are not used with EOP limit status indicators.

## 2.3 GENERAL DISPLAY DESIGN GUIDELINES

There are four basic types of displays presented in the General and Graphic Display Area (GGDA) of the the SPDS display terminal screen: bar charts, trend plots, multi-parameter X-Y plots and mimics. Design guidelines common to all displays are listed below. More specific guidelines for each display type are described later in this section.

A. In each display, a unique title appears in large print at the top of the GGDA.

B. The engineering range of a bar or plot axis corresponds to the engineering range of the respective data point, as specified in the PMIS data base.

C. PMIS data base constants define the values at which high/low warning and high/low alarm conditions exist for each data point. These constants may be redefined in the data base for each of the following plant operating modes:

- RUN
- STARTUP
- REFUEL
- SHUTDOWN

Current plant mode is determined from PMIS data point IGL_MODE, which can take on the following values: 1 = RUN, 2 = STARTUP, 3 = REFUEL, and 4 = SHUTDOWN.

D. The following general guidelines were used in setting the number of decimal places specified in the PMIS data base for analog points used in the SPDS displays.

- All calculated rates-of-change are displayed to the nearest whole number (i.e., no decimal places).
- Points associated with equipment status only have integer values and are displayed with no decimal places.

- Other analog points are displayed with 0, 1 or 2 decimal places as needed to show current values to three significant figures (Note that four significant figures are used to display current values greater than 999).

E. The digital rate-of-change is displayed CYAN, in terms of units per minute, unless otherwise stated.

F. A CYAN direction-of-change indicator is provided adjacent to the digital rate-of-change value. This indicator is an "up" arrow when rate-of-change is positive and a "down" arrow when rate-of-change is negative. The indicator is blanked when rate-of-change is zero.

G. The following status indicator boxes may be included in the GGDA.

- Equipment Status Indicators (ESI)
- EOP Limit Status Indicators (EOPSI)

Operation of these status indicator boxes are described in Section 6. These status indicators are in addition to the Safety Function Indicator (SFI) boxes located in the SPDS Status Area (SSA), near the bottom of all SPDS displays.

### 2.3.1 Bar Chart Guidelines

There are two types of bar charts that are used in the SPDS displays: horizontal and vertical. The following guidelines apply to both types of bar charts. Specific details on each type of bar chart are provided in following sections.

A. The color fill of the bar is determined by the quality code of the data point which is used to drive the bar (see Section 2.1). In summary, the bar color fill will operate as follows:

- GREEN: Healthy data, although point may be deleted from alarm processing (quality DALM) or alarm may be inhibited by a digital alarm cutout point specified in the PMIS data base (quality INHB)

- YELLOW: Healthy data, with current value in warning high region (quality HWRN) or warning low region (quality LWRN)

- RED: Healthy data, with current value in alarm high region (quality HALM) or alarm low region (quality LALM)

- BLUE: Healthy data, but substitute value assigned to point (quality SUB)

- MAGENTA plus Not-Valid Indicator:
  Healthy data, but failure of redundant point check (quality REDU)

- MAGENTA: Data not healthy

- WHITE: Point not processed yet (quality UNK)

B. Digital current value and rate-of-change are displayed adjacent to each bar. The color of the digital current value corresponds to the color of the bar. The rate-of-change is always CYAN.

C. A CYAN direction-of-change indicator is provided to the left of the digital rate-of-change value.

2.3.1.1 Horizontal Bar Chart Guidelines

A. The name of the associated plant variable is shown at the left of each horizontal bar.

B. Maximum and minimum bar values are shown beneath the bar.

C. Regularly spaced "tic marks", and/or tic marks and values for specific warning and alarm limits are shown beneath the bar.

D. The digital current value is shown to the right of the horizontal bar.

E. The digital rate-of-change is shown to the right of the current value, with a direction-of-change indicator.

F. When a data point fails its validation check, the characters "NV" are displayed to the right of the bar, near the current value.

G. When a downscale condition exists, the characters "DNSC" are displayed immediately above the bar, at the left end.

2.3.1.2 Vertical Bar Chart Guidelines

A. The name of the associated plant variable is shown above each vertical bar.

B. Maximum and minimum bar values are shown along the left edge of the vertical bar.

C. Regularly spaced "tic marks", and/or tic marks and values for specific warning and alarm limits are shown along the left edge of the vertical bar.

D. The digital current value is shown above the vertical bar, or in some other suitable location dictated by space constraints of the specific display.

E. If included in the display, the digital rate-of-change is shown above the current value, with or without a direction-of-change arrow, as space permits.

F. When a data point fails its validation check, the characters "NV" are displayed near the current value.

G. When a downscale condition exists, the characters "DNSC" are displayed near the bottom left edge of the vertical bar.

2.3.2 Trend Plot Guidelines

These displays are used to show the time variation of key plant variables that are related to the plant safety functions. As such, trend plots are used in conjunction with bar charts in Level 2 displays in the CNS SPDS (see Section 8). General features include:

A. A plant variable is assigned to the Y axis and time is assigned to the X axis of the display.

B. The title of the X axis is: "TIME (min)" The X axis covers a ten-minute time period, with the current value at the right-hand edge of the plot. The trend plot thus scrolls to the left, with values greater than ten minutes old being deleted at the left-hand edge of the plot. The X axis is divided in increments of minutes with current time labeled "0" and the preceding ten minutes labeled as negative values (i.e. "-1" to "-10").

C. The name of the Y-axis variable is shown to the left of the trend plot, while its digital current value, rate-of-change and the direction-of-change indicator are shown to the right of the trend plot.

D. When a trend plot is called up, it immediately includes a trend line showing the last 10 minutes of data.

E. The maximum and minimum values of the Y axis are shown along the left edge of the trend plot.

F. Regularly spaced "tic marks", or tic marks and values for specific warning or alarm limits are shown along the left-hand edge of the trend plot.

G. The color of the trend line is always CYAN.

H. When a data point fails its validation check, the characters "NV" are displayed near the current value.

I. Downscale Indicators are not used in trend plots.

2.3.3 Multi-Parameter X-Y Plot Guidelines

These displays generally are used to show the proximity of the plant to multi-parameter limits defined in the symptom-oriented Emergency Operating Procedures. The x-y plots appear only as Level 3 displays in the CNS SPDS (see Section 9). General features of these displays include:

A. Plant variables are assigned to both the X and the Y axes of the x-y plot. The digital current value of each variable is displayed adjacent to the respective axis of the x-y plot.

B. The maximum and minimum values of the respective axes are shown on the plot.

C. One or more multi-parameter limit curves may be included on each x-y plot.

D. A cursor (*) is used to indicate the current state of f(x,y) on the x-y plot, and proximity to appropriate limit curves.

E. When an x-y plot is called up, the cursor is displayed and begins to generate a "tail" as the value of f(x,y) changes with time. A dynamic file is used to describe many of the attributes of an x-y plot. Included in the dynamic file are two parameters which determine the amount of historical data that is contained in the "tail" of an x-y plot. The first parameter is named "Seconds per

cycle," and is used to establish the update rate of the display (i.e., specified in terms of seconds per update cycle). The second parameter is named "Number of point to display," and is used to determine the number of values of f(x,y) from past display update cycles that are retained in the current display. The table below lists: (a) the range of values that can potentially be assigned to each of these parameters, and (b) the parameter values currently specified.

| Parameter Name | Minimum Value | Current Value | Maximum Value |
|---|---|---|---|
| Seconds per cycle | 1 | 2 | very large |
| Number of points to display | 1 | 10 | 50 |

Using the current parameter values listed above, the "tail" of an x-y plot will display the values that f(x,y) took on during the prior 20 second period. The PMIS dynamic editor can be used to change the values of these display parameters, and thereby change the amount of historical data contained in the "tail" of the x-y plot. Because the amount of historical data in the "tail" can be varied, there is no time-indexing of the "tail" (i.e., no tic marks on the "tail").

F. The color of the cursor (*) and the "tail" in the x-y plot is always CYAN.

G. Limit curves and warning or alarm zones on the x-y plot are DARK BLUE. This color was selected to provide good contrast when the cursor is in a warning or alarm zone. Normal zones have a BLACK background.

H. When a data point fails its validation check, the characters "NV" are displayed near the current value.

I. Downscale Indicators are not used in x-y plots.

2.3.4 Mimic Guidelines

Mimic displays are special graphic representations of: (a) physical features of the reactor plant (i.e., a reactor vessel vertical section, or a primary containment horizontal section), or (b) specific safety systems (i.e., a piping and instrumentation diagram). Mimic displays may include bar charts to indicate the current value of relevant variables. Bar chart conventions described previously are applicable. Mimic displays also may include component status information using the following color conventions.

A. Valves, dampers, or circuit breakers are shown in RED when open and GREEN when closed.

B. Pumps, fans, or diesel generators are shown in RED when operating and GREEN when not operating.

# 3. FIELD INPUT DATA POINTS AND CALCULATED DATA POINTS FOR GENERATING COOPER SPDS DISPLAYS

## 3.1 SPDS DATA REQUIREMENTS

The technical basis for selecting the plant variables to be included in the Cooper SPDS is presented in the SPDS Safety Analysis*. A summary of the data points used to provide this SPDS monitoring capability is presented in Table 3-1. This table includes the following types of data points:

- Field input points
  - Analog
  - Digital
- PMIS composed points
  - Pseudo analog
    - healthy maximum
    - healthy average
    - logarithm
  - Transform
    - rate-of-change
  - Boolean
    - healthy OR
    - healthy AND
- SPDS composed points
  - External (real) points

Also included in Table 3-1 is a listing of how the data points are used by the SPDS. Data points are used as follows:

*Safety Parameter Display System Safety Analysis, 503-8500000-76

- To drive a bar, trend, one axis of an x-y plot, or a digital current value that appears in a display. The associated display is identified in Table 3-1.

- To calculate another data point (the other data point is listed in Table 3-1).

- To drive a status indicator
  - Safety Function Indicator (SFI)
  - Equipment Status Indicator (ESI)
  - EOP Limit Status Indicator (EOPSI)
  - Downscale Indicator (DNSCI)
  - Not-Valid Indicator (NVI)
  - System Alarm Area (SAA) Indicator

The SPDS displays are described in detail in Sections 7 to 9. Operation of the SFIs are described in Section 5 and the ESIs, EOPSIs and the SAA Indicator are described in Section 6. The operation of the DNSCIs and NVIs have been described in Section 2.

Table 3-1. Data Points for Generating Cooper SPDS Displays.

| Point ID* | Point Type** | Variable Name | Use*** |
|---|---|---|---|
| B000 | A | APRM A flux level | Calculate SPDSBOX1 |
| B001 | A | B | Calculate SPDSBOX1 |
| B002 | A | C | Calculate SPDSBOX1 |
| B003 | A | D | Calculate SPDSBOX1 |
| B004 | A | E | Calculate SPDSBOX1 |
| B005 | A | F | Calculate SPDSBOX1 |
| SPDS0006 | HMAX | Healthy maximum APRM A,C,E | Calculate SPDS0008 |
| SPDS0007 | HMAX | Healthy maximum APRM B,D,F | Calculate SPDS0008 |
| SPDS0008 | HAVE | Average APRM (avg of SPDS0006, 0007) | L1.0, L2.1 Calculate SPDS0009 |
| SPDS0009 | TRAN | Average APRM rate-of-change (ROC SPDS0008) | L1.0, L2.1 |
| SPDS0080 | EXTR | All APRM below downscale trip | L2.1 ESI, Calculate SPDS0039 |
| A527 | D | APRM upscale alarm (any) | L2.1 ESI |
| A528 | D | APRM inoperative alarm (any) | L2.1 ESI |
| A535 | D | APRM Ch A bypassed | Calculate SPDS0001 |
| A536 | D | Ch B | Calculate SPDS0001 |
| A537 | D | Ch C | Calculate SPDS0001 |
| A538 | D | Ch D | Calculate SPDS0001 |
| A539 | D | Ch E | Calculate SPDS0001 |
| A540 | D | Ch F | Calculate SPDS0001 |
| SPDS0001 | HOR | Any APRM bypassed (OR of A535 to A540) | L2.1 ESI |
| N040 | A | SRM log count rate Ch A | Calculate SPDS0014 |
| N041 | A | B | Calculate SPDS0014 |
| N042 | A | C | Calculate SPDS0014 |
| N043 | A | D | Calculate SPDS0014 |
| SPDS0014 | HAVE | Average SRM (healthy avg. N040, N041, N042, N043) | L2.1, Calculate SPDS0013, SPDS0015 |
| SPDS0013 | LOG | Log of average SRM (LOG SPDS0014) | L2.1 |
| SPDS0087 | TRAN | Average SRM rate-of-change (ROC SPDS0014) | Calculate SPDS0015 |
| SPDS0015 | EXTR | SRM reactor period | L2.1 |
| A519 | D | SRM detector not startup position (any) | L2.1 ESI |
| A520 | D | SRM upscale alarm (any) | L2.1 ESI |
| A521 | D | SRM inoperative alarm (any) | L2.1 ESI |
| A533 | D | SRM bypassed (any) | L2.1 ESI |

Table 3-1. Data Points for Generating Cooper SPDS Displays (continued).

| Point ID* | Point Type** | Variable Name | Use*** |
|---|---|---|---|
| N520 | D | All control rods in | L1.0 & L2.1 ESI |
| D530 | D | Reactor scram Ch A | Calculate SPDS0083 |
| D531 | D | B | Calculate SPDS0083 |
| SPDS0083 | HAND | Reactor scram A/B (D530 AND D531) | Calculate SPDS0039 SPDSBOX1 |
| SPDS0039 | EXTR | Reactor scram status | L1.0 & L2.1 ESI |
| IGL_MODE | GC | Plant mode | Mode designation |
| B021 | A | RPV water level - narrow range (0 to 60") A | L2.2, Calculate SPDSBOX2 |
| N011 | A | B | L2.2, Calculate SPDSBOX2 |
| N012 | A | C | L2.2, Calculate SPDSBOX2 |
| SPDS0016 | TRAN | RPV water level NR A rate-of-change (ROC B021) | L2.2 |
| SPDS0017 | TRAN | NR B rate-of-change (ROC N011) | L2.2 |
| SPDS0018 | TRAN | NR C rate-of-change (ROC N012) | L2.2 |
| SPDS0019 | HAVE | Average narrow range RPV level (healthy avg, B021, N011, N012) | L1.0, L2.2, Calculate SPDS0020 |
| SPDS0020 | TRAN | Average narrow range RPV level rate-of-change (ROC SPDS0019) | L1.0, L2.2 |
| G032 | A | RPV water level wide range (-150" to 60") A | L2.2, Calculate SPDSBOX2 |
| G033 | A | B | L2.2, Calculate SPDSBOX2 |
| SPDS0021 | TRAN | RPV water level WR A rate-of-change (ROC G032) | L2.2 |
| SPDS0022 | TRAN | WR B rate-of-change (ROC G033) | L2.2 |
| SPDS0023 | HAVE | Average wide range RPV level (healthy avg, G032, G033) | L2.2, L3.15, Calc SPDS0024 & SPDS0029 |
| SPDS0024 | TRAN | Average wide range RPV level rate-of-change (ROC SPDS0023) | L2.2, L3.15 |
| N009 | A | RPV water level - fuel zone range (-100" to 200") A | L2.2 |
| N010 | A | B | L2.2 |
| SPDS0025 | TRAN | RPV water level FZ A rate-of-change (ROC N009) | L2.2 |
| SPDS0026 | TRAN | FZ B rate-of-change (ROC N010) | L2.2 |

Table 3-1. Data Points for Generating Cooper SPDS Displays (continued).

| Point ID* | Point Type** | Variable Name | Use*** |
|---|---|---|---|
| SPDS0027 | HAVE | Average FZ range RPV level (healthy avg, N009, N010) | L2.2, Calculate SPDS0028 & SPDS0029 |
| SPDS0028 | TRAN | Average FZ range RPV level rate-of-change (ROC SPDS0027) | L2.2 |
| SPDS0029 | EXTR | RPV mimic water level (healthy avg, onscale G032, G033, N009 & N010 after conversion to common reference zero) | L2.2 |
| N013 | A | Reactor pressure (0-1500 psi) A | Calculate SPDS0030 & SPDSBOX3 |
| N014 | A | B | Calculate SPDS0030 & SPDSBOX3 |
| SPDS0030 | HAVE | Average RPV pressure (healthy avg, N013, N014) | L1.0, L2.2, L2.3, L2.4, L3.1, L3.3, L3.11 & L3.15 Calculate SPDS0031 |
| SPDS0031 | TRAN | Avg RPV pressure rate-of-change (ROC SPDS0030) | L1.0, L2.3 & L3.15 |
| D554 | D | Group 1 isolation A signal | Calculate SPDS0032 |
| D555 | D | B | Calculate SPDS0032 |
| SPDS0032 | HOR | Group 1 (D554 OR D555) | L2.3 & L2.4 ESI, Calculate SPDSBOX3 |
| N781 | D | Group 2 isolation signal - inboard | Calculate SPDS0033 |
| N782 | D | - outboard | Calculate SPDS0033 |
| SPDS0033 | HOR | Group 2 (N781 OR N782) | L2.3 & L2.4 ESI |
| N783 | D | Group 3 isolation signal - inboard | Calculate SPDS0034 |
| N784 | D | - outboard | Calculate SPDS0034 |
| SPDS0034 | HOR | Group 3 (N783 OR N784) | L2.3 & L2.4 ESI |
| N785 | D | Group 4 isolation A signal | Calculate SPDS0035 |
| N786 | D | B | Calculate SPDS0035 |
| SPDS0035 | HOR | Group 4 (N785 OR N786) | L2.3 & L2.4 ESI |
| N787 | D | Group 5 isolation A signal | Calculate SPDS0036 |
| N788 | D | B | Calculate SPDS0036 |
| SPDS0036 | HOR | Group 5 (N787 OR N788) | L2.3 & L2.4 ESI |
| N789 | D | Group 6 isolation A signal | Calculate SPDS0037 |
| N790 | D | B | Calculate SPDS0037 |
| SPDS0037 | HOR | Group 6 (N789 OR N790) | L2.3 & L2.4 ESI |

Table 3-1. Data Points for Gererating Cooper SPDS Displays (continued).

| Point ID* | Point Type** | Variable Name | Use*** |
|---|---|---|---|
| N791 | D | Group 7 isolation signal - inboard | Calculate SPDS0038 |
| N792 | D | - outboard | Calculate SPDS0038 |
| SPDS0038 | HOR | Group 7 (N791 OR N792) | L2.3 & L2.4 ESI |
| N797 | D | Main Steam iso valve A inboard | Calculate SPDS0010 |
| N801 | D | A outboard | Calculate SPDS0010 |
| N798 | D | Main steam iso valve B inboard | Calculate SPDS0010 |
| N802 | D | B outboard | Calculate SPDS0010 |
| N799 | D | Main steam iso valve C inboard | Calculate SPDS0010 |
| N803 | D | C outboard | Calculate SPDS0010 |
| N800 | D | Main steam iso valve D inboard | Calculate SPDS0010 |
| N804 | D | D outboard | Calculate SPDS0010 |
| SPDS0010 | EXTR | MSIV status | L2.2 & L2.3 ESI, Calculate SPDSBOX3 |
| D556 | D | Main stm relief valve A press sw | Calculate SPDS0089 |
| T142 | A | A temp | Calculate SPDS0089 |
| SPDS0089 | EXTR | A "position" | L2.4, Calc SPDS0050 |
| D557 | D | B press sw | Calculate SPDS0093 |
| T143 | A | B temp | Calculate SPDS0093 |
| SPDS0093 | EXTR | B "position" | L2.4, Calc SPDS0050 |
| D558 | D | C press sw | Calculate SPDS0094 |
| T144 | A | C temp | Calculate SPDS0094 |
| SPDS0094 | EXTR | C "position" | L2.4, Calc SPDS0050 |
| D559 | D | D press sw | Calculate SPDS0095 |
| T145 | A | D temp | Calculate SPDS0095 |
| SPDS0095 | EXTR | D "position" | L2.4, Calc SPDS0050 |
| D560 | D | E press sw | Calculate SPDS0096 |
| T146 | A | E temp | Calculate SPDS0096 |
| SPDS0096 | EXTR | E "position" | L2.4, Calc SPDS0050 |
| D561 | D | F press sw | Calculate SPDS0097 |
| T147 | A | F temp | Calculate SPDS0097 |
| SPDS0097 | EXTR | F "position" | L2.4, Calc SPDS0050 |
| D562 | D | G press sw | Calculate SPDS0098 |
| T148 | A | G temp | Calculate SPDS0098 |
| SPDS0098 | EXTR | G "position" | L2.4, Calc SPDS0050 |
| D563 | D | H press sw | Calculate SPDS0099 |
| T149 | A | H temp | Calculate SPDS0099 |
| SPDS0099 | EXTR | H "position" | L2.4, Calc SPDS0050 |

Table 3-1. Data Points for Generating Cooper SPDS Displays (continued).

| Point ID* | Point Type** | Variable Name | Use*** |
|---|---|---|---|
| M186 | A | MS safety valve A temp | Calculate SPDS0040 |
| T139 | A | A temp | Calculate SPDS0040 |
| SPDS0040 | EXTR | A "position" | L2.4, Calc SPDS0050 |
| M187 | A | B temp | Calculate SPDS0041 |
| T140 | A | B temp | Calculate SPDS0041 |
| SPDS0041 | EXTR | B "position" | L2.4, Calc SPDS0050 |
| M188 | A | C temp | Calculate SPDS0042 |
| T141 | A | C temp | Calculate SPDS0042 |
| SPDS0042 | EXTR | C "position" | L2.4, Calc SPDS0050 |
| SPDS0050 | EXTR | Number of SRVs open (RV A to H + SV A to C) | L2.2 & L2.3 ESI, Calculate SPDSBOX3 |
| N002 | A | HPCI flow | Calculate SPDS0085 |
| SPDS0085 | EXTR | HPCI status | L2.4 & L3.15 ESI |
| N003 | A | RCIC flow | Calculate SPDS0086 |
| SPDS0086 | EXTR | RCIC status | L2.4 & L3.15 ESI |
| N000 | A | Core spray pump A flow | L3.9 |
| N001 | A | B | L3.9 |
| M578 | D | Core spray A status | L3.9 & L3.15 ESI |
| M580 | D | B | L3.9 & L3.15 ESI |
| N004 | A | RHR loop A flow | L3.8 |
| N005 | A | B | L3.8 |
| N861 | D | RHR pump 1A status | L3.8 & 3.15 ESI |
| N862 | D | 1B status | L3.8 & 3.15 ESI |
| N863 | D | 1C status | L3.8 & 3.15 ESI |
| N864 | D | 1D status | L3.8 & 3.15 ESI |
| N806 | D | RHR suction isolation valve, inbd | Calculate SPDSBOX3 |
| N807 | D | RHR suction isolation valve, outbd | Calculate SPDSBOX3 |
| N017 | A | Containment (drywell) pressure (-5 to +5 psig) A | Calculate SPDS0043 SPDSBOX3, SPDSBOX4 |
| N018 | A | B | Calculate SPDS0043 SPDSBOX3, SPDSBOX4 |
| SPDS0043 | HAVE | Avg narrow range drywell pressure (healthy avg N017, N018) | L1.0, Calc SPDS0044 |
| SPDS0044 | TRAN | Avg NR drywell pressure rate-of-change (ROC SPDS0043) | L1.0 |

Table 3-1. Data Points for Generating Cooper SPDS Displays (continued).

| Point ID* | Point Type** | Variable Name | Use*** |
|---|---|---|---|
| F084 | A | Drywell pressure (0-80 psia) A | Calculate SPDS0045 |
| F085 | A | B | Calculate SPDS0045 |
| SPDS0045 | HAVE | Avg mid-range drywell pressure (healthy avg F084, F085) | L2.3, L2.4, L3.4, L3.5, L3.6, L3.7, L3.8 & L3.9, Calculate SPDS0046 |
| SPDS0046 | TRAN | Avg mid-range drywell pressure rate-of-change (ROC SPDS0045) | L2.4 |
| M161 | A | Drywell temperature PT-10 | Calculate SPDS0051 |
| M162 | A | PT-11 | Calculate SPDS0051 |
| M163 | A | PT-12 | Calculate SPDS0051 |
| N276 | A | Drywell zone 2B area temp B | Calculate SPDS0051 |
| N277 | A | D | Calculate SPDS0051 |
| SPDS0051 | HMAX | Calculated drywell temp (healthy max, M161, M162, M163, N276, N277) | L2.4, L3.11, Calc SPDS0052 & SPDSBOX4 |
| SPDS0052 | TRAN | Avg drywell temp rate-of-change (ROC SPDS0051) | L2.4 |
| T122 | A | Drywell hydrogen level | L3.6 |
| N061 | A | Drywell/torus 0-5% oxygen level | Calculate SPDS0069, SPDS0090, SPDS0091, & SPDS0092 |
| N062 | A | Drywell/torus 0-10% oxygen level | Calculate SPDS0069, SPDS0090, SPDS0091 & SPDS0092 |
| N065 | A | Drywell/torus 0-25% oxygen level | Calculate SPDS0069, SPDS0090, SPDS0091 & SPDS0092 |
| N627 | D | Drywell oxygen sample No. 1 | Calculate SPDS0090 |
| N628 | D | Drywell oxygen sample No. 2 | Calculate SPDS0091, & SPDS0092 |
| N629 | D | Drywell oxygen sample No. 3 | Calculate SPDS0092 |
| N630 | D | Torus oxygen sample | Calculate SPDS0069 |
| N631 | D | Drywell/torus oxygen range No. 1 (0-5%) | Calculate SPDS0069, SPDS0090, SPDS0091 & SPDS0092 |
| N632 | D | Drywell/torus oxygen range No. 2 (0-10%) | Calculate SPDS0069, SPDS0090, SPDS0091, & SPDS0092 |

Table 3-1. Data Points for Generating Cooper SPDS Displays (continued).

| Point ID* | Point Type** | Variable Name | Use*** |
|---|---|---|---|
| N633 | D | Drywell/torus oxygen range No. 3 (0-25%) | Calculate SPDS0069, SPDS0090, SPDS0091, & SPDS0092 |
| SPDS0090 | EXTR | Calculated drywell oxygen, point 1 | Calculate SPDS0100 |
| SPDS0091 | EXTR | Calculated drywell oxygen, point 2 | Calculate SPDS0100 |
| SPDS0092 | EXTR | Calculated drywell oxygen, point 3 | Calculate SPDS0100 |
| SPDS0100 | HMAX | Healthy maximum drywell oxygen | L3.6, Calc SPDSBOX4 |
| SPDS0069 | EXTR | Calculated torus oxygen | L3.7, Calc SPDSBOX4 |
| N059 | A | Drywell flr sump pump 1F1/2 flow | Calculate SPDS0054 |
| N060 | A | pump 1G1/2 flow | Calculate SPDS0055 |
| SPDS0054 | EXTR | Drywell sump pump status | L2.3 ESI |
| N063 | A | High range drywell airlock area rad monitor | L2.3, Calc SPDS0049, SPDS0082 & SPDSBOX3 |
| SPDS0082 | LOG | Log of drywell area rad (LOG N063) | L2.3 |
| SPDS0049 | TRAN | High range drywell airlock area rad monitor rate-of-change (ROC N063) | L2.3 |
| N023 | A | Suppression pool water temp 1A | Calculate SPDS0055 |
| N024 | A | 1B | Calculate SPDS0056 |
| N025 | A | 1C | Calculate SPDS0057 |
| N026 | A | 1D | Calculate SPDS0058 |
| N027 | A | 1E | Calculate SPDS0059 |
| N028 | A | 1F | Calculate SPDS0060 |
| N029 | A | 1G | Calculate SPDS0061 |
| N030 | A | 1H | Calculate SPDS0062 |
| N031 | A | 2A | Calculate SPDS0055 |
| N032 | A | 2B | Calculate SPDS0056 |
| N033 | A | 2C | Calculate SPDS0057 |
| N034 | A | 2D | Calculate SPDS0058 |
| N035 | A | 2E | Calculate SPDS0059 |
| N036 | A | 2F | Calculate SPDS0060 |
| N037 | A | 2G | Calculate SPDS0061 |
| N038 | A | 2H | Calculate SPDS0062 |
| SPDS0055 | HAVE | Supp. pool temp healthy avg 1A, 2A | L2.4, calc SPDS0094 |
| SPDS0056 | HAVE | avg 1B, 2B | L2.4, calc SPDS0095 |

Table 3-1. Data Points for Generating Cooper SPDS Displays (continued).

| Point ID* | Point Type** | Variable Name | Use*** |
|---|---|---|---|
| SPDS0057 | HAVE | Supp. pool temp healthy avg 1C, 2C | L2.4, calc SPDS0096 |
| SPDS0058 | HAVE | avg 1D, 2D | L2.4, calc SPDS0097 |
| SPDS0059 | HAVE | avg 1E, 2E | L2.4, calc SPDS0098 |
| SPDS0060 | HAVE | avg 1F, 2F | L2.4, calc SPDS0099 |
| SPDS0061 | HAVE | avg 1G, 2G | L2.4, calc SPDS0100 |
| SPDS0062 | HAVE | avg 1H, 2H | L2.4, calc SPDS0101 |
| SPDS0063 | HAVE | Overall avg supp pool water temp (healthy avg SPDS0055 to 0062) | L2.4, L3.1, L3.5, L3.8, L3.9, Calculate SPDS0064 & SPDSBOX4 |
| SPDS0064 | TRAN | Avg supp pool temp rate-of-change (ROC SPDS0063) | L2.4 |
| SPDS0084 | EXTR | Delta T heat capacity (limit minus SPDS0063) | L3.2 |
| N019 | A | Suppression pool level (0-30') A | Calculate SPDS0065 |
| N020 | A | B | Calculate SPDS0065 |
| SPDS0065 | HAVE | Avg supp pool wide range level (healthy avg N019, N020) | L2.4, L3.2, L3.3, SFI, calculate SPDS0066 & SPDSBOX4 |
| SPDS0066 | TRAN | Avg supp pool wide level rate-of-change (ROC SPDS0065) | L2.4 |
| N021 | A | Containment water level (0-100') A | Calculate SPDS0067 |
| N022 | A | B | Calculate SPDS0067 |
| SPDS0067 | HAVE | Avg cont. wide range level (healthy avg N021, N022) | L3.4 |
| N079 | A | ERP normal range rad monitor | L2.5, Calc SPDS0070, SPDS0071 & SPDSBOX5 |
| SPDS0070 | LOG | Log of ERP normal range (LOG N079) | L2.5 |
| SPDS0071 | TRAN | ERP effluent rate-of-change (ROC N079) | L2.5 |
| N073 | A | AOG & RW effluent normal range rad mon | L2.5, Calc SPDS0072, SPDS0073 & SPDSBOX5 |
| SPDS0072 | LOG | Log of AOG & RW normal range (LOG N073) | L2.5 |
| SPDS0073 | TRAN | AOG & RW eff rate-of-change (ROC N073) | L2.5 |

Table 3-1. Data Points for Generating Cooper SPDS Displays (continued).

| Point ID* | Point Type** | Variable Name | Use*** |
|---|---|---|---|
| N074 | A | Rx bldg effluent rad monitor | L2.5, Calc SPDS0074 SPDS0075 & SPDSBOX5 |
| SPDS0074 | LOG | Log of Rx bldg effluent (LOG N074) | L2.5 |
| SPDS0075 | TRAN | Rx bldg effluent rate-of-change (ROC N074) | L2.5 |
| N069 | A | Turbine bldg effluent normal range rad mon | L2.5, Calc SPDS0076, SPDS0077 & SPDSBOX5 |
| SPDS0076 | LOG | Log of turb bldg effluent (LOG N069) | L2.5 |
| SPDS0077 | TRAN | Turb bldg eff rate-of-change (ROC N069) | L2.5 |
| N082 | A | SJAE radiation monitor A | Calculate SPDS0078 |
| N083 | A | B | Calculate SPDS0078 |
| N084 | A | SJAE A air flow | Calculate SPDS0078 |
| N085 | A | B air flow | Calculate SPDS0078 |
| SPDS0078 | EXTR | Calculated SJAE effluent | L2.5, Calc SPDS0079, SPDS0081 & SPDSBOX5 |
| SPDS0081 | LOG | LOG of SJAE effluent (LOG SPDS0078) | L2.5 |
| SPDS0079 | TRAN | SJAE effluent rate-of-change (ROC SPDS0078) | L2.5 |
| SPDS000B | EXTR | Supp. pool heat cap. temp lim. | L2.4 EOPSI |
| SPDS001B | EXTR | Supp. pool heat cap. level lim. | L2.4 EOPSI |
| SPDS002B | EXTR | Supp. pool load lim. | L2.4 EOPSI |
| SPDS004B | EXTR | Containment pressure lim. | L2.4 EOPSI |
| SPDS006B | EXTR | Drywell spray init press lim. | L2.4 EOPSI |
| SPDS007B | EXTR | Drywell hydrogen lim. | L2.4 EOPSI |
| SPDS009B | EXTR | Drywell oxygen lim. | L2.4 EOPSI |
| SPDS010B | EXTR | Torus oxygen lim. | L2.4 EOPSI |
| SPDS011B | EXTR | NPSH lim. | L2.2 EOPSI |
| SPDS021B | EXTR | Constant 100 psig | L3.15 EOPSI |
| SPDS022B | EXTR | Constant 425 psig | L3.15 EOPSI |
| SPDS023B | EXTR | RPV press hi/level inc. | L3.15 EOPSI |
| SPDS024B | EXTR | RPV press int/level inc. | L3.15 EOPSI |
| SPDS025B | EXTR | RPV press low/level inc. | L3.15 EOPSI |
| SPDS026B | EXTR | RPV press hi-int/level dec. | L3.15 EOPSI |
| SPDS027B | EXTR | RPV press low/level dec. | L3.15 EOPSI |
| SPDS028B | EXTR | RPV sat temp lim | L1.0, L2.2 & L3.15 EOPSI |
| IAD_EOP | GC | SAA "E" driver | SAA "E" |

Table 3-1. Data Points for Generating Cooper SPDS Displays (continued).

| Point ID* | Point Type** | Variable Name | Use*** |
|---|---|---|---|
| SPDSBOX1 | EXTR | Reactivity control SFI driver | SFI |
| SPDSBOX2 | EXTR | Core cooling SFI driver | SFI |
| SPDSBOX3 | EXTR | Coolant sys integrity SFI driver | SFI |
| SPDSBOX4 | EXTR | Containment integrity SFI driver | SFI |
| SPDSBOX5 | EXTR | Radioactive release SFI driver | SFI |
| SPDS01DS | EXTR | APRM (SPDS0008) DNSC ind | L1.0 & L2.1 DNSCI |
| SPDS02DS | EXTR | RPV press (SPDS0030) DNSC ind | L1.0 & L2.3 DNSCI |
| SPDS03DS | EXTR | RPV level avg NR (SPDS0019) DNSC ind | L1.0 DNSCI |
| SPDS04DS | EXTR | Drywell press (SPDS0043) DNSC ind | L1.0 DNSCI |
| SPDS05DS | EXTR | SRM (SPDS0014) DNSC ind | L2.1 DNSCI |
| SPDS06DS | EXTR | RPV level NR A (B021) DNSC ind | L2.2 DNSCI |
| SPDS07DS | EXTR | B (N011) | L2.2 DNSCI |
| SPDS08DS | EXTR | C (N012) | L2.2 DNSCI |
| SPDS09DS | EXTR | RPV level WR A (G032) DNSC ind | L2.2 DNSCI |
| SPDS10DS | EXTR | B (G033) | L2.2 DNSCI |
| SPDS11DS | EXTR | RPV level FZ A (N009) DNSC ind | L2.2 DNSCI |
| SPDS12DS | EXTR | B (N010) | L2.2 DNSCI |
| SPDS13DS | EXTR | Drywell press (SPDS0045) MR DNSC ind | L2.3 & L2.4 DNSCI |
| SPDS14DS | EXTR | Containment rad (SPDS0082) DNSC ind | L2.3 DNSCI |
| SPDS15DS | EXTR | Drywell temp (SPDS0051) DNSC ind | L2.4 DNSCI |
| SPDS16DS | EXTR | Supp. pool level WR (SPDS0065) DNSC ind | L2.4 DNSCI |
| SPDS17DS | EXTR | Supp. pool temp avg (SPDS0063) DNSC ind | L2.4 DNSCI |
| SPDS18DS | EXTR | ERP eff (SPDS0070) DNSC ind | L2.5 DNSCI |
| SPDS19DS | EXTR | AOG & RW eff. (SPDS0072) DNSC ind | L2.5 DNSCI |
| SPDS20DS | EXTR | Rx bldg. eff. (SPDS0074) DNSC ind | L2.5 DNSCI |
| SPDS21DS | EXTR | Turb. bldg eff (SPDS0076) DNSC ind | L2.5 DNSCI |
| SPDS22DS | EXTR | SJAE eff. (SPDS0078) DNSC ind | L2.5 DNSCI |
| SPDS01NV | EXTR | Average APRM (SPDS0008) NV | L1.0 & L2.1 NVI |
| SPDS02NV | EXTR | Average SRM (SPDS0014) NV | L2.1 NVI |

Table 3-1. Data Points for Generating Cooper SPDS Displays (continued).

| Point ID* | Point Type** | Variable Name | Use*** |
|---|---|---|---|
| SPDS03NV | EXTR | Average narrow range RPV level (SPDS0019) NV | L1.0 NVI |
| SPDS04NV | EXTR | Average wide range RPV level (SPDS0023) NV | L2.2 & L3.15 NVI |
| SPDS05NV | EXTR | Average FZ range RPV level (SPDS0027) NV | L2.2 NVI |
| SPDS06NV | EXTR | Maximum drywell temp (SPDS0051) NV | L2.4 & L3.11 NVI |
| SPDS07NV | EXTR | Average RPV pressure (SPDS0030) NV | L1.0, L2.2, L2.3, L2.4, L3.1, L3.3, L3.11 & L3.15 NVI |
| SPDS08NV | EXTR | Avg NR drywell pressure (SPDS0043) NV | L1.0 NVI |
| SPDS09NV | EXTR | Avg MR drywell pressure (SPDS0045) NV | L2.3, L2.4, L3.4 to L3.9 NVI |
| SPDS10NV | EXTR | Supp pool 1A, 2A temp (SPDS0055) NV | L2.4 NVI |
| SPDS11NV | EXTR | Supp pool 1B, 2B temp (SPDS0056) NV | L2.4 NVI |
| SPDS12NV | EXTR | Supp pool 1C, 2C temp (SPDS0057) NV | L2.4 NVI |
| SPDS13NV | EXTR | Supp pool 1D, 2D temp (SPDS0058) NV | L2.4 NVI |
| SPDS14NV | EXTR | Supp pool 1E, 2E temp (SPDS0059) NV | L2.4 NVI |
| SPDS15NV | EXTR | Supp pool 1F, 2F temp (SPDS0060) NV | L2.4 NVI |
| SPDS16NV | EXTR | Supp pool 1G, 2G temp (SPDS0061) NV | L2.4 NVI |
| SPDS17NV | EXTR | Supp pool 1H, 2H temp (SPDS0062) NV | L2.4 NVI |
| SPDS18NV | EXTR | Supp pool WR level (SPDS0065) NV | L2.4, L3.2 & L3.3 NVI |
| SPDS19NV | EXTR | Containment WR level (SPDS0067) NV | L3.4 NVI |
| SPDS0101 | PSEU | Spare | |
| SPDS0102 | PSEU | Spare | |
| SPDS0103 | PSEU | Spare | |
| SPDS0104 | PSEU | Spare | |
| SPDS0105 | TRAN | Spare | |
| SPDS0106 | TRAN | Spare | |
| SPDS0107 | TRAN | Spare | |

Table 3-1. Data Points for Generating Cooper SPDS Displays (continued).

| Point ID* | Point Type** | Variable Name | Use*** |
|---|---|---|---|
| SPDS0108 | TRAN | Spare | |
| SPDS0109 | TRAN | Spare | |
| SPDS0110 | BOOL | Spare | |
| SPDS0111 | BOOL | Spare | |
| SPDS0112 | BOOL | Spare | |
| SPDS0113 | BOOL | Spare | |
| SPDS0114 | BOOL | Spare | |
| SPDS0115 | EXTR | Spare | |
| SPDS0116 | EXTR | Spare | |
| SPDS0117 | EXTR | Spare | |
| SPDS0118 | EXTR | Spare | |
| SPDS0119 | EXTR | Spare | |
| SPDS0120 | EXTR | Spare | |
| SPDS0121 | EXTR | Spare | |
| SPDS0122 | EXTR | Spare | |
| SPDS0123 | EXTR | Spare | |
| SPDS0124 | EXTR | Spare | |

Notes:

* Four digit point ID numbers indicate analog or digital points available on PMIS. Eight digit point ID numbers prefaced with the characters "SPDS" are composed points.

** Point type:
- A = analog
- D = digital
- PSEU = pseudo analog, spare
- HMAX = pseudo analog, maximum of healthy inputs
- HAVE = pseudo analog, healthy average
- LOG = pseudo analog, logarithm
- TRAN = transform, rate-of-change
- BOOL = Boolean, spare
- HOR = Boolean, healthy OR
- HAND = Boolean, healthy AND
- EXTR = external (real)
- GC = PMIS global common variable

*** If the variable appears in a display, the display is identified as follows:

- Level 1 display
  L1.0 = overview bar

Table 3-1. Data Points for Generating Cooper SPDS Displays (continued).

- Level 2 displays
  In this table, Level 2 displays are identified only by their first two digits. The third digit in the Level 2 display designation uniquely identifies multiple displays related to the same function as follows: L2.1 are reactivity control displays, L2.2 are core cooling displays, L2.3 are coolant system integrity displays, L2.4 are containment integrity displays, and L2.5 are radioactive release displays. The full set of Level 2 displays are the following:

  L2.1.1 = reactivity control (bar)
  L2.1.2 = reactivity control (trend)
  L2.2.1 = RPV water level (bar/RPV mimic)
  L2.2.2 = core cooling (trend)
  L2.3.1 = coolant system integrity (bar)
  L2.3.2 = coolant system integrity (trend)
  L2.4.1 = containment integrity (bar)
  L2.4.2 = containment integrity (trend)
  L2.4.3 = suppression chamber mimic
  L2.5.1 = radioactive release (bar)
  L2.5.2 = radioactive release (trend, page 1/2)
  L2.5.3 = radioactive release (trend, page 2/2)

- Level 3 displays
  L3.1 = heat capacity temperature limit
  L3.2 = heat capacity level limit
  L3.3 = suppression pool load limit
  L3.4 = containment pressure limits
  L3.5 = drywell spray initiation pressure limit
  L3.6 = drywell hydrogen and oxygen status
  L3.7 = suppression chamber hydrogen and oxygen status
  L3.8 = RHR pump NPSH limits
  L3.9 = Core spray pump NPSH limits
  L3.11 = RPV saturation temperature limit
  L3.12 = maximum core uncovery time limit
  L3.15 = RPV pressure/level status matrix

- Status indicators

  SFI = safety function indicator (on all SPDS displays)
  ESI = equipment status indicator
  EOPSI = emergency operating procedure limit status indicator
  DNSCI = downscale indicator
  NVI = not-valid indicator
  SAA = system alarm area indicator

## 3.2 DEFINITION OF SPDS POINTS IN THE PMIS DATA BASE

Data points used by the SPDS are formally defined in the PMIS data base. NPPD has responsibility for defining all field input points. The field input points used by the SPDS are functionally grouped and listed in Table 3-2. The analog field input points used by the SPDS are listed sequentially by point ID number in Table 3-3, and the digital field input points are listed in a similar manner in Table 3-4. The PMIS data base descriptions for these field input points should identify them as SPDS points. The SPDS composed points are defined in the PMIS data base using the following conventions.

### 3.2.1 Point ID

A. All SPDS-composed points have eight-character point ID's, with the first four characters being "SPDS".

B. Point ID's from SPDSBOX1 to SPDSBOX5 are used to drive the Safety Function Indicators. These are all external (real) points.

C. Point ID's ending in "B" are associated with the EOP limits in the Level 3 displays. These are all external (real) points.

D. Point ID's ending in "NV" are used to drive the Not-Valid Indicators. These are all external (real) points.

E. Point ID's ending in "DS" are used to drive the Downscale Indicators. These are all external (real) points.

F. Point ID's from SPDS0001 to SPDS0100 are pseudo-analog, transform, Boolean, or external (real) points used for a variety of other functions in the SPDS displays. Some point ID numbers in this interval are not used.

G. Point ID's from SPDS0101 to SPDS0124 are spare points that are are reserved for future SPDS needs. These 24 reserved points are specified as follows: pseudo-analog (4), transform (5), Boolean (5), and external (real) (10).

Table 3-2. Summary of Field Input Points for Generating Cooper SPDS Displays.

| Point ID | Point Type* | Variable Name |
|---|---|---|
| B000 | A | APRM A flux level |
| B001 | A | B |
| B002 | A | C |
| B003 | A | D |
| B004 | A | E |
| B005 | A | F |
| A527 | D | APRM upscale alarm (any) |
| A528 | D | APRM inoperative alarm (any) |
| A535 | D | APRM Ch A bypassed |
| A536 | D | Ch B |
| A537 | D | Ch C |
| A538 | D | Ch D |
| A539 | D | Ch E |
| A540 | D | Ch F |
| N040 | A | SRM log count rate Ch A |
| N041 | A | B |
| N042 | A | C |
| N043 | A | D |
| A519 | D | SRM detector not startup position (any) |
| A520 | D | SRM upscale alarm (any) |
| A521 | D | SRM inoperative alarm (any) |
| A533 | D | SRM bypassed (any) |
| N520 | D | All control rods in |
| D530 | D | Reactor scram Ch A |
| D531 | D | B |
| B021 | A | RPV water level - narrow range (0 to 60") A |
| N011 | A | B |
| N012 | A | C |
| G032 | A | RPV water level - wide range (-150" to 60") A |
| G033 | A | B |
| N009 | A | RPV water level - fuel zone range (-100" to 200") A** |
| N010 | A | B** |
| N013 | A | Reactor pressure (0-1500 psi) A |
| N014 | A | B |
| D554 | D | Group 1 isolation A signal |
| D555 | D | B |
| N781 | D | Group 2 isolation signal - inboard |
| N782 | D | - outboard |
| N783 | D | Group 3 isolation signal - inboard |
| N784 | D | - outboard |

Table 3-2. Field Input Points for Generating Cooper SPDS Displays (Continued).

| Point ID | Point Type* | Variable Name |
|---|---|---|
| N785 | D | Group 4 isolation A signal |
| N786 | D | B |
| N787 | D | Group 5 isolation A signal |
| N788 | D | B |
| N789 | D | Group 6 isolation A signal |
| N790 | D | B |
| N791 | D | Group 7 isolation signal - inboard |
| N792 | D | - outboard |
| N797 | D | Main steam iso valve A inboard |
| N801 | D | A outboard |
| N798 | D | Main steam iso valve B inboard |
| N802 | D | B outboard |
| N799 | D | Main steam iso valve C inboard |
| N803 | D | C outboard |
| N800 | D | Main steam iso valve D inboard |
| N804 | D | D outboard |
| D556 | D | Main stm relief valve A press sw |
| T142 | A | A temp |
| D557 | D | B press sw |
| T143 | A | B temp |
| D558 | D | C press sw |
| T144 | A | C temp |
| D559 | D | D press sw |
| T145 | A | D temp |
| D560 | D | E press sw |
| T146 | A | E temp |
| D561 | D | F press sw |
| T147 | A | F temp |
| D562 | D | G press sw |
| T148 | A | G temp |
| D563 | D | H press sw |
| T149 | A | H temp |
| M186 | A | Main stm safety valve A temp |
| T139 | A | A temp |
| M187 | A | B temp |
| T140 | A | B temp |
| M188 | A | C temp |
| T141 | A | C temp |
| N002 | A | HPCI flow |
| N003 | A | RCIC flow |
| N000 | A | Core spray pump A flow |
| N001 | A | B |
| M578 | D | Core spray pump A status |
| M580 | D | B |

Table 3-2. Field Input Points for Generating Cooper SPDS Displays (Continued).

| Point ID | Point Type* | Variable Name |
|---|---|---|
| N004 | A | RHR loop A flow |
| N005 | A | B |
| N861 | D | RHR pump 1A status |
| N862 | D | 1B status |
| N863 | D | 1C status |
| N864 | D | 1D status |
| N806 | D | RHR suction isolation valve, inbd |
| N807 | D | outbd |
| N017 | A | Containment (drywell) pressure (-5 to +5 psig) A |
| N018 | A | B |
| F084 | A | Drywell pressure (0-80 psia) A |
| F085 | A | B |
| M161 | A | Drywell temperature PT-10 |
| M162 | A | PT-11 |
| M163 | A | PT-12 |
| N276 | A | Drywell zone 2B area temp B |
| N277 | A | D |
| T122 | A | Drywell hydrogen level |
| N061 | A | Drywell/torus 0-5% oxygen level |
| N062 | A | Drywell/torus 0-10% oxygen level |
| N065 | A | Drywell/torus 0-25% oxygen level |
| N627 | D | Drywell oxygen sample No. 1 |
| N628 | D | Drywell oxygen sample No. 2 |
| N629 | D | Drywell oxygen sample No. 3 |
| N630 | D | Torus oxygen sample |
| N631 | D | Drywell/torus oxygen range No. 1 (0-5%) |
| N632 | D | Drywell/torus oxygen range No. 2 (0-10%) |
| N633 | D | Drywell/torus oxygen range No. 3 (0-25%) |
| N059 | A | Drywell flr sump pump 1F1/2 flow |
| N060 | A | pump 1G1/2 flow |
| N063 | A | High range drywell airlock area rad monitor |
| N023 | A | Suppression pool water temp 1A |
| N024 | A | 1B |
| N025 | A | 1C |

Table 3-2. Summary of Field Input Points for Generating Cooper SPDS Displays (Continued).

| Point ID | Point Type* | Variable Name |
|---|---|---|
| N026 | A | Suppression pool water temp 1D |
| N027 | A | 1E |
| N028 | A | 1F |
| N029 | A | 1G |
| N030 | A | 1H |
| N031 | A | 2A |
| N032 | A | 2B |
| N033 | A | 2C |
| N034 | A | 2D |
| N035 | A | 2E |
| N036 | A | 2F |
| N037 | A | 2G |
| N038 | A | 2H |
| N019 | A | Suppression pool level (0-30') A |
| N020 | A | B |
| N021 | A | Containment water level (0-100') A |
| N022 | A | B |
| N079 | A | ERP normal range rad monitor |
| N073 | A | AOG & RW effluent normal range rad monitor |
| N074 | A | Rx bldg effluent rad monitor |
| N069 | A | Turbine bldg effluent normal range rad monitor |
| N082 | A | SJAE radiation monitor A |
| N083 | A | B |
| N084 | A | SJAE A air flow |
| N085 | A | B air flow |

Notes: * A = analog, D = digital

** Data points not yet available on PMIS, but SPDS has display features and software to present this data when it becomes available

Table 3-3. Sequential Listing of Analog Field Input Points Used by the Cooper SPDS.

| Point ID | Variable Name |
|---|---|
| B000 | APRM A flux level |
| B001 | B |
| B002 | C |
| B003 | D |
| B004 | E |
| B005 | F |
| B021 | RPV water level - narrow range (0 to 60") A |
| F084 | Drywell pressure (0 to 80 psia) A |
| F085 | B |
| G032 | RPV water level - wide range (-150 to 60") A |
| G033 | B |
| M161 | Drywell temperature PT-10 |
| M162 | PT-11 |
| M163 | PT-12 |
| M186 | MS safety valve A temp |
| M187 | B |
| M188 | C |
| N000 | Core spray pump A flow |
| N001 | B |
| N002 | HPCI flow |
| N003 | RCIC flow |
| N004 | RHR loop A flow |
| N005 | B |
| N009 | RPV water level - fuel zone range (-100" to 200") A* |
| N010 | B* |
| N011 | RPV water level - narrow range (0 to 60") B |
| N012 | C |
| N013 | Reactor pressure (0 to 1500 psi) A |
| N014 | B |
| N017 | Containment (drywell) pressure (-5 to +5 psig) A |
| N018 | B |
| N019 | Suppression pool level (0 to 30') A |
| N020 | B |
| N021 | Containment water level (0 to 100') A |
| N022 | B |
| N023 | Suppression pool water temp 1A |
| N024 | 1B |
| N025 | 1C |
| N026 | 1D |
| N027 | 1E |
| N028 | 1F |
| N029 | 1G |
| N030 | 1H |

Table 3-3. Sequential Listing of Analog Field Input Points Used by the Cooper SPDS (Continued).

| Point ID | Variable Name |
|---|---|
| N031 | Suppression pool water temp 2A |
| N032 | 2B |
| N033 | 2C |
| N034 | 2D |
| N035 | 2E |
| N036 | 2F |
| N037 | 2G |
| N038 | 2H |
| N040 | SRM log count rate Ch A |
| N041 | B |
| N042 | C |
| N043 | D |
| N059 | Drywell floor sump pump 1F1/2 flow |
| N060 | 1G1/2 |
| N061 | Drywell/torus 0 to 5% oxygen level |
| N062 | Drywell/torus 0 to 10% oxygen level |
| N063 | High range drywell airlock area radiation monitor |
| N065 | Drywell/torus 0 to 25% oxygen level |
| N069 | Turbine bldg effluent normal range radiation monitor |
| N073 | AOG & RW effluent normal range radiation monitor |
| N074 | Reactor bldg effluent radiation monitor |
| N079 | ERP normal range radiation monitor |
| N082 | SJAE radiation monitor A |
| N083 | B |
| N084 | SJAE A air flow |
| N085 | B |
| N276 | Drywell zone 2B area temp B |
| N277 | D |
| T122 | Drywell hydrogen level |
| T139 | MS safety valve A temp |
| T140 | B |
| T141 | C |
| T142 | Main steam relief valve A temp |
| T143 | B |
| T144 | C |
| T145 | D |
| T146 | E |
| T147 | F |
| T148 | G |
| T149 | H |

*Data points not yet available on PMIS.

Table 3-4. Sequential Listing of Digital Field Input Points Used by the Cooper SPDS.

| Point ID | Variable Name |
|---|---|
| A519 | SRM detector not startup position (any) |
| A520 | SRM upscale alarm (any) |
| A521 | SRM inoperative alarm (any) |
| A527 | APRM upscale alarm (any) |
| A528 | APRM inoperative alarm (any) |
| A533 | SRM bypassed (any) |
| A535 | APRM Ch A bypassed |
| A536 | B |
| A537 | C |
| A538 | D |
| A539 | E |
| A540 | F |
| D530 | Reactor scram Ch A |
| D531 | B |
| D554 | Group 1 isolation A signal |
| D555 | B |
| D556 | Main steam relief valve A press sw |
| D557 | B |
| D558 | C |
| D559 | D |
| D560 | E |
| D561 | F |
| D562 | G |
| D563 | H |
| M578 | Core spray A status |
| M579 | B |
| N520 | All control rods in |
| N627 | Drywell oxygen sample No. 1 status |
| N628 | 2 |
| N629 | 3 |
| N630 | Drywell/torus oxygen range No. 1 (0-5%) |
| N631 | 2 (0-10%) |
| N632 | 3 (0-25%) |
| N781 | Group 2 isolation signal - inboard |
| N782 | - outboard |
| N783 | Group 3 isolation signal - inboard |
| N784 | - outboard |
| N785 | Group 4 isolation A signal |
| N786 | B |
| N787 | Group 5 isolation A signal |
| N788 | B |
| N789 | Group 6 isolation A signal |
| N790 | B |
| N791 | Group 7 isolation signal - inboard |
| N792 | - outboard |

Table 3-4. Sequential Listing of Digital Field Input Points Used by the Cooper SPDS (Continued).

| Point ID | Variable Name |
|---|---|
| N797 | Main steam iso valve A inboard |
| N798 | B |
| N799 | C |
| N800 | D |
| N801 | A outboard |
| N802 | B |
| N803 | C |
| N804 | D |
| N806 | RHR suction isolation valve - inboard |
| N807 | - outboard |
| N861 | RHR pump 1A status |
| N862 | 1B |
| N863 | 1C |
| N864 | 1D |

3.2.2 SPDS point/NRC 1.97 point

A. All SPDS composed points are declared as "SPDS points." None of these points are declared as "NRC 1.97 points."
B. All field inputs listed in Table 3-1 should be declared to be SPDS points.

3.2.3 Processing frequency

A. All SPDS composed points have been assigned processing frequency B (1 second).
B. All field input points listed in Table 3-1 also should be assigned either processing frequency B or A (0.1 second).

3.2.4 Processing control logicals

A. All composed points associated with trend or x-y plots have logicals set to YYYYNNNN (i.e., process, quality and alarm checking, archive, and quick look).
B. The following field input points are used directly in SPDS trend or x-y plots and also should have processing control logicals set to YYYYNNNN (i.e., to ensure that data is sent to quick look file):
   - N000, Core spray pump A flow
   - N001, Core spray pump B flow
   - N004, RHR loop A flow
   - N005, RHR loop B flow
   - T122, Drywell hydrogen concentration
C. All rates-of-change computed using transform #8 have logicals set to YNYNNNNN (i.e., no quality and alarm checking).
D. All other points have logicals set to YYYNNNNN (i.e., not sent to quick look file).

3.2.5 Engineering limit high/low

A. No engineering limits are required for rates-of-change. The PMIS default values of .1000E8 and -.100E8 are used for engineering limits high and low, respectively.

B. Engineering high/low limits for analog composed points correspond directly to the engineering high/low limits of the respective field input points.

3.2.6 Engineering units

A. All rates-of-change (ROC) computed using transform #8 are specified in terms of units per minute.

B. Engineering units for the following ROC variable are specified in the data base, but are not meaningful engineering terms. In the SPDS displays, these variables only drive the direction-of-change arrows. No analog value of rate-of-change is displayed.
   - SPDS0049, Drywell radiation monitor ROC (R/hr/min)
   - SPDS0071, ERP effluent ROC (uCi/sec/min)
   - SPDS0073, AOG & RW effluent ROC (uCi/sec/min)
   - SPDS0075, Rx Bldg effluent ROC (uCi/sec/min)
   - SPDS0077, Turbine Bldg effluent ROC (uCi/sec/min)
   - SPDS0079, SJAE effluent ROC (uCi/sec/min)

C. Engineering units for the data points which drive the following status indicators are defined as "Status":
   - Safety Function Indicators
   - Equipment Status Indicators
   - EOP limit status indicators
   - Not-Valid Indicators
   - Downscale Indicators

D. Engineering units for spare points are defined as "Spare".

3.2.7 Display fractional digits

A. All calculated rates-of-change are displayed to the nearest whole number, with no decimal places (i.e., displayed fractional digits = 0).

B. Points associated with equipment status, EOP limit status, or safety function indicator boxes are external (real) points but actually have integer values (i.e., 0,1,2 ... etc.). They are presented as whole numbers, with no decimal places (i.e., displayed fractional digits = 0).

C. Other analog points are displayed with 0, 1 or 2 decimal places as needed to show current values to three significant figures. The only exception to this guideline is that four significant figures are used to display analog values greater than 999.

3.2.8 Compression limits

A. All linear range analog points have been assigned compression limits that are 10 percent of the engineering range, rounded up to the nearest whole number.

B. An exception to (A), above, is that the compression limit for all RPV water level ranges have been set at 10 percent of the narrow range scale, for uniformity.

C. All log range analog points have been assigned compression limits that are 10 percent of the engineering limit high.

D. All external (real) points which can take on only integer values (i.e., 0,1,2 ... etc.), have been assigned a compression limit of 1.

3.2.9 Alarm/Warning limits

A. For analog points, only actual alarm and warning limits are specified in the data base (See Section 4). Where no relevant alarm or warning setpoint exists, it is indicated by the special characters 'NA'.

B. There are no warning or alarm limits specified for rate-of-change variables.

C. For all external (real) points which can take on only integer values (i.e., 0,1,2 ... etc.), the warning low and alarm low limits have been specified as 'NA'.

D. All field input points associated with SPDS composed points should have corresponding warning and alarm limits (see Section 4 for a listing of field input points and related SPDS composed points).

3.2.10 Alarm deadband

A. All ROC variables calculated using transform #8 are assigned a default deadband of 100000. This actually is a meaningless value because none of the ROC variables have alarm or warning limits specified.

B. For all other analog points, a deadband of about 1 percent of the instrument range is assigned, rounded to the nearest whole number greater than 0.

C. An exception to (B), above, is that the alarm deadband is specified as 1 percent of the alarm setpoint when the alarm setpoint is encountered at the low end of the instrument range (i.e., an example is point SPDS0078, SJAE effluent).

3.2.11 Initialization value desired/initialization value

A. Initialization values are specified for the Safety Function Indicators (SPDSBOX1 to SPDSBOX5). An initialization value of '0' is specified. This is the value assigned for normal conditions.

B. Initialization values are specified for two constants (SPDS021B) and SPDS022B) associated with Display L3.15. Initialization values are set equal to the respective values of the constants.

C. No other initialization values have been assigned.

### 3.2.12 Tranform interval

A. The rate-of-change algorithm used for the SPDS (transform #8) has a fixed transform interval, as described later in this section.

B. No other PMIS transforms are used for SPDS displays.

## 3.3 DESCRIPTION OF CALCULATIONS FOR SELECTED PMIS COMPOSED POINTS

The calculations associated with PMIS composed points are standard PMIS routines that are separately documented. Selected PMIS composed point calculations are described in the following section.

### 3.3.1 PMIS Rate-of-Change Transform

With the exception of source range reactor period (i.e., source range monitor rate-of-change), all SPDS rate-of-change variables are calculated by applying PMIS transform #8 to a field input point or to an SPDS composed point. The algorithm for this transform utilizes the last four scan values to calculate a rate-of-change as follows:

$$T_n = (15/SR)((P_n + P_{n-1}) - (P_{n-2} + P_{n-3}))$$

where $T_n$ = transform output (units/minute)
$P_n$ = input variable at scan point n (units)
n = scan point, where n = 1 is current scan
SR = scan rate (seconds)

This transform simply averages the last two scan values and the previous two scan values and computes a simple change rate between the two averaged values. This approach is expected to yield a rate-of-change that is reasonably responsive for both slow changing and fast changing variables. The scan rate of a point is explicitly treated in the algorithm for transform #8. The scan rate for the point in question is read from main memory each time transform #8 is used. If the scan rate of a point is changed, transform #8 will continued to calculate a correct rate-of-change.

It should be noted that ROC data is provided in the SPDS as supplementary data. The SPDS Safety Analysis* did not identify any ROC data that was directly related to safety function status or EOP entry conditions. Therefore, the expected use of ROC data does not warrant a more sophisticated algorithm than the algorithm described above for PMIS transform #8.

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*Safety Parameter Display System Safety Analysis, 503-8500000-76

### 3.3.2 PMIS Healthy Calculations

As described in Section 2, many calculations for the SPDS are performed only using input points with a quality that is considered to be "healthy". Important examples of such PMIS calculations are healthy average (HAVE), healthy maximum (HMAX), healthy OR (HOR), and healthy AND (HAND). All of these healthy calculations will yield meaningful results if at least one input point maintains a healthy data quality. When no healthy input points are available, the quality of the "healthy" result is NCAL. In this case, the PMIS current value table retains the last healthy value of the respective variable, and the table is not updated until a healthy input point again becomes available. Each of the PMIS healthy calculations are described below.

#### 3.3.2.1 Healthy Average

A healthy average is an arithmetic average of the current values of those input points that have a healthy data quality. As an example, an average of many input points will actually be an average as long as two or more input points remain healthy. If only one input point is healthy, the value of that input point is assigned to the healthy average result. This result is no longer an average value, but it does represent the best available information on the current value of the respective variable.

#### 3.3.2.2 Healthy Maximum

A healthy maximum determines the maximum current value of these input points that have a healthy data quality. As an example, a maximum of many input points is determined by a comparison process, and the greatest current value is assigned to the healthy maximum result. If only one input point is healthy, that value is the maximum and it is assigned to the healthy maximum result.

#### 3.3.2.3 Healthy OR

A healthy OR of two healthy input points is equivalent to a simple Boolean OR operation. If one input point is not healthy, it is assumed to have a value of "0". In this case, the healthy OR result is the value of the remaining healthy input point.

3.3.2.4 Healthy AND

A healthy AND of two healthy input points is equivalent to a simple Boolean AND operation. If one input point is not healthy, it is assumed to have a value of "1". In this case, the healthy AND result is the value of the remaining healthy input point.

## 3.4 DESCRIPTION OF CALCULATIONS FOR EXTERNAL (REAL) POINTS

The calculations performed for external (real) points are not supported by the PMIS and are documented in this report, as listed in Table 3-5. To the extent practical, "healthy" calculations are used to determine the current value of external (real) points. Special SPDS software has been developed to support these external (real) points.

Table 3-5. Cross-Reference to Descriptions of Calculations to Support External (Real) Points.

| External (Real) Point | Use* | Report Section Describing Calculation |
|---|---|---|
| SPDS0010 | ESI | 6.1 |
| SPDS0015 | Analog | 8.1 |
| SPDS0029 | Analog | 8.3 |
| SPDS0039 | ESI | 6.1 |
| SPDS0040 | ESI | 6.1 |
| SPDS0041 | ESI | 6.1 |
| SPDS0042 | ESI | 6.1 |
| SPDS0050 | ESI | 6.1 |
| SPDS0054 | ESI | 6.1 |
| SPDS0069 | Analog | 9.7 |
| SPDS0078 | Analog | 8.10 |
| SPDS0080 | ESI | 6.1 |
| SPDS0084 | Analog | 9.1 |
| SPDS0085 | ESI | 6.1 |
| SPDS0086 | ESI | 6.1 |
| SPDS0089 | ESI | 6.1 |
| SPDS0090 | Analog | 9.6 |
| SPDS0091 | Analog | 9.6 |
| SPDS0092 | Analog | 9.6 |
| SPDS0093 | ESI | 6.1 |
| SPDS0094 | ESI | 6.1 |
| SPDS0095 | ESI | 6.1 |
| SPDS0096 | ESI | 6.1 |
| SPDS0097 | ESI | 6.1 |
| SPDS0098 | ESI | 6.1 |
| SPDS0099 | ESI | 6.1 |
| SPDS000B | EOPSI | 9.1 |
| SPDS001B | EOPSI | 9.2 |
| SPDS002B | EOPSI | 9.3 |
| SPDS004B | EOPSI | 9.4 |
| SPDS006B | EOPSI | 9.5 |
| SPDS007B | EOPSI | 9.6 |
| SPDS009B | EOPSI | 9.6 |
| SPDS010B | EOPSI | 9.7 |
| SPDS011B | EOPSI | 9.8 |
| SPDS021B | EOPSI | 9.12 |
| SPDS022B | EOPSI | 9.12 |
| SPDS023B | EOPSI | 9.12 |
| SPDS024B | EOPSI | 9.12 |
| SPDS025B | EOPSI | 9.12 |
| SPDS026B | EOPSI | 9.12 |
| SPDS027B | EOPSI | 9.12 |
| SPDS028B | EOPSI | 9.10 |
| SPDSBOX1 | SFI | 5.1 |

Table 3-5. Cross-Reference to Descriptions of Calculations to Support External (Real) Points (continued)

| External (Real) Point | Use* | Report Section Describing Calculation |
|---|---|---|
| SPDSB0X2 | SFI | 5.2 |
| SPDSB0X3 | SFI | 5.3 |
| SPDSB0X4 | SFI | 5.4 |
| SPDSB0X5 | SFI | 5.5 |
| SPDS01DS | DNSCI | 2.2 |
| SPDS02DS | DNSCI | 2.2 |
| SPDS03DS | DNSCI | 2.2 |
| SPDS04DS | DNSCI | 2.2 |
| SPDS05DS | DNSCI | 2.2 |
| SPDS06DS | DNSCI | 2.2 |
| SPDS07DS | DNSCI | 2.2 |
| SPDS08DS | DNSCI | 2.2 |
| SPDS09DS | DNSCI | 2.2 |
| SPDS10DS | DNSCI | 2.2 |
| SPDS11DS | DNSCI | 2.2 |
| SPDS12DS | DNSCI | 2.2 |
| SPDS13DS | DNSCI | 2.2 |
| SPDS14DS | DNSCI | 2.2 |
| SPDS15DS | DNSCI | 2.2 |
| SPDS16DS | DNSCI | 2.2 |
| SPDS17DS | DNSCI | 2.2 |
| SPDS18DS | DNSCI | 2.2 |
| SPDS19DS | DNSCI | 2.2 |
| SPDS20DS | DNSCI | 2.2 |
| SPDS21DS | DNSCI | 2.2 |
| SPDS22DS | DNSCI | 2.2 |
| SPDS01NV | NVI | 2.2 |
| SPDS02NV | NVI | 2.2 |
| SPDS03NV | NVI | 2.2 |
| SPDS04NV | NVI | 2.2 |
| SPDS05NV | NVI | 2.2 |
| SPDS06NV | NVI | 2.2 |
| SPDS07NV | NVI | 2.2 |
| SPDS08NV | NVI | 2.2 |
| SPDS09NV | NVI | 2.2 |
| SPDS10NV | NVI | 2.2 |
| SPDS11NV | NVI | 2.2 |
| SPDS12NV | NVI | 2.2 |
| SPDS13NV | NVI | 2.2 |
| SPDS14NV | NVI | 2.2 |
| SPDS15NV | NVI | 2.2 |
| SPDS16NV | NVI | 2.2 |
| SPDS17NV | NVI | 2.2 |
| SPDS18NV | NVI | 2.2 |
| SPDS19NV | NVI | 2.2 |

Table 3-5. Cross-Reference to Descriptions of Calculations to Support External (Real) Points (continued)

* Abbreviations are defined as follows:
DNSCI = Downscale indicator
EOPSI = EOP status indicator
ESI = Equipment status indicator
NVI = Not-valid indicator
SFI = Safety-function indicator

## 3.5 GUIDELINES FOR SEPARATION OF REDUNDANT FIELD INPUT POINTS USED BY THE SPDS

As described in Section 2, some of the field input analog points are treated as redundant points. To enhance SPDS reliability, these points will provided with some level of separation when practical. In the absence of established design criteria for the separation of redundant SPDS field input points, the following guidelines present a "common sense" approach for providing reasonable separation:

- The redundant points should be terminated to different multiplexers when multiplexers powered from different divisions of electric power are available in the same vicinity. If the available multiplexers are supplied from the same electrical division (i.e., the same external source of power), a loss of that electrical division will result in a loss of all supplied multiplexers. In this case, terminating the redundant points to different multiplexers is of limited value, because the only class of single-point failure to be eliminated is a multiplexer failure having a "global" effect on all connected field inputs. If multiplexer reliability is on the same order as the reliability of the supplying electrical division, or better, this type of separation probably is not worth the effort.

- Redundant points terminated to the same multiplexer should be connected to different termination boards in that multiplexer. This type of separation ensures that a board failure will affect only one of the redundant field inputs. Multiplexer design allows replacement of a single board without having to take the entire multiplexer out of service, therefore, the redundant field input points(s) remain available during replacement of a failed board. The SPDS will be able to display accurate data following failure of a single board. Validation of the redundant input data points is performed by the PMIS and the SPDS. As described in Section 2, a Not-Valid Indicator (i.e., the characters "NV") will be displayed adjacent to bar charts, trend plots, x-y plots or current values that present calculated data, when the

contributing input points fail prescribed validation checks. This status information will alert the operators to the possible loss of a redundant field input.

It should be emphasized, however, that there are no NRC separation requirements that are specifically applicable to the SPDS, other than the generally applicable Class 1E separation requirements which are met by the PMIS.

# 4. WARNING AND ALARM LIMITS FOR KEY PLANT VARIABLES

## 4.1 WARNING AND ALARM LIMITS

A summary is presented in Table 4-1 of the limiting conditions for operation (LCO), limiting safety system settings (LSSS), and other operating limits that are applicable to variables used by the SPDS. The source of each warning or alarm limit is identified. Table 4-1 is a comprehensive source listing from which warning and alarm limits were selected for variables used by the SPDS. Many of the limits listed in Table 4-1 do not appear in the SPDS or in the PMIS data base, but are included in the table for information only.

The PMIS data base allows the following warning and alarm limits to be specified for an analog, pseudo-analog or external (real) data point:

- Alarm high (HALM)
- Warning high (HWRN)
- Warning low (LWRN)
- Alarm low (LALM)

These warning and alarm limits can be redefined in the PMIS data base for each of the following plant modes:

- Run (mode 1)
- Startup (mode 2)
- Refuel (mode 3)
- Shutdown (mode 4)

Up to 16 warning and alarm constants can be defined for each analog, pseudo-analog or external (real) variable in the PMIS data base. Table 4-2 lists the warning and alarm constants that should be used in the PMIS data base for variables that are used directly by the SPDS (i.e., to drive a bar chart, trend or x-y plot, or a status indicator). The format of the warning and alarm listing in Table 4-2 is similar to the format of a listing of the

PMIS data base. This should facilitate the verificatiton of the warning and alarm limits in the PMIS data base record for each variable.

In a few cases, the applicability of warning and alarm limits in Table 4-2 is different than that listed in Table 4-1. In those cases, a RUN mode limit listed in Table 4-1 has been applied to all plant modes in Table 4-2 because no other limits were identified for other plant modes but engineering judgement indicated that the RUN limit could reasonably be extended to other plant modes.

Selected warning and alarm limits listed in Table 4-2 appear as annotated "tic-marks" on SPDS bar charts, trend plots or x-y plots. The specific tic-marks included in each display are listed in Sections 7, 8 and 9.

Table 4-1. Instrument Ranges, Normal Operating Limits and Warning/Alarm Limits.

| Variable Name | Instrument Range | Operating/Warning/ Alarm Limit* | Plant Mode** | Affected Point ID |
|---|---|---|---|---|
| APRM flux level | 0 to 125% | 120% (LSS 2.1.A.1) | 1 | B000, |
| | | 100% (OPLIM) | 1 | B001, |
| | | Variable (LSS 2.1.A.1 & LCO 3.1) | 1 | B002, B003, |
| | | 20% (LCO 3.3.B.3) | 1,2 | B004, |
| | | 15% (LSS 2.1.A.1 & LCO 3.1) | 2,3,4 | B005 |
| | | 2.5% (LCO 3.1) | 1,4 | |
| Average APRM | Same as above | Same as above | | SPDS0008 |
| SRM log count rate | $10^{-1}$ to $10^{6}$ cps | None | | N040, N041, N042, N043 |
| Average SRM | Same as above | Same as above | | SPDS0013, SPDS0014 |
| RPV level narrow range | 0 to 60 in | 58.5 in (LCO 3.2.B) | 1,2 | B021, |
| | | 42.5 in (OPLIM) | 1,2 | N011, |
| | | 27.5 in (OPLIM) | 1,2 | N012 |
| | | 12.5 in (LSS 2.1.A.2 & LCO 3.1) | All | |
| Average narrow range RPV level | Same as above | Same as above | | SPDS0019 |
| RPV level wide range | -150 in to 60 in | 58.5 in (LCO 3.2.B) | 1,2 | G032, |
| | | 42.5 in (OPLIM) | 1,2 | G033 |
| | | 27.5 in (OPLIM) | 1,2 | |
| | | 12.5 in (LCO 3.2.B) & LCO 3.1) | All | |
| | | -37 in (LCO 3.2.A) | All | |
| | | -145.5 in (LSS 2.1.B & LCO 3.2.A) | All | |
| Average wide range RPV level | Same as above | Same as above | | SPDS0023 |

Table 4-1. Instrument Ranges, Normal Operating Limits and Warning/Alarm Limits (continued).

| Variable Name | Instrument Range | Operating/Warning/ Alarm Limit* | Plant Mode** | Affected Point ID |
|---|---|---|---|---|
| RPV level fuel zone range | -100 in to 200 in | -39 in (2/3 core height) | All | N009, N010 |
| Average FZ range RPV level | Same as above | Same as above | All | SPDS0027 |
| HPCI flow | 0 to 5000 gpm | 4250 gpm (SR 4.5.C) | All | N002 |
| | | 400 gpm (LCO 3.2.B) | All | |
| RCIC flow | 0 to 500 gpm | 400 gpm (SR 4.5.D) | All | N003 |
| | | 40 gpm (LCO 3.2.B) | All | |
| Core spray flow | 0 to 6000 gpm | 4720 gpm (SR 4.5.A) | All | N000, N001 |
| RHR flow | 0 to 30,000 gpm | 23,100 gpm (OPLIM) | All | N004, N005 |
| | | 15,000 gpm (SR 4.5.A) | All | |
| | | 8,400 gpm (SR 4.5.A) | All | |
| | | 7,700 gpm (SR 4.5.A) | All | |
| | | 2,500 gpm (LCO 3.2.B) | All | |
| RPV pressure | 0 to 1500 psig | 1240 psig (LSS 2.2.1.C) | 1 | N013, N014 |
| | | 1120 psig (LCO 3.2.G) | 1,2,4 | |
| | | 1080 psig to 1100 psig (LSS 2.2.1.B) | 1 | |
| | | 1045 psig (LSS 2.2.1.A & LCO 3.1) | All | |
| | | 1025 psig (LCO 3.2.B) | 1 | |
| | | 1015 psig (LCO 3.2.B) | 1 | |
| | | 1005 psig (SAR) | All | |
| | | 875 psig (LCO 3.2.B) | 1 | |
| | | 825 psig (LSS 2.1.A.6) | 1 | |
| | | 450 psig (LCO 3.2.B) | 1 | |
| | | 425 psig (EOP C1) | 4 | |
| | | 200 psig (LCO 3.7.A.1) | 4 | |
| | | 100 psig (EOP C1) | 4 | |
| | | 113 psig (LCO 3.5.E) | 3,4 | |
| | | 75 psig (LSS 2.2.2 & LCO 3.2.A) | 3,4 | |
| Average RPV pressure | Same as above | Same as above | | SPDS0030 |

Table 4-1. Instrument Ranges, Normal Operating Limits and Warning/Alarm Limits (continued).

| Variable Name | Instrument Range | Operating/Warning/ Alarm Limit* | Plant Mode** | Affected Point ID |
|---|---|---|---|---|
| Drywell pressure narrow range | -5 to +5 psig | 2 psig (LCO 3.1)<br>1.45 psig (OPLIM) | All<br>All | N017, N018 |
| Average narrow range drywell pressure | Same as above | Same as above | | SPDS0043 |
| Drywell pressure mid-range | 0 to 80 psia | 16.7 psia (LCO 3.1)<br>16.2 psia (OPLIM) | All | F084, F085 |
| Average mid-range drywell pressure | Same as above | Same as above | All | SPDS0045 |
| Drywell temperature, individual points | 0 to 400°F | 185°F (OPLIM)<br>160°F (OPLIM) | All<br>All | M161, M162, and M163 |
| Drywell temperature, individual points | 50 to 300°F | Same as above | | N276, N277 |
| Maximum drywell temperature | 50 to 400°F | Same as above | | SPDS0051 |
| Drywell hydrogen concentration | 0 to 10% | 2.5% (OPLIM) | All | T122 |
| Calculated drywell oxygen concentration | 0 to 25% (over 3 inst. ranges) | 4% (LCO 3.7.A.4) | 1,2 | SPDS0090, SPDS0091, SPDS0092, SPDS0100 |
| Calculated torus oxygen concentration | Same as above | Same as above | | SPDS0069 |
| Drywell floor sump pump flow | 0 to 150 gpm | None | All | N059, N060 |

Table 4-1. Instrument Ranges, Normal Operating Limits and Warning/Alarm Limits (continued).

| Variable Name | Instrument Range | Operating/Warning/ Alarm Limit* | Plant Mode** | Affected Point ID |
|---|---|---|---|---|
| Supp. pool sector temperature | 0 to 250°F | 120°F (LCO 3.7.A.1)<br>110°F (LCO 3.7.A.1)<br>105°F (LCO 3.7.A.1)<br>95°F (LCO 3.7.A.1) | 1<br>1<br>1<br>1 | SPDS0055,<br>SPDS0056,<br>SPDS0057,<br>SPDS0058,<br>SPDS0059,<br>SPDS0060,<br>SPDS0061,<br>SPDS0062 |
| Average supp pool temperature | Same as above | Same as above | | SPDS0063 |
| Suppression pool water level, wide range | 0 to 30 ft | 9.17 ft (OPLIM)<br>8.88 ft (OPLIM) | All<br>All | N019,<br>N020 |
| Avg supp pool water level, wide range | 0 to 30 ft | Same as above | | SPDS0065 |
| High range drywell airlock area rad. monitor | $10^0$ to $10^7$ Rad/hr | 30 rad/hr (OPLIM)<br>15 rad/hr (OPLIM) | All<br>All | N063 |
| ERP effluent rad monitor, normal range | $10^{-4}$ to $10^6$ uCi/sec | $2.21 \times 10^4$ (OPLIM)<br>$2.21 \times 10^3$ (OPLIM) | All<br>All | N079,<br>SPDS0070 |
| AOG & RW effluent rad monitor normal range | $10^{-3}$ to $10^7$ uCi/sec | $3.80 \times 10^3$ (OPLIM)<br>$3.80 \times 10^2$ (OPLIM) | All<br>All | N073,<br>SPDS0072 |
| Rx bldg effluent rad monitor, normal range | $10^{-3}$ to $10^7$ uCi/sec | $4.29 \times 10^3$ (OPLIM)<br>$4.20 \times 10^2$ (OPLIM) | All<br>All | N074,<br>SPDS0074 |
| Turbine bldg effluent rad monitor, normal range | $10^{-3}$ to $10^7$ uCi/sec | $4.60 \times 10^3$ (OPLIM)<br>$4.60 \times 10^2$ (OPLIM) | All<br>All | N069,<br>SPDS0076 |

Table 4-1. Instrument Ranges, Normal Operating Limits and Warning/Alarm Limits (continued).

| Variable Name | Instrument Range | Operating/Warning/ Alarm Limit* | Plant Mode** | Affected Point ID |
|---|---|---|---|---|
| SJAE effluent rad monitor | $1.0^0$ to $10^9$ uCi/sec | $3.52 \times 10^5$ (OPLIM)<br>$6.75 \times 10^4$ (OPLIM) | All<br>All | SPDS0078,<br>SPDS0081 |
| Main steam SV and SRV tailpipe temperature | 0 to 600°F | 300°F (OPLIM) | All | M186 to M188, T139 to T149 |

* The LCO alarm or trip settings are stated in one of the following sources:

LSS = Limiting Safety Systems Settings (See Cooper Tech Specs)

LCO = Limiting Condition for Operation (See Cooper Tech Specs)

SR = Surveillance Requirement (See Cooper Tech Specs)

EOP = Emergency Operating Procedures

OPLIM = Operating Limit Specified by NPPD

Note that references to the Tech Specs only include the first occurrence of the LCO or SR limit. The limit may also be referenced in other Sections of the Tech Specs.

** Plant mode: 1 = RUN
2 = STARTUP
3 = REFUEL
4 = SHUTDOWN

Table 4-2. Summary of Warning and Alarm Limits for Data Points Used Directly by SPDS.

| Variable (Units) | Point ID | Plant Mode* | Alarm High (HALM) | Warning High (HWRN) | Warning Low (LWRN) | Alarm Low (LALM) |
|---|---|---|---|---|---|---|
| APRM (%) | B000, B001, B002, B003, B004, B005, SPDS0008 | 1 | 120 | 100 | - | - |
| | | 2 | 15 | - | - | - |
| | | 3 | 15 | - | - | - |
| | | 4 | 15 | - | - | - |
| SRM (cps) | SPDS0014 | 1 | - | - | - | - |
| | | 2 | - | - | - | - |
| | | 3 | - | - | - | - |
| | | 4 | - | - | - | - |
| SRM (logarithm) | SPDS0013 | 1 | - | - | - | - |
| | | 2 | - | - | - | - |
| | | 3 | - | - | - | - |
| | | 4 | - | - | - | - |
| RPV Level Narrow Range (inches) | B021, N011, N012, SPDS0019 | 1 | 58.5 | 42.5 | 27.5 | 12.5 |
| | | 2 | - | - | - | 12.5 |
| | | 3 | - | - | - | 12.5 |
| | | 4 | - | - | - | 12.5 |
| RPV Level Wide Range (inches) | G032, G033, SPDS0023 | 1 | 58.5 | 42.5 | 27.5 | 12.5 |
| | | 2 | - | - | - | 12.5 |
| | | 3 | - | - | - | 12.5 |
| | | 4 | - | - | - | 12.5 |
| RPV Level FZ Range (inches) | N009, N010, SPDS0027 | 1 | - | - | 191.7 | 176.7 |
| | | 2 | - | - | - | 176.7 |
| | | 3 | - | - | - | 176.7 |
| | | 4 | - | - | - | 176.7 |
| RPV Level Mimic (inches) | SPDS0029 | 1 | 575.3 | 559.3 | 544.3 | 529.3 |
| | | 2 | - | - | - | 529.3 |
| | | 3 | - | - | - | 529.3 |
| | | 4 | - | - | - | 529.3 |

Table 4-2. Summary of Warning and Alarm Limits for Data Points Used Directly by SPDS (continued).

| Variable (Units) | Point ID | Plant Mode* | Alarm High (HALM) | Warning High (HWRN) | Warning Low (LWRN) | Alarm Low (LALM) |
|---|---|---|---|---|---|---|
| RPV Pressure (psig) | N013, N014, SPDS0030 | 1 | 1045 | 1005 | 825 | 825 |
| | | 2 | 1045 | 1005 | - | - |
| | | 3 | 1045 | 1005 | - | - |
| | | 4 | 1045 | 1005 | - | - |
| Drywell Pressure Narrow Range (psig) | SPDS0043 | 1 | 2.00 | 1.45 | - | - |
| | | 2 | 2.00 | 1.45 | - | - |
| | | 3 | 2.00 | 1.45 | - | - |
| | | 4 | 2.00 | 1.45 | - | - |
| Drywell Pressure Mid-Range (psia) | SPDS0045 | 1 | 16.7 | 16.2 | - | - |
| | | 2 | 16.7 | 16.2 | - | - |
| | | 3 | 16.7 | 16.2 | - | - |
| | | 4 | 16.7 | 16.2 | - | - |
| Maximum Drywell Temperature (°F) | SPDS0051 | 1 | 185 | 160 | - | - |
| | | 2 | 185 | 160 | - | - |
| | | 3 | 185 | 160 | - | - |
| | | 4 | 185 | 160 | - | - |
| Drywell Hydrogen Concentration (%) | T122 | 1 | 2.5 | - | - | - |
| | | 2 | 2.5 | - | - | - |
| | | 3 | 2.5 | - | - | - |
| | | 4 | 2.5 | - | - | - |
| Drywell Oxygen Concentration (%) | SPDS0090, SPDS0091, SPDS0092, SPDS0100 | 1 | 4.0 | - | - | - |
| | | 2 | 4.0 | - | - | - |
| | | 3 | - | - | - | - |
| | | 4 | - | - | - | - |
| Torus Oxygen Concentration (%) | SPDS0069 | 1 | 4.0 | - | - | - |
| | | 2 | 4.0 | - | - | - |
| | | 3 | - | - | - | - |
| | | 4 | - | - | - | - |
| Average Supp. Pool Temperature (°F) | SPDS0063 | 1 | 110 | 95 | - | - |
| | | 2 | 110 | 95 | - | - |
| | | 3 | 110 | 95 | - | - |
| | | 4 | 110 | 95 | - | - |

Table 4-2. Summary of Warning and Alarm Limits for Data Points Used Directly by SPDS (continued).

| Variable (Units) | Point ID | Plant Mode* | Alarm High (HALM) | Warning High (HWRN) | Warning Low (LWRN) | Alarm Low (LALM) |
|---|---|---|---|---|---|---|
| Supp. Pool Sector Temperature (°F) | SPDS0055, SPDS0056, SPDS0057, SPDS0058, SPDS0059, SPDS0060, SPDS0061, SPDS0062 | 1 | 110 | 95 | - | - |
| | | 2 | 110 | 95 | - | - |
| | | 3 | 110 | 95 | - | - |
| | | 4 | 110 | 95 | - | - |
| Supp. Pool Water Level, Wide Range (feet) | SPDS0065 | 1 | 13.17 | - | - | 12.88 |
| | | 2 | 13.17 | - | - | 12.88 |
| | | 3 | 13.17 | - | - | 12.88 |
| | | 4 | 13.17 | - | - | 12.88 |
| Containment Water Level, Wide Range (feet) | SPDS0067 | 1 | - | - | - | - |
| | | 2 | - | - | - | - |
| | | 3 | - | - | - | - |
| | | 4 | - | - | - | - |
| SV and SRV Tailpipe Temperature (°F) | M186 to M188, T139 to T149, | 1 | 300 | - | - | - |
| | | 2 | 300 | - | - | - |
| | | 3 | 300 | - | - | - |
| | | 4 | 300 | - | - | - |
| HPCI Flow (gpm) | N002 | 1 | - | - | - | 400 |
| | | 2 | - | - | - | 400 |
| | | 3 | - | - | - | 400 |
| | | 4 | - | - | - | 400 |
| RCIC Flow (gpm) | N003 | 1 | - | - | - | 40 |
| | | 2 | - | - | - | 40 |
| | | 3 | - | - | - | 40 |
| | | 4 | - | - | - | 40 |
| Core Spray Flow (gpm) | N000, N001 | 1 | - | - | - | - |
| | | 2 | - | - | - | - |
| | | 3 | - | - | - | - |
| | | 4 | - | - | - | - |
| RHR Flow (gpm) | N004, N005 | 1 | - | - | - | - |
| | | 2 | - | - | - | - |
| | | 3 | - | - | - | - |
| | | 4 | - | - | - | - |

Table 4-2. Summary of Warning and Alarm Limits for Data Points Used Directly by SPDS (continued).

| Variable (Units) | Point ID | Plant Mode* | Alarm High (HALM) | Warning High (HWRN) | Warning Low (LWRN) | Alarm Low (LALM) |
|---|---|---|---|---|---|---|
| Drywell Floor Sump Pump Flow (gpm) | N059, N060 | 1 | - | - | - | 10 |
| | | 2 | - | - | - | 10 |
| | | 3 | - | - | - | 10 |
| | | 4 | - | - | - | 10 |
| Containment Radiation (Rad/hr) | N063 | 1 | 30 | 15 | - | - |
| | | 2 | 30 | 15 | - | - |
| | | 3 | 30 | 15 | - | - |
| | | 4 | 30 | 15 | - | - |
| Containment Radiation (logarithm) | SPDS0082 | 1 | 1.48 | 1.18 | - | - |
| | | 2 | 1.48 | 1.18 | - | - |
| | | 3 | 1.48 | 1.18 | - | - |
| | | 4 | 1.48 | 1.18 | - | - |
| ERP Effluents (uCi/sec) | N079 | 1 | 2.21E4 | 2.21E3 | - | - |
| | | 2 | 2.21E4 | 2.21E3 | - | - |
| | | 3 | 2.21E4 | 2.21E3 | - | - |
| | | 4 | 2.21E4 | 2.21E3 | - | - |
| ERP Effluents (logarithm) | SPDS0070 | 1 | 4.34 | 3.34 | - | - |
| | | 2 | 4.34 | 3.34 | - | - |
| | | 3 | 4.34 | 3.34 | - | - |
| | | 4 | 4.34 | 3.34 | - | - |
| AOG & RW Effluents (uCi/sec) | N073 | 1 | 3.80E3 | 3.80E2 | - | - |
| | | 2 | 3.80E3 | 3.80E2 | - | - |
| | | 3 | 3.80E3 | 3.80E2 | - | - |
| | | 4 | 3.80E3 | 3.80E2 | - | - |
| AOG & RW Effluents (logarithm) | SPDS0072 | 1 | 3.58 | 2.58 | - | - |
| | | 2 | 3.58 | 2.58 | - | - |
| | | 3 | 3.58 | 2.58 | - | - |
| | | 4 | 3.58 | 2.58 | - | - |
| Rx Bldg Effluents (uCi/sec) | N074 | 1 | 4.29E3 | 4.29E2 | - | - |
| | | 2 | 4.29E3 | 4.29E2 | - | - |
| | | 3 | 4.29E3 | 4.29E2 | - | - |
| | | 4 | 4.29E3 | 4.29E2 | - | - |

Table 4-2. Summary of Warning and Alarm Limits for Data Points Used Directly by SPDS (continued).

| Variable (Units) | Point ID | Plant Mode* | Alarm High (HALM) | Warning High (HWRN) | Warning Low (LWRN) | Alarm Low (LALM) |
|---|---|---|---|---|---|---|
| Rx Bldg Effluents (logarithm) | SPDS0074 | 1 | 3.63 | 2.63 | - | - |
| | | 2 | 3.63 | 2.63 | - | - |
| | | 3 | 3.63 | 2.63 | - | - |
| | | 4 | 3.63 | 2.63 | - | - |
| Turb. Bldg Effluents (uCi/sec) | N069 | 1 | 4.60E3 | 4.60E2 | - | - |
| | | 2 | 4.60E3 | 4.60E2 | - | - |
| | | 3 | 4.60E3 | 4.60E2 | - | - |
| | | 4 | 4.60E3 | 4.60E2 | - | - |
| Turb. Bldg Effluents (logarithm) | SPDS0076 | 1 | 3.66 | 2.66 | - | - |
| | | 2 | 3.66 | 2.66 | - | - |
| | | 3 | 3.66 | 2.66 | - | - |
| | | 4 | 3.66 | 2.66 | - | - |
| SJAE Effluents (uCi/sec) | SPDS0078 | 1 | 3.52E5 | 6.75E4 | - | - |
| | | 2 | 3.52E5 | 6.75E4 | - | - |
| | | 3 | 3.52E5 | 6.75E4 | - | - |
| | | 4 | 3.52E5 | 6.75E4 | - | - |
| SJAE Effluents (logarithm) | SPDS0081 | 1 | 5.55 | 4.83 | - | - |
| | | 2 | 5.55 | 4.83 | - | - |
| | | 3 | 5.55 | 4.83 | - | - |
| | | 4 | 5.55 | 4.83 | - | - |

*Plant mode: 1 = Run
2 = Startup
3 = Refuel
4 = Shutdown

## 4.2 GUIDELINES FOR MAINTAINING WARNING AND ALARM LIMITS

In actual practice, warning and alarm limits for CNS instrumentation systems are set at values different than the LCO, LSSS, or operating limit values. As shown in Figure 4-1, an operating margin is imposed to allow for instrument drift, minor operational errors, and fluctuations in process or control characteristics. The resulting operating limit causes the instrument to generate warnings and alarms at some conservative increment before the technical specification or operating limit is reached.

There are two basic approaches for establishing and maintaining SPDS warning and alarm limits in the PMIS data base. The first approach is to use the technical specification and operating limits to establish the actual warning and alarm limits in the PMIS data base. These setpoints essentially are treated as constants, and are revised only when changes are made in the technical specifications or other plant operating references. This approach simplifies maintenance of the PMIS data base, but may result in inconsistencies between control room alarms and SPDS-generated alarms.

The second approach is to use actual instrument settings as the basis for establishing the warning and alarm limits in the PMIS data base. These setpoints essentially are treated as "variables" (or rather frequently changed constants), and data base changes are required to match any setpoint changes identified during surveillance or maintenance of the instrumentation systems. This approach reduces or eliminates inconsistencies between control room instrumentation and SPDS-generated alarms, but requires greater efforts to ensure the continuing integrity of the PMIS data base. It is particularly important to note that changing the warning and alarm limits of a field input data point may affect the corresponding limits of SPDS composed points which use the field input point (i.e., healthy averages, healthy maximums, logarithms and external (real) points). Table 4-3 provides a summary of the SPDS analog composed points that are affected by changes of field input point warning and alarm limits in the PMIS data base.

If NPPD chooses the first approach for establishing and maintaining SPDS warning and alarm limits, infrequent data base changes are expected. Maintenance of the PMIS data base can be accommodated using established procedures. If the second approach is chosen by NPPD, the utility will need to ensure that PMIS data base integrity is not impaired by: (a) the more frequent updating of warning and alarm limits for field

input points, and (b) the maintenance of warning and alarm limits for affected SPDS composed points.

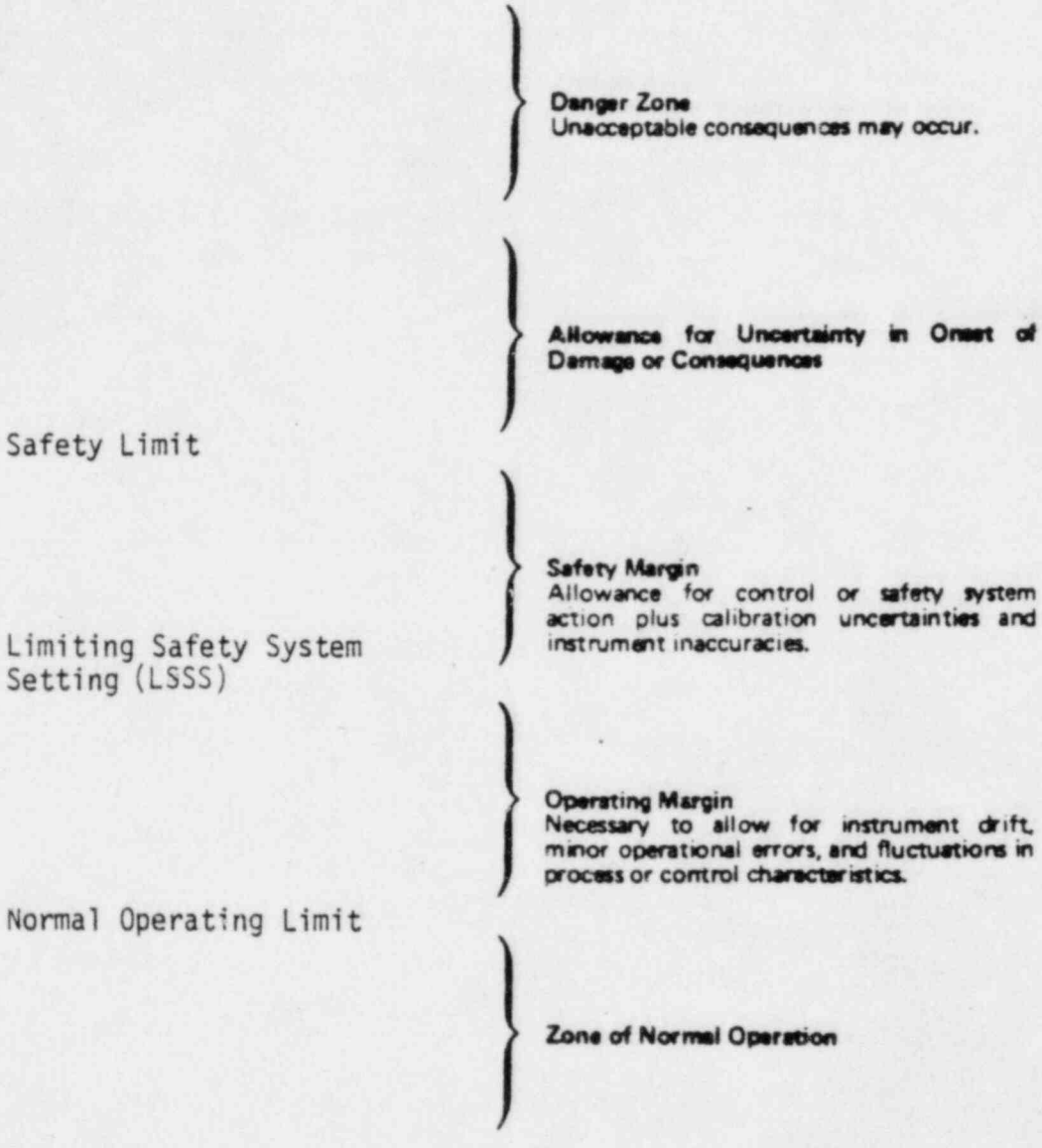



Figure 4-1. Limits on Safety Variables.

Table 4-3. Summary of SPDS Composed Points That are Affected by Changes of Field Input Point Warning and Alarm Limits in the PMIS Data Base.

| Analog Field Input Points | Related SPDS Composed Points | Relationship |
|---|---|---|
| B000, B002, B004 | SPDS00006 | HMAX |
| | SPDS00008 | HAVE (of HMAX) |
| B001, B003, B005 | SPDS0007 | HMAX |
| | SPDS0008 | HAVE (of HMAX) |
| B021, N011, N012 | SPDS0019 | HAVE |
| F084, F085 | SPDS0045 | HAVE |
| G032, G033 | SPDS0023 | HAVE |
| | SPDS0029 | EXTR |
| M161, M162, M163, N276, N277 | SPDS0051 | HMAX |
| N009, N010 | SPDS0027 | HAVE |
| | SPDS0029 | EXTR |
| N013, N014 | SPDS0030 | HAVE |
| N017, N018 | SPDS0043 | HAVE |
| N019, N020 | SPDS0065 | HAVE |
| N021, N022 | SPDS0067 | HAVE |
| N023, N031 | SPDS0055, SPDS0063 | HAVE |
| N024, N032 | SPDS0056, SPDS0063 | HAVE |
| N025, N033 | SPDS0057, SPDS0063 | HAVE |
| N026, N034 | SPDS0058, SPDS0063 | HAVE |
| N027, N035 | SPDS0059, SPDS0063 | HAVE |
| N028, N036 | SPDS0060, SPDS0063 | HAVE |
| N029, N037 | SPDS0061, SPDS0063 | HAVE |
| N030, N038 | SPDS0062, SPDS0063 | HAVE |

Table 4-3. Summary of SPDS Composed Points That are Affected by Changes of Field Input Point Warning and Alarm Limits in the PMIS Data Base (continued).

| Analog Field Input Points | Related SPDS Composed Points | Relationship |
|---|---|---|
| N040, N041, N042, N043 | SPDS0014 | HAVE |
| | SPDS0013 | LOG (of HAVE) |
| N061, N062, N065 | SPDS0090, SPDS0091, SPDS0092 | EXTR |
| | SPDS0100 | HMAX |
| | SPDS0069 | EXTR |
| N063 | SPDS0082 | LOG |
| N069 | SPDS0076 | LOG |
| N073 | SPDS0072 | LOG |
| N074 | SPDS0074 | LOG |
| N079 | SPDS0070 | LOG |
| N082, N083 | SPDS0078 | EXTR |
| | SPDS0081 | LOG (OF EXTR) |

# 5. SAFETY FUNCTION INDICATORS

All SPDS displays include in the SPDS Status Area (SSA) the five basic Safety Function Indicators (SFIs) of reactivity control, core cooling, coolant system integrity, containment integrity and radioactive release. The SFIs are the primary means of continuously providing the operator with an overview of the safety status of the plant, regardless of the SPDS display being viewed.

The SFIs are shown as individual boxes along the bottom of each SPDS display, with GREEN color fill for satisfactory conditions, YELLOW color fill for a warning condition and RED color fill for a more serious alarm condition. A MAGENTA color fill is used to indicate that there is some problem associated with input data used to drive a Safety Function Indicator. A valid warning or alarm condition takes priority over an input data problem, therefore a MAGENTA color fill is superseded by a YELLOW or RED color fill that is based on healthy data. (See Section ? for a definition of healthy data.) The status of the safety function indicators are controlled by the following external (real) data points:

| SFI | External (Real) Point |
|---|---|
| Reactivity Control | SPDSBOX1 |
| Core Cooling | SPDSBOX2 |
| Coolant System Integrity | SPDSBOX3 |
| Containment Integrity | SPDSBOX4 |
| Radioactive Release | SPDSBOX5 |

Each of the above listed data points has three allowed values: 0, 1, and 2. The color fill of an SFI is GREEN when the associated external (real) data point has a value of "0," (i.e., satisfactory conditions). When the associated data point has a value of "1," the color fill is YELLOW (i.e., warning condition) and when the value is "2," the color fill is RED (i.e.,

alarm condition). The criteria for changing the color status of the Safety Function Indicators to MAGENTA, YELLOW, or RED are presented in this section in the form of logic trees. When these conditions do not exist, the color fill of the SFIs is GREEN. Warning and alarm limits associated with the SFI input variables are listed in Section 4. In the following text, the following abbreviations are used to denote warning and alarm limits:

- HALM = alarm high limit
- HWRN = warning high limit
- LWRN = warning low limit
- LALM = alarm low limit

These are the quality codes that are assigned to variables when the associated limit check is failed (see Section 2).

## 5.1 REACTIVITY CONTROL SFI

This SFI is YELLOW when the current value of any healthy APRM field input is greater than HWRN limit. At the present time, APRM HWRN is only defined for the RUN mode, thus this SFI can only be YELLOW in the RUN mode.

This SFI is RED when any of the following alarm conditions exist:

- Current value of any healthy APRM field input reaches the HALM limit for the respective plant mode.
- Current value of any healthy APRM field input is greater than the downscale trip setpoint (2.5%), in the RUN on SHUTDOWN mode, following a scram demand signal. If this condition persists, it is indicative of a failure to scram.

This SFI indicates the existence of an input data validation problem by changing to MAGENTA when any of the following conditions occur, and the SFI is not otherwise required to be YELLOW or RED:

- No healthy APRM field input data is available
- Scram demand signal status is not known at a time when reactor power is above the downscale trip setpoint (2.5%)

The logic diagrams which detail the operation of the reactivity control SFI are shown in Figures 5-1 to 5-3.

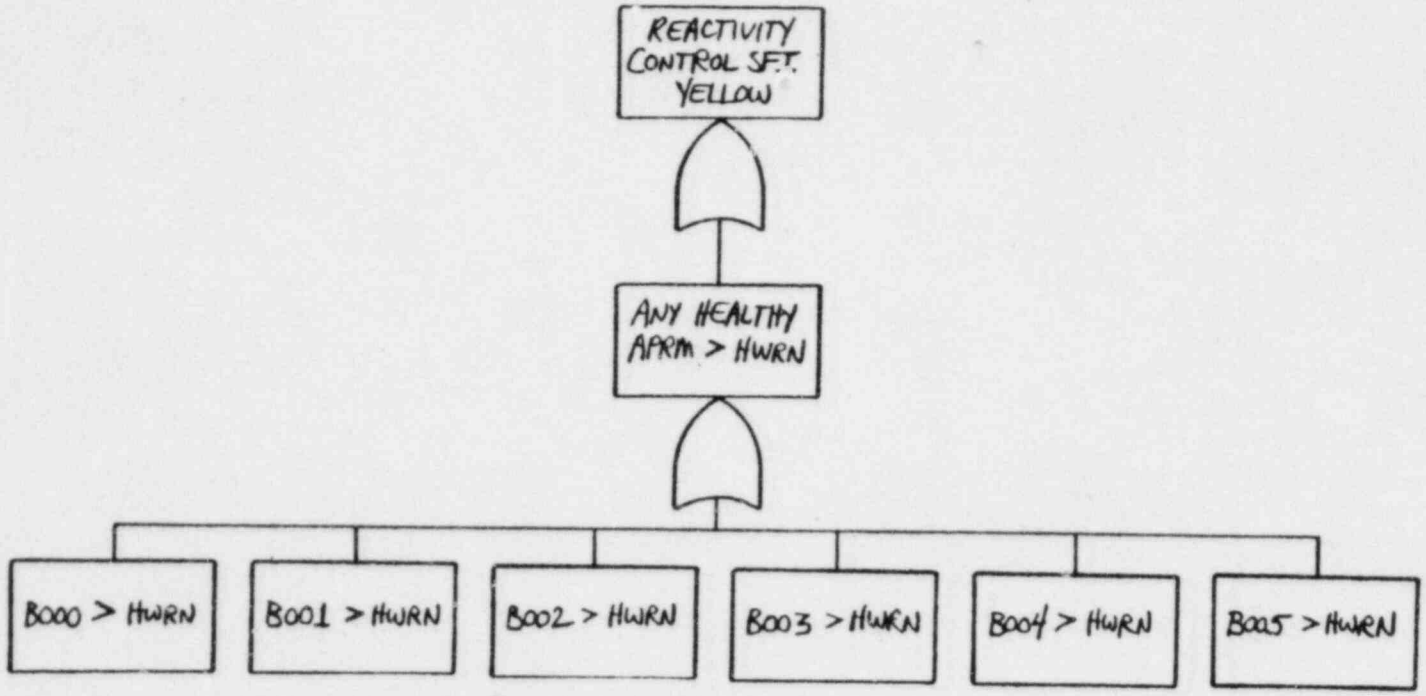



Figure 5-1. Criteria for YELLOW Reactivity Control SFI.

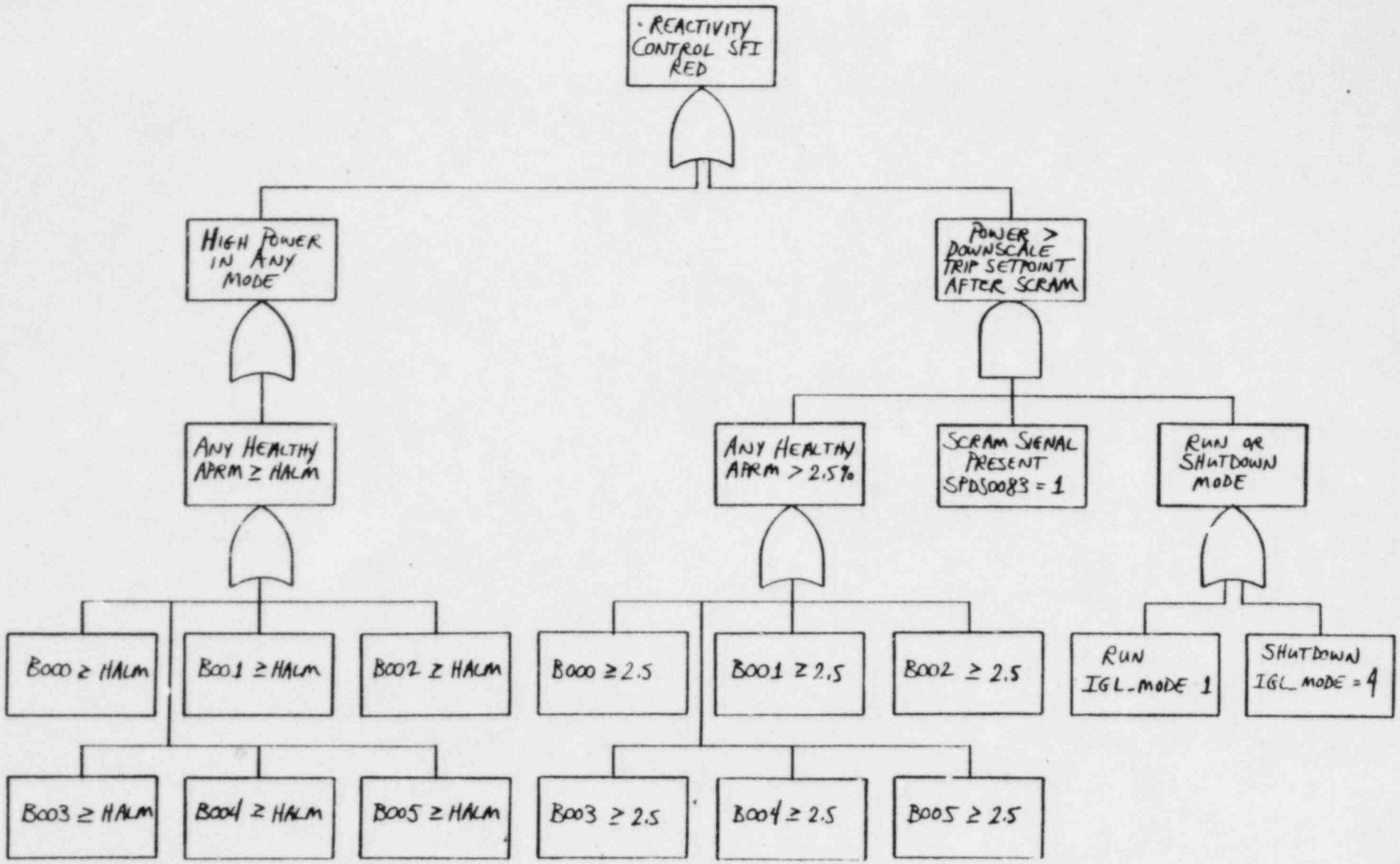



Figure 5-2. Criteria for RED Reactivity Control SFI.

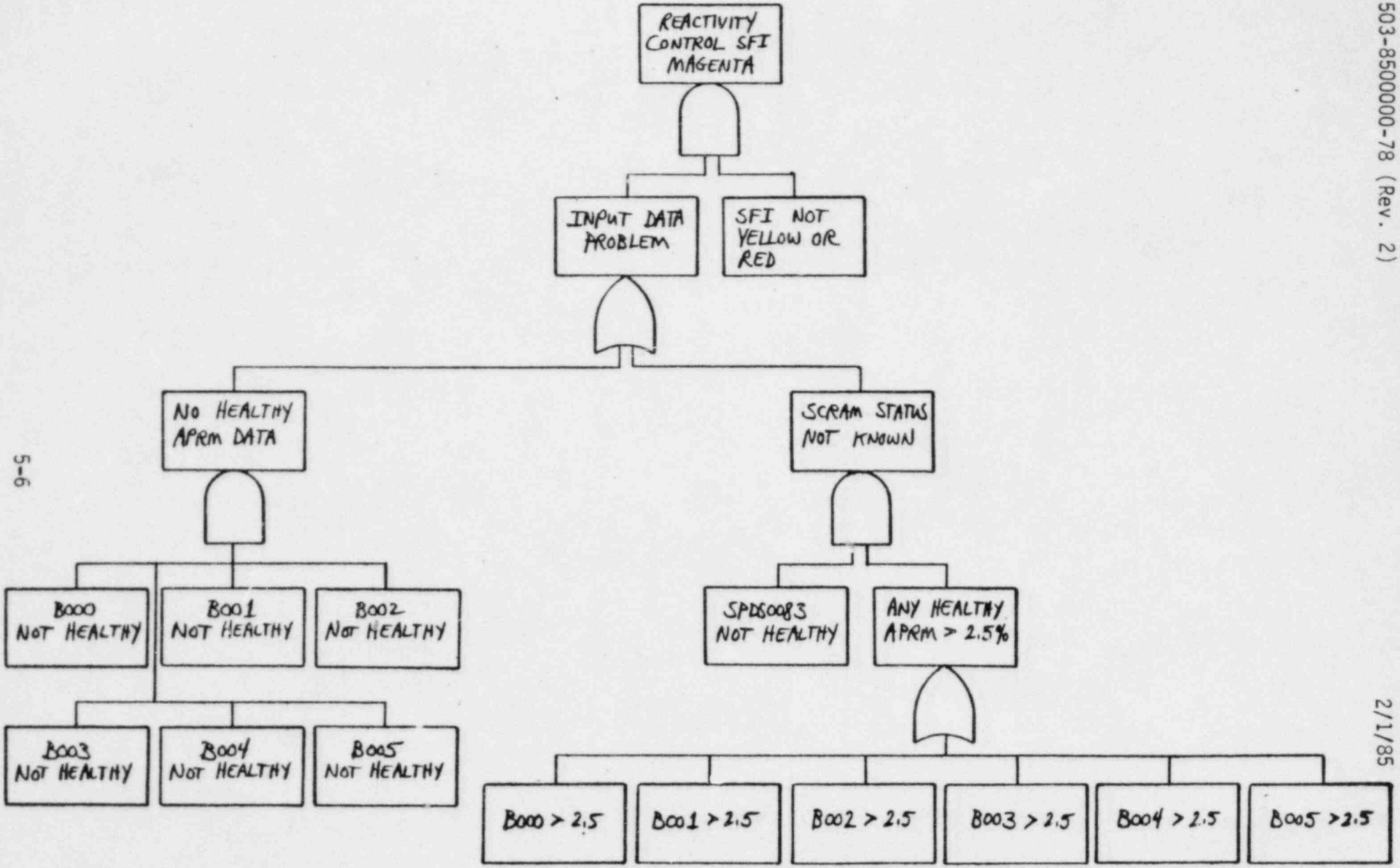



Figure 5-3. Criteria for MAGENTA Reactivity Control SFI.

## 5.2 CORE COOLING SFI

This SFI is YELLOW when the current value of any narrow range or wide range RPV water level field inputs drops to LWRN, or increases to HWRN. There are three narrow range field input points: B021, N011 and N012. The two wide range field input points are G032 and G033.

This SFI is RED when the current value of any narrow range or wide range RPV water level field input drops to LALM, or increases to HALM. This SFI indicates the existence of a data validation problem by changing to MAGENTA if any narrow range or wide range RPV water level field input is not healthy.

The logic diagrams which detail the operation of the core cooling SFI are shown in Figures 5-4 to 5-6.

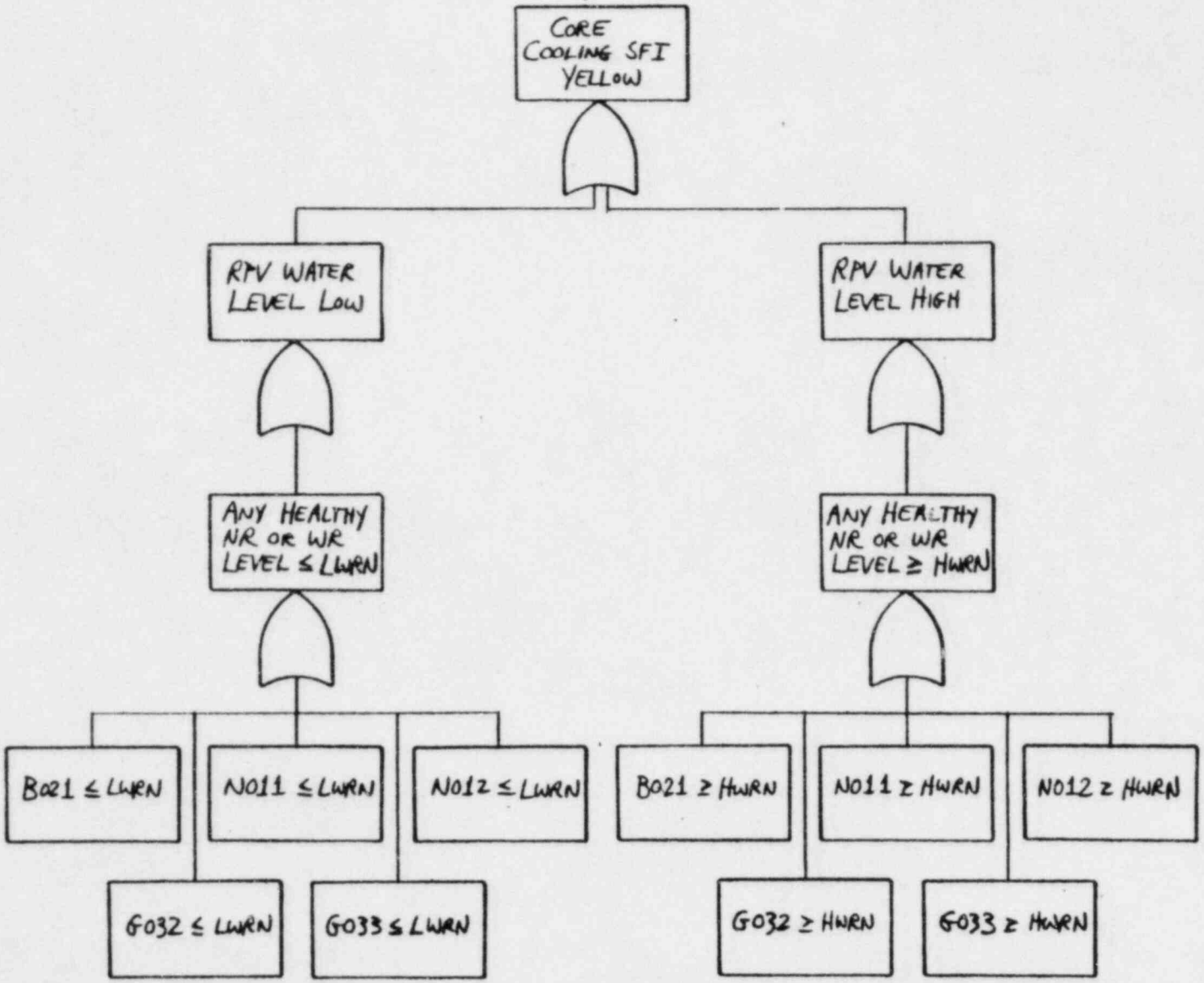



Figure 5-4. Criteria for YELLOW Core Cooling SFI.

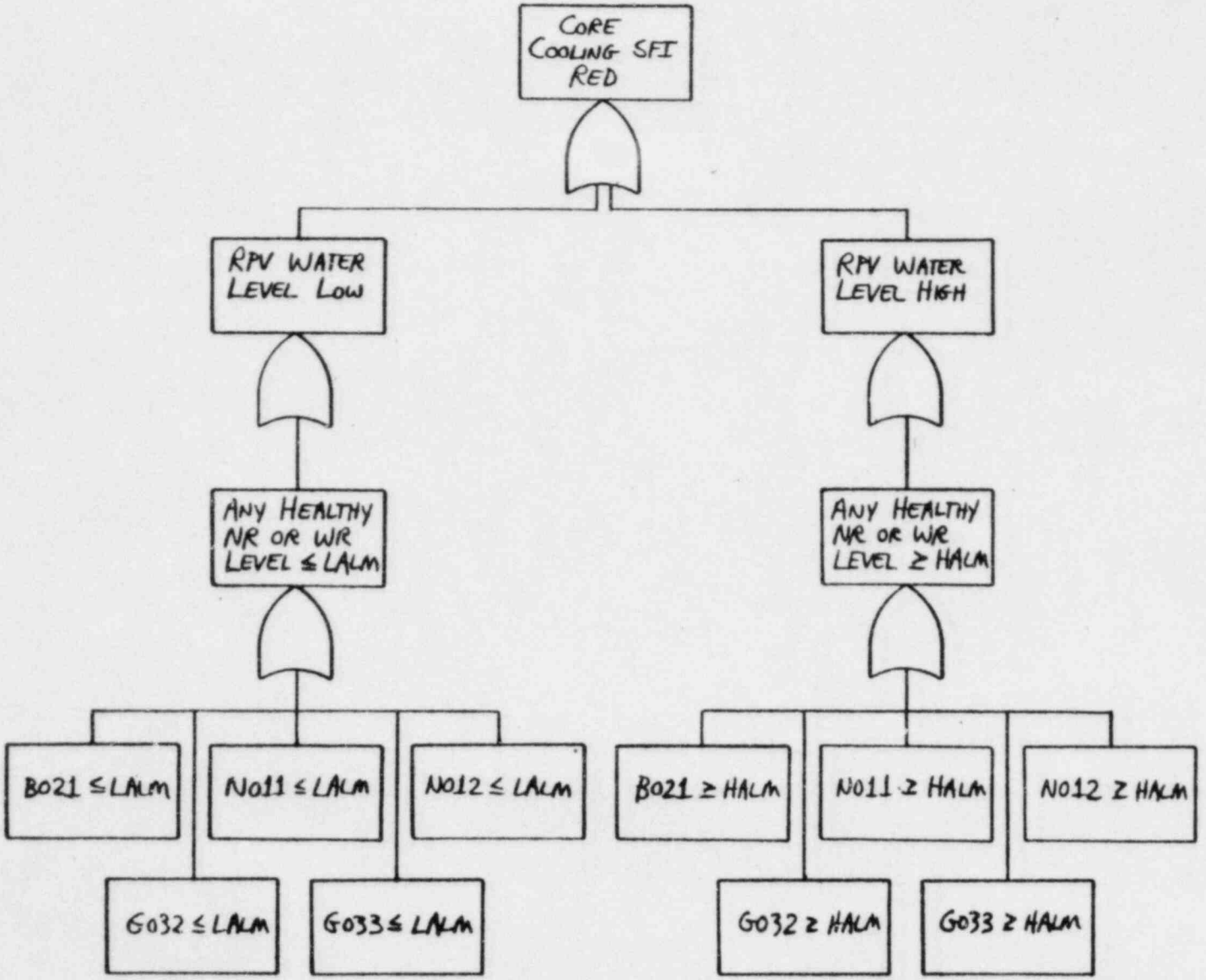



Figure 5-5. Criteria for RED Core Cooling SFI.

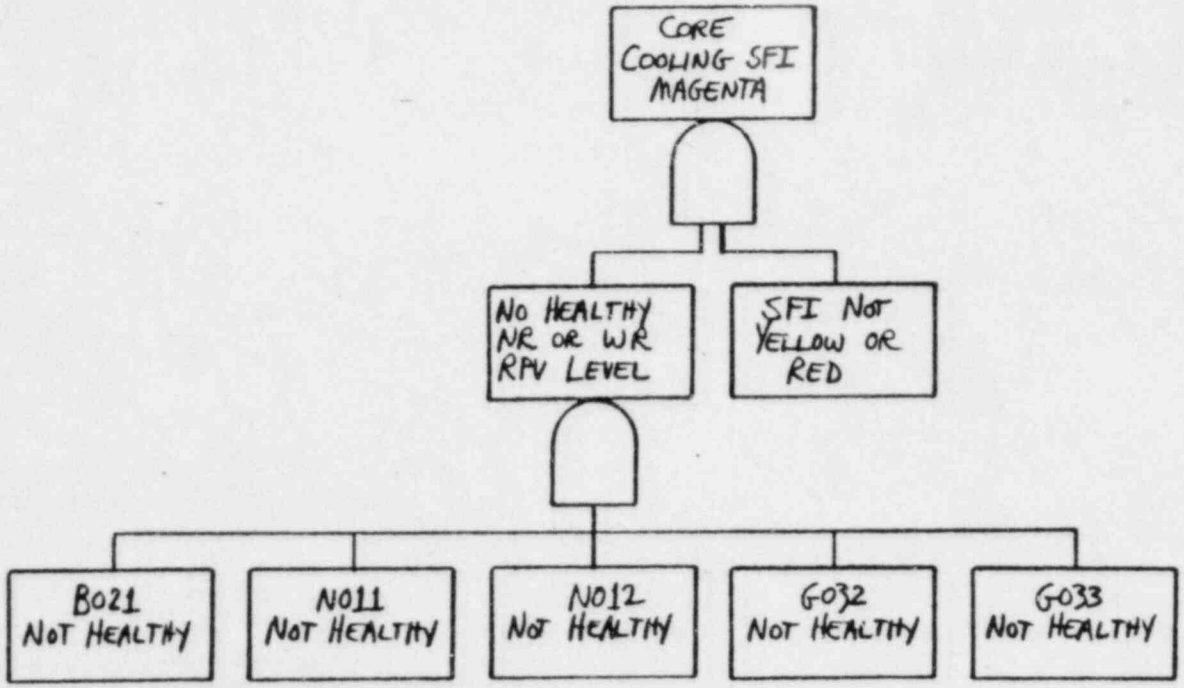



Figure 5-6. Criteria for MAGENTA Core Cooling SFI.

5.3 COOLANT SYSTEM INTEGRITY SFI

This SFI is YELLOW when any of the following warning conditions exist:

- Either narrow-range drywell pressure field input (N017, N018) increases to HWRN
- Either RPV pressure field input (N013, N014) increases to HWRN when the Residual Heat Removal (RHR) system is isolated from the RPV. Isolation is indicated by at least one RHR shutdown cooling suction line isolation valve being closed, as indicated by digital field input points N806 and/or N807
- Containment area radiation level (N063) increases to HWRN

This SFI is RED if any of the following alarm conditions exist:

- Either narrow range drywell pressure field input increases to HALM
- RPV pressure increases to HALM or decreases to LALM when the RHR system is isolated from the RPV
- RPV pressure increases to 75 psig when the RHR system is aligned to the RPV. Alignment of the RHR system is indicated by both shutdown cooling suction isolation valves being open. Note that the 75 psig limit is dependent on the alignment of the RHR system, therefore is not specified as a warning/alarm limit in the PMIS data base. The RHR system is only aligned to the RPV during SHUTDOWN or REFUELING plant modes
- Containment area radiation level increases to HALM
- A Group 1 isolation demand occurs in the RUN or STARTUP plant mode
- Any Main Steam Isolation Valve (MSIV) closes in the RUN or STARTUP plant mode
- Any Safety Relief Valve (SRV) or Code Safety Valve (SV) opens

This SFI indicates the existence of a data validation problem by changing to MAGENTA if insufficient healthy data exists to determine the current conditions of the following:

- Drywell pressure
- RPV pressure
- RHR system isolation status
- Containment area radiation level
- Group 1 isolation demand status
- MSIV status
- SRV and SV status

The logic diagrams which detail the operation of the coolant system integrity SFI are shown in Figures 5-7 to 5-9.

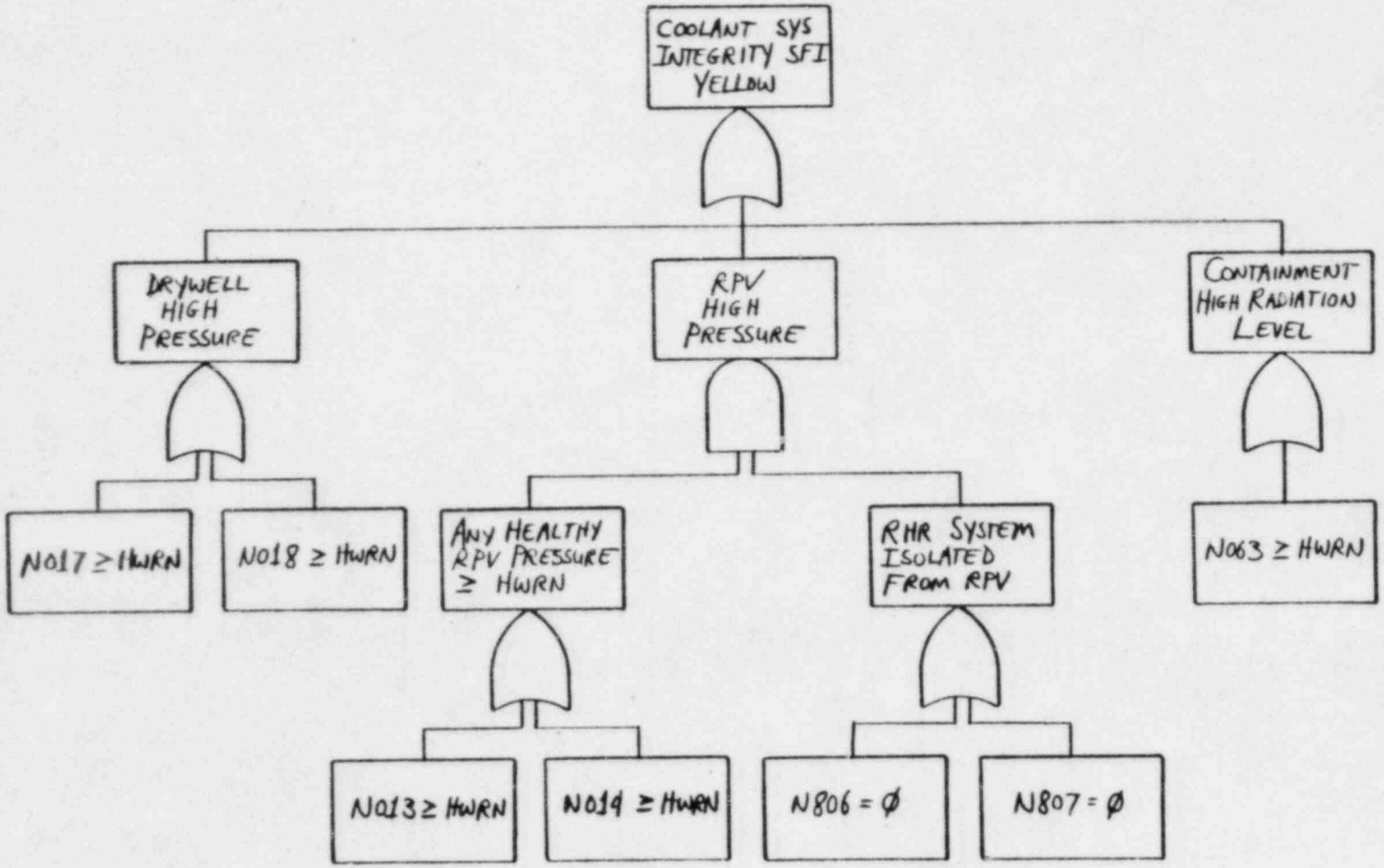



Figure 5-7. Criteria for YELLOW Coolant System Integrity SFI.

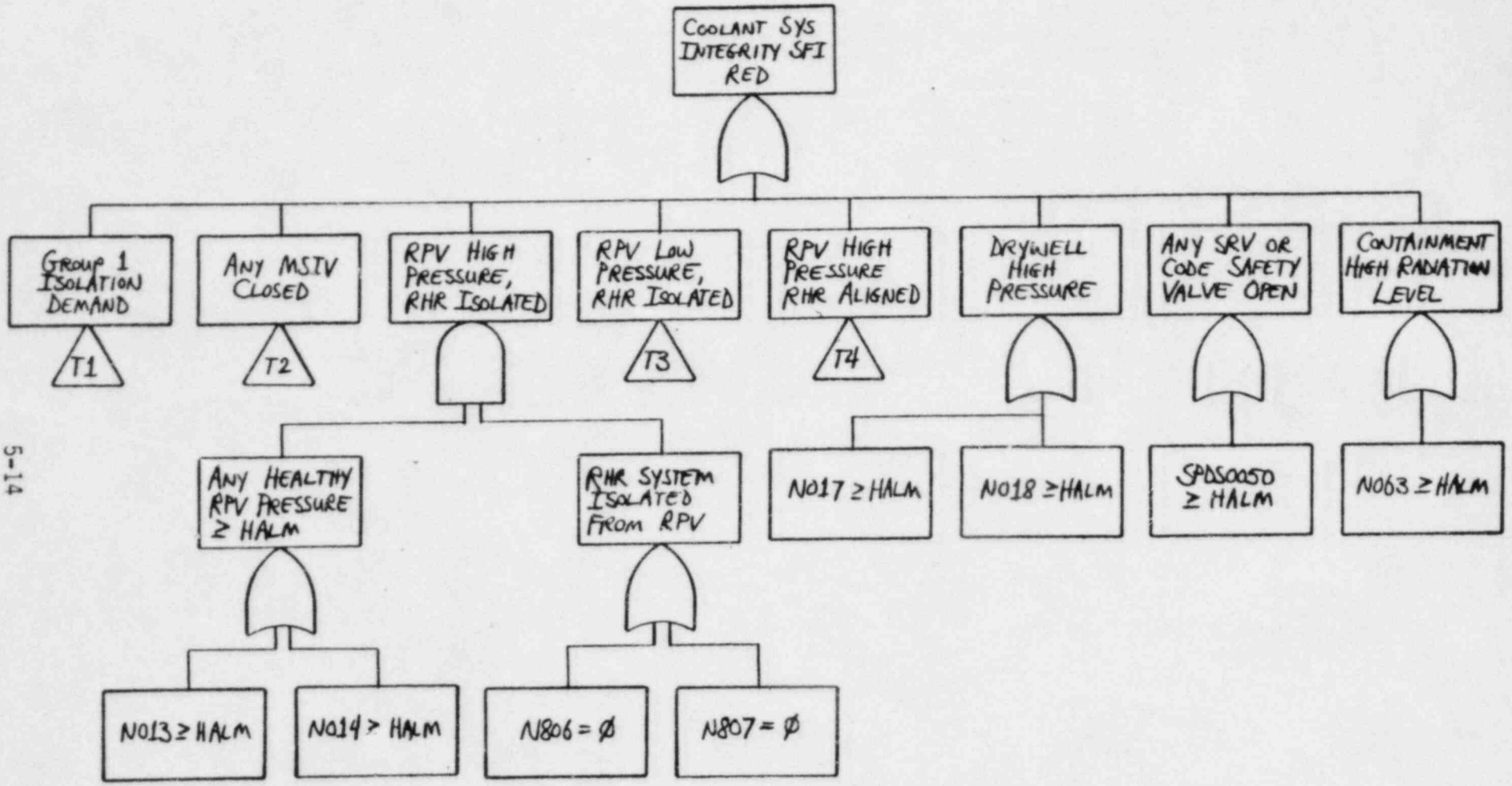



Figure 5-8. Criteria for RED Coolant System Integrity SFI.

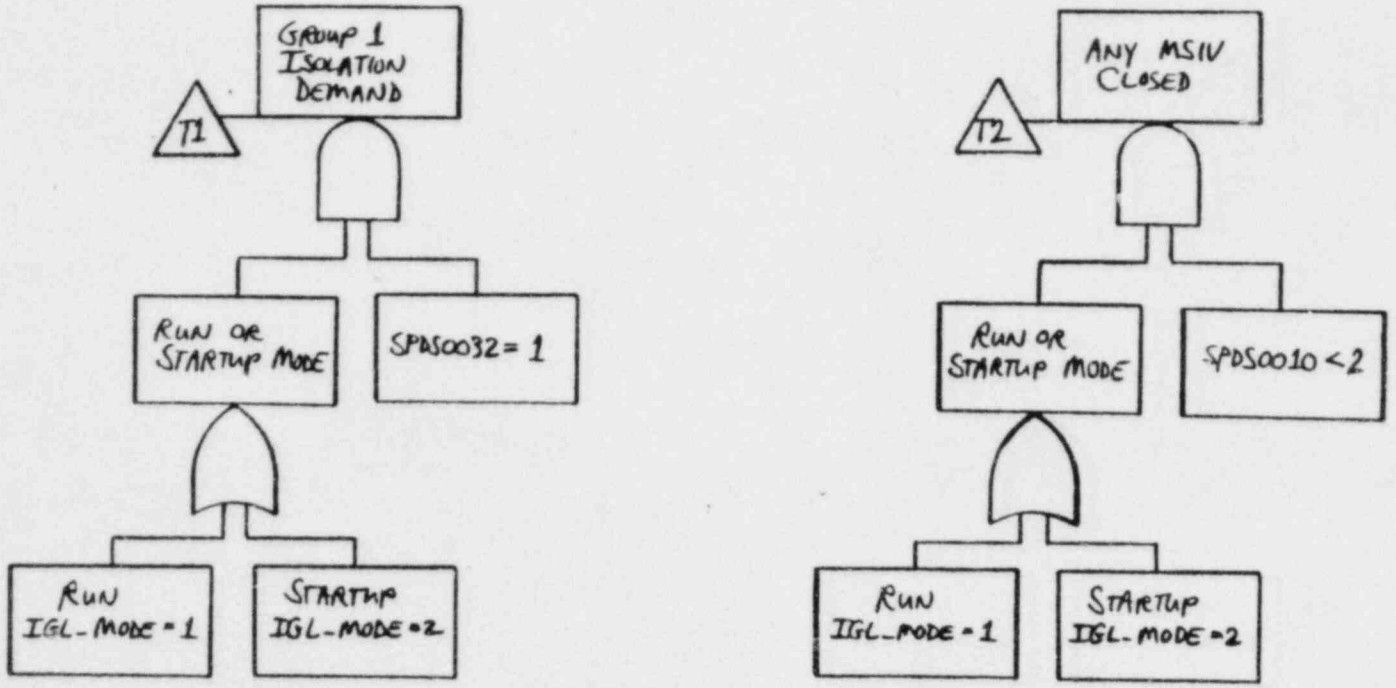



Figure 5-8. Criteria for RED Coolant System Integrity SFI (Continued).

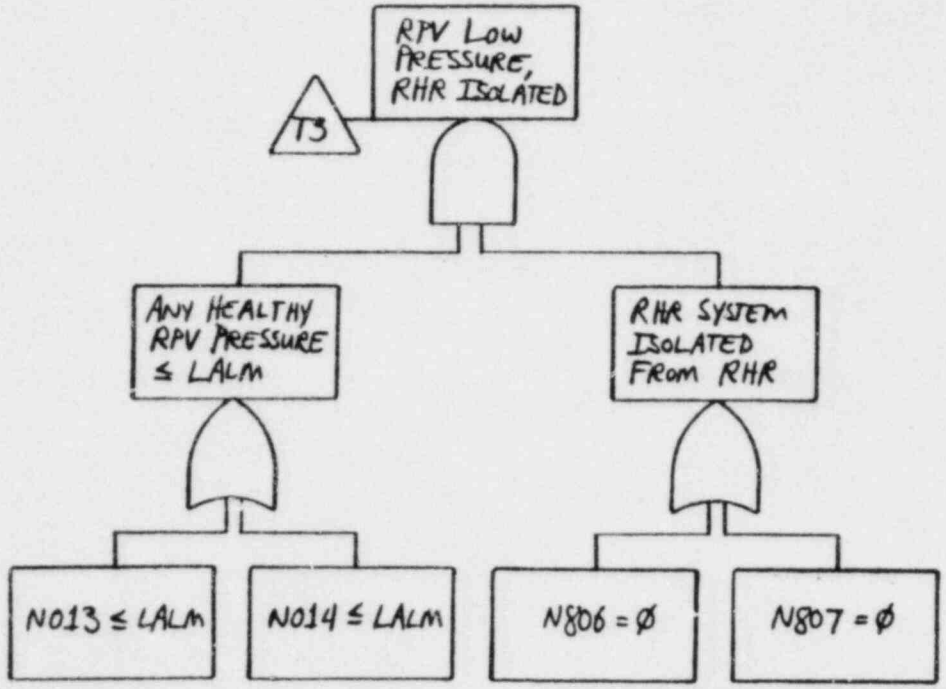



Figure 5-8. Criteria for RED Coolant System Integrity SFI (Continued).

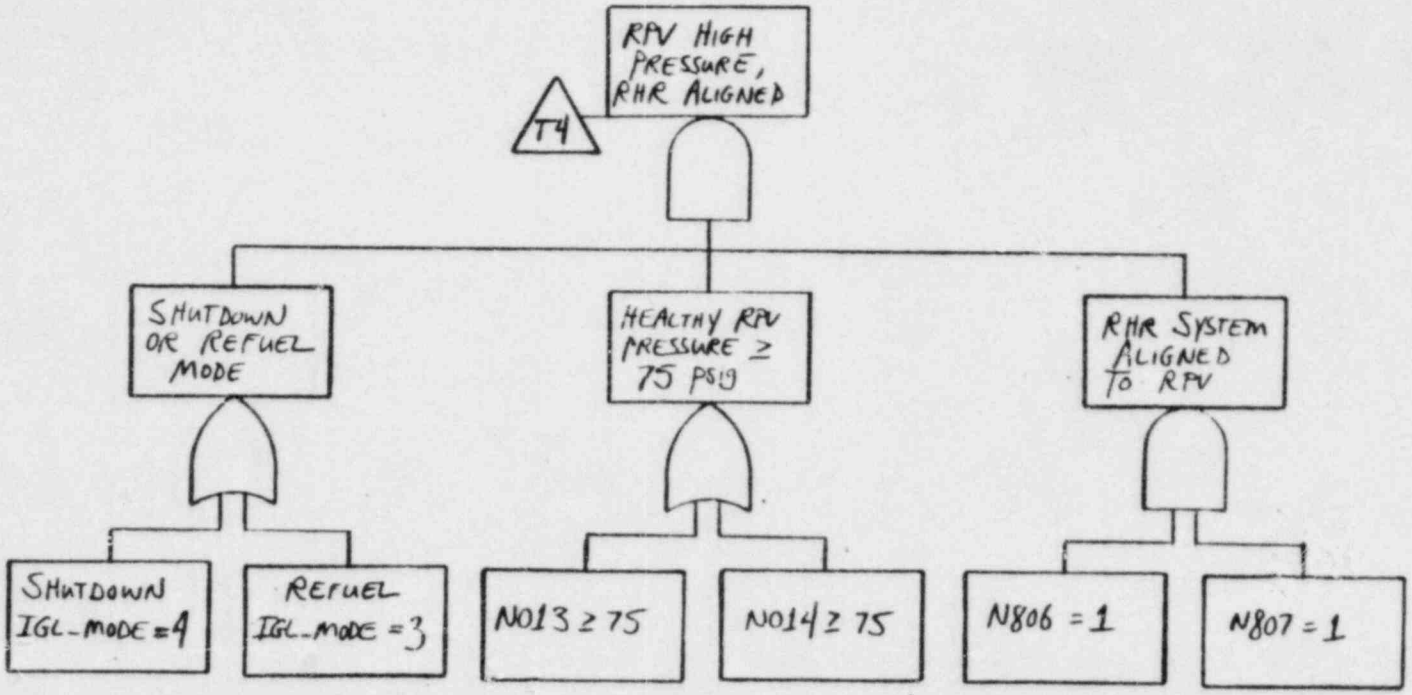



Figure 5-8. Criteria for RED Coolant System Integrity SFI (Continued).

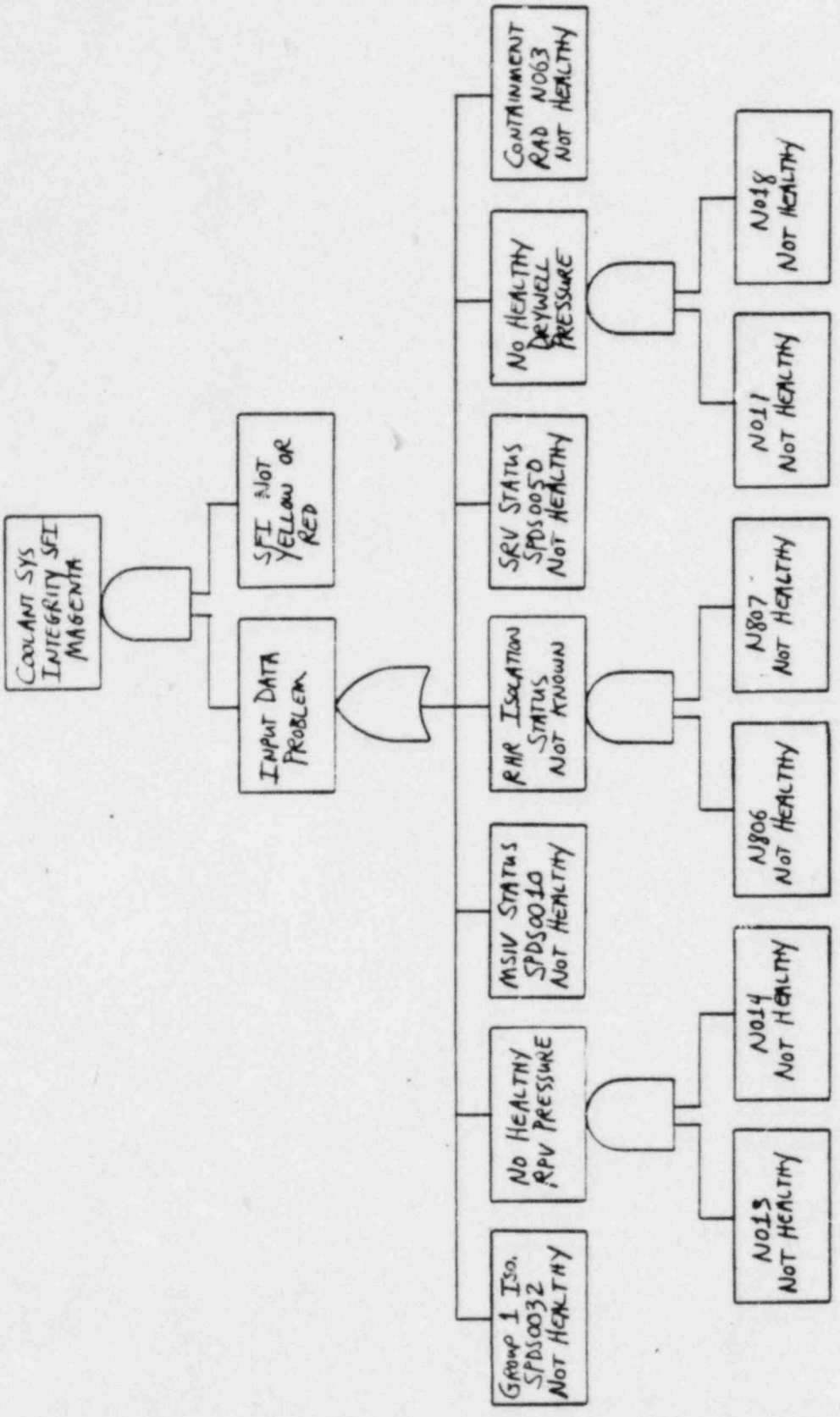



Figure 5-9. Criteria for MAGENTA Coolant System Integrity SFI.

## 5.4 CONTAINMENT INTEGRITY SFI

This SFI is YELLOW if any of the following warning conditions exist:

- Maximum drywell temperature (SPDS0051) increases to HWRN
- Either narrow range drywell pressure field input (N017, N018) increases to HWRN
- Suppression pool average temperature (SPDS0063) increases to HWRN

This SFI is RED if any of the following alarm conditions exist:

- Maximum drywell temperature increases to HALM
- Either drywell pressure field input increases to HALM
- Suppression pool average temperture increases to HALM
- Maximum drywell oxygen concentration (SPDS0100) increases to HALM
- Suppression chamber oxygen concentration (SPDS0069) increases to HALM
- Suppression pool water level (SPDS0065) increases to HALM or decreases to LALM

This SFI indicates the existence of a data validation problem by changing to MAGENTA if insufficient healthy data exists to determine the current conditions of the following:

- Drywell temperature
- Drywell pressure
- Suppression pool temperature
- Suppression pool water level
- Drywell oxygen concentration
- Suppression chamber oxygen concentration

The logic diagrams which detail the operation of the containment integrity SFI are shown in Figures 5-10 to 5-12.

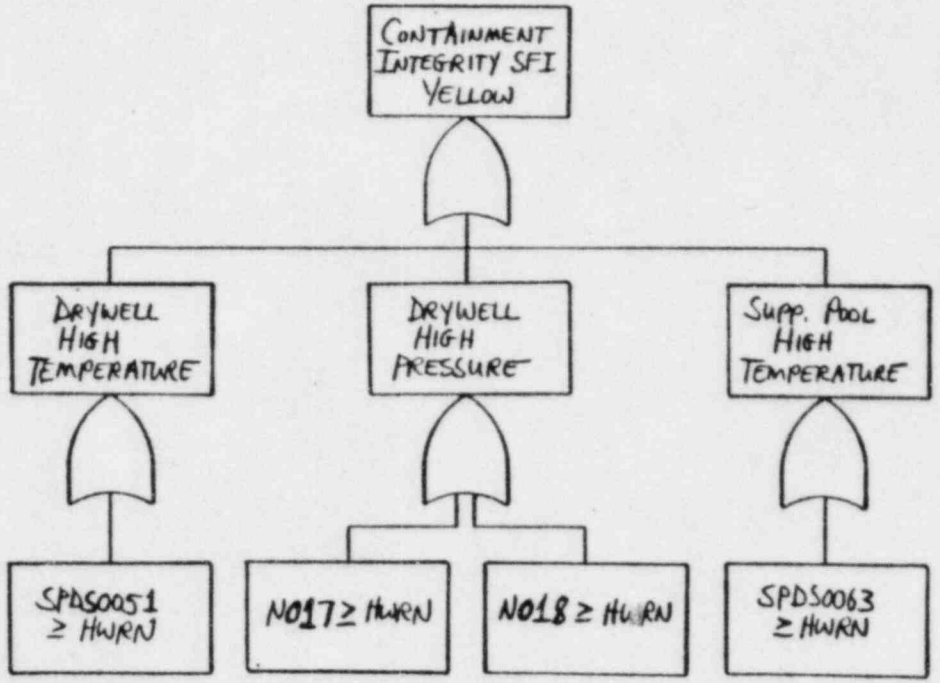



Figure 5-10. Criteria for YELLOW Containment Integrity SFI.

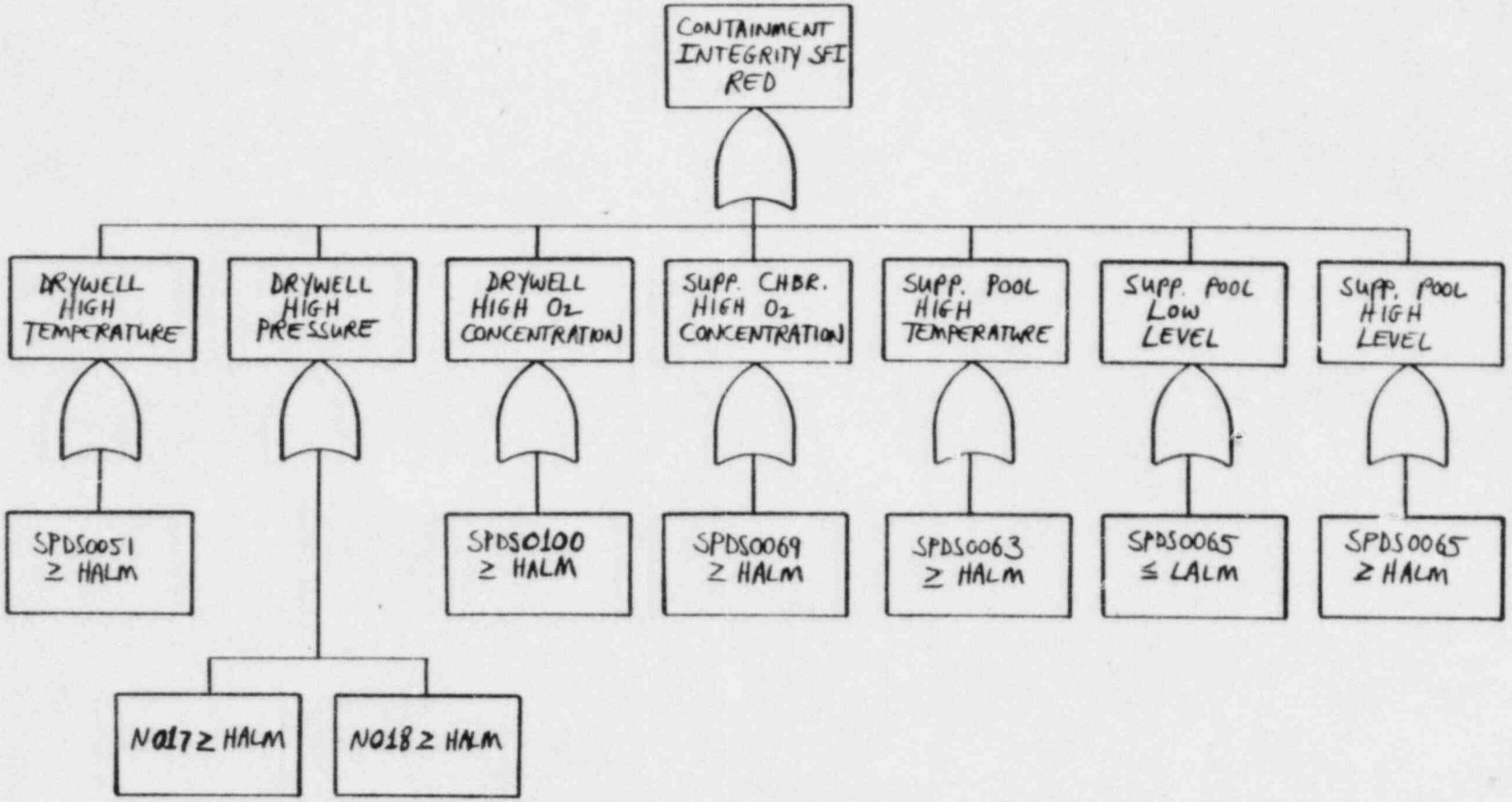



Figure 5-11. Criteria for RED Containment Integrity SFI.

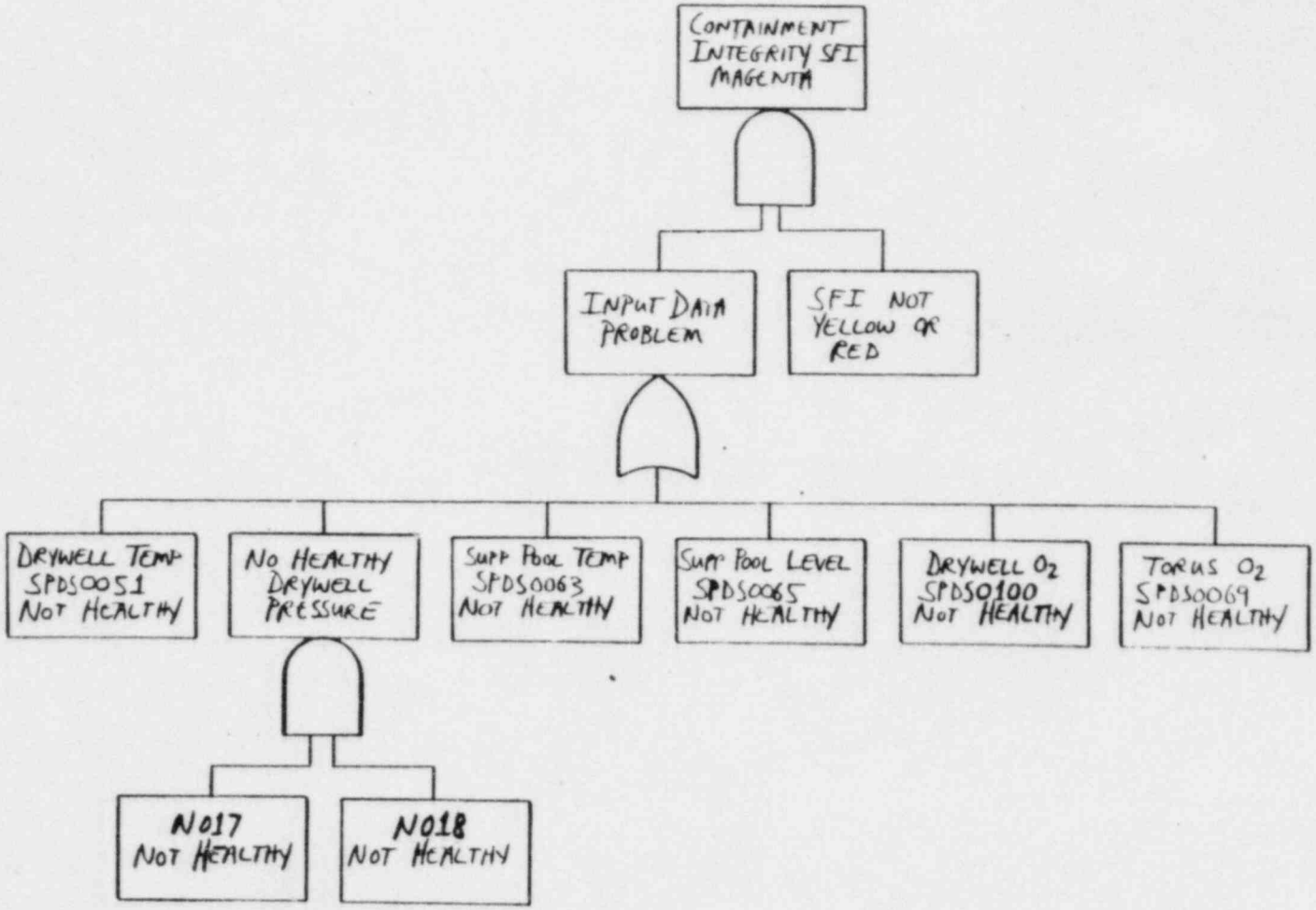



Figure 5-12. Criteria for MAGENTA Containment Integrity SFI.

## 5.5 RADIOACTIVE RELEASE SFI

This SFI is YELLOW when the release rate from any of the following release points increase to HWRN:

- Elevated release point (N079)
- AOG and RW (N073)
- Reactor building (N074)
- Turbine building (N069)
- Steam jet air ejector (SPDS0078)

When any of the release rates increase to HALM, this SFI turns RED. If the data point for any release rates is not healthy, a data validation problem exists, and this SFI turns MAGENTA.

The logic diagrams which detail the operation of the radioactive release SFI are shown in Figures 5-13 to 5-15.

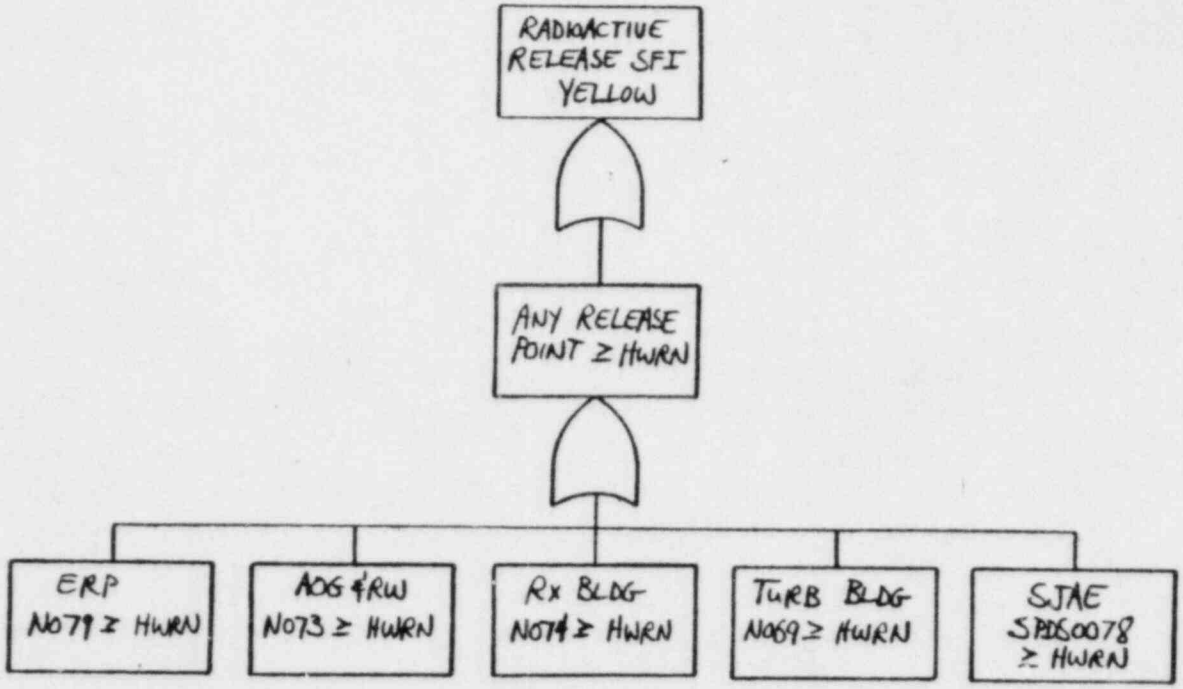



Figure 5-13. Criteria for YELLOW Radioactive Release SFI.

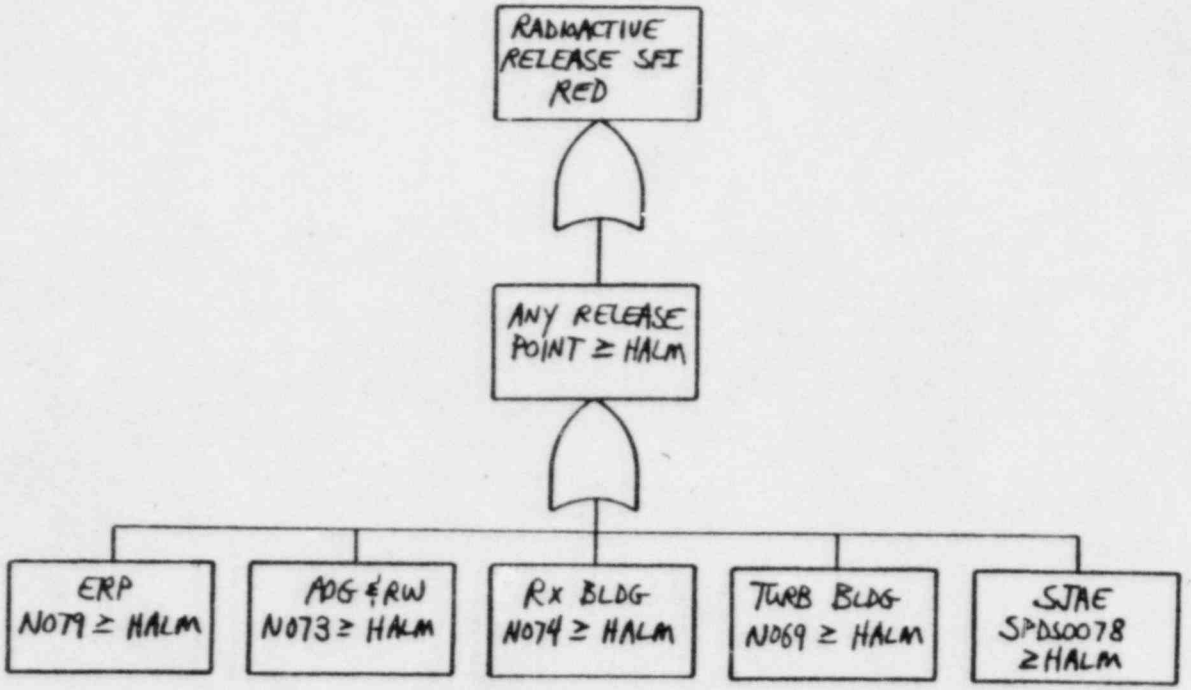



Figure 5-14. Criteria for RED Radioactive Release SFI.

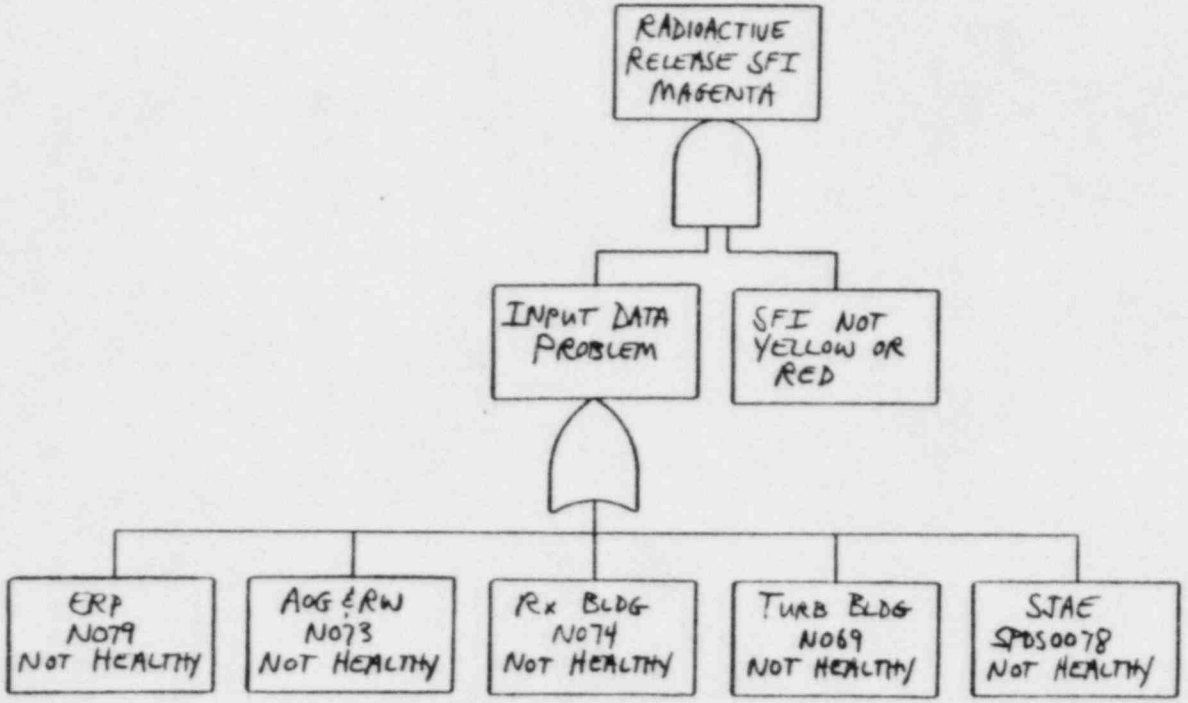



Figure 5-15. Criteria for MAGENTA Radioactive Release SFI.

# 6. OTHER STATUS INDICATORS INCLUDED IN SPDS DISPLAYS

The Safety Function Indicators (SFIs) described in Section 5 are the primary status indicators included in SPDS displays. Other status indicators that have been described in Section 2 are the Not-Valid Indicators (NVIs) and Downscale Indicators (DNSCIs) which perform data validation functions. The following additional status indicators also are used in the SPDS displays:

- Equipment Status Indicators (ESIs)
- EOP Limit Status Indicators (EOPSIs)
- System Alarm Area (SAA) Indicator

Operation of these status indicators are described in this section.

## 6.1 EQUIPMENT STATUS INDICATORS

There are a total of thirty-nine Equipment Status indicators that provide summary and status information on important systems or equipment. The operation of each ESI is described in this section, and a summary of all ESIs is presented in Table 6-1.

Color conventions used for the ESIs were selected, to the extent practical, to present a "green board" appearance during normal power operation. Exceptions to this convention had to be made to accommodate the color coding conventions normally used to denote the ON/OFF status of pumps, the OPEN/CLOSED status of valves and the IN/OUT status of the source range monitors (SRM). The pump, SRM and some valve status indicators include a text field inside the ESI block to clearly specify the equipment status being displayed. The other valve status indicators are shaped like a "bow tie" to represent a valve in a mimic display. Therefore, their color coding should be readily interpreted.

Table 6-1. Summary of Equipment Status Indicators.

| Status Indicator Title | Allowed States | Condition | Use |
|---|---|---|---|
| All APRM downscale | Green | SPDS0080 = 0 | L2.1 |
| | Red | SPDS0080 = 1 | |
| | Magenta | Validation failure | |
| Any APRM upscale | Green | A527 = 0 | L2.1 |
| | Red | A527 = 1 | |
| | Magenta | A527 not healthy | |
| Any APRM inoperative | Green | A528 = 0 | L2.1 |
| | Red | A528 = 1 | |
| | Magenta | A528 not healthy | |
| Any APRM bypassed | Green | SPDS0001 = 1 | L2.1 |
| | Red | SPDS0001 = 0 | |
| | Magenta | SPDS0001 not healthy | |
| SRM position | Red "In" | A519 = 0, mode 1 | L2.1 |
| | Green "Out" | A519 = 1, mode 1 | |
| | Green "In" | A519 = 0, modes 2 to 4 | |
| | Red "Out" | A519 = 1, modes 2 to 4 | |
| | Magenta | A519 not healthy | |
| Any SRM upscale | Green | A520 = 0 | L2.1 |
| | Red | A520 = 1 | |
| | Magenta | A520 not healthy | |
| Any SRM inoperative | Green | A521 = 0 | L2.1 |
| | Red | A521 = 1 | |
| | Magenta | A521 not healthy | |
| Any SRM bypassed | Green | A533 = 1 | L2.1 |
| | Red | A533 = 0 | |
| | Magenta | A533 not healthy | |
| All rods in | Green | N520 = 0 | L1.0, L2.1 |
| | Red | N520 = 1 | |
| | Magenta | N520 not healthy | |
| Reactor scram | Green | SPDS0039 = 0 or 1 | L1.0, L2.1 |
| | Red | SPDS0039 = 2 | |
| | Magenta | Validation failure | |

Table 6-1. Summary of Equipment Status Indicators (continued).

| Status Indicator Title | Allowed States | Condition | Use |
|---|---|---|---|
| Group 1 iso demand | Red | SPDS0032 = 1 (trip) | L2.3, L2.4 |
| | Green | SPDS0032 = 0 (no demand) | |
| | Magenta | Validation failure | |
| Group 2 iso demand | Red | SPDS0033 = 1 | L2.3, L2.4 |
| | Green | SPDS0033 = 0 | |
| | Magenta | Validation failure | |
| Group 3 iso demand | Red | SPDS0034 = 1 | L2.3, L2.4 |
| | Green | SPDS0034 = 0 | |
| | Magenta | Validation failure | |
| Group 4 iso demand | Red | SPDS0035 = 1 | L2.3, L2.4 |
| | Green | SPDS0035 = 0 | |
| | Magenta | Validation failure | |
| Group 5 iso demand | Red | SPDS0036 = 1 | L2.3, L2.4 |
| | Green | SPDS0036 = 0 | |
| | Magenta | Validation failure | |
| Group 6 iso demand | Red | SPDS0037 = 1 | L2.3, L2.4 |
| | Green | SPDS0037 = 0 | |
| | Magenta | Validation failure | |
| Group 7 iso demand | Red | SPDS0038 = 1 | L2.3, L2.4 |
| | Green | SPDS0038 = 0 | |
| | Magenta | Validation failure | |
| SRV A | Green | SPDS0089 = 0 (closed) | L2.4 |
| | Red | SPDS0089 = 1 (open) | |
| | Magenta | Validation failure | |
| SRV B | Green | SPDS0093 = 0 | L2.4 |
| | Red | SPDS0093 = 1 | |
| | Magenta | Validation failure | |
| SRV C | Green | SPDS0094 = 0 | L2.4 |
| | Red | SPDS0094 = 1 | |
| | Magenta | Validation failure | |
| SRV D | Green | SPDS0095 = 0 | L2.4 |
| | Red | SPDS0095 = 1 | |
| | Magenta | Validation failure | |

Table 6-1. Summary of Equipment Status Indicators (continued).

| Status Indicator Title | Allowed States | Condition | Use |
|---|---|---|---|
| SRV E | Green | SPDS0096 = 0 | L2.4 |
| | Red | SPDS0096 = 1 | |
| | Magenta | Validation failure | |
| SRV F | Green | SPDS0097 = 0 | L2.4 |
| | Red | SPDS0097 = 1 | |
| | Magenta | Validation failure | |
| SRV G | Green | SPDS0098 = 0 | L2.4 |
| | Red | SPDS0098 = 1 | |
| | Magenta | Validation failure | |
| SRV H | Green | SPDS0099 = 0 | L2.4 |
| | Red | SPDS0099 = 1 | |
| | Magenta | Validation failure | |
| SV A | Green | SPDS0040 = 0 | L2.4 |
| | Red | SPDS0040 = 1 | |
| | Magenta | Validation failure | |
| SV B | Green | SPDS0041 = 0 | L2.4 |
| | Red | SPDS0041 = 1 | |
| | Magenta | Validation failure | |
| SV C | Green | SPDS0042 = 0 | L2.4 |
| | Red | SPDS0042 = 1 | |
| | Magenta | Validation failure | |
| SRV and SV status | Green "closed" | SPDS0050 = 0 | L2.2, L2.3 |
| | Red "open" | SPDS0050 > 0 | |
| | Magenta | Validation failure | |
| MSIV status | Green "closed" | SPDS0010 = 0 | L2.2, L2.3 |
| | Yellow | SPDS0010 = 1 | |
| | Red "open" | SPDS0010 = 2 | |
| | Magenta | Validation failure | |

Table 6-1. Summary of Equipment Status Indicators (continued).

| Status Indicator Title | Allowed States | Condition | Use |
|---|---|---|---|
| RHR pump 1A | Green "off" | N861 = 0 | L3.8, L3.15 |
| | Red "on" | N861 = 1 | |
| | Magenta | N861 not healthy | |
| RHR pump 1B | Green "off" | N862 = 0 | L3.8, L3.15 |
| | Red "on" | N862 = 1 | |
| | Magenta | N862 not healthy | |
| RHR pump 1C | Green "off" | N863 = 0 | L3.8, L3.15 |
| | Red "on" | N863 = 1 | |
| | Magenta | N863 not healthy | |
| RHR pump 1D | Green "off" | N864 = 0 | L3.8, L3.15 |
| | Red "on" | N864 = 1 | |
| | Magenta | N864 not healthy | |
| Core spray pump 1A | Green "off" | M578 = 0 | L3.9, L3.15 |
| | Red "on" | N578 = 1 | |
| | Magenta | M578 not healthy | |
| Core spray pump 1B | Green "off" | M580 = 0 | L3.9, L3.15 |
| | Red "on" | M580 = 1 | |
| | Magenta | M580 not healthy | |
| HPCI pump | Green "off" | SPDS0085 = 0 | L2.4, L3.15 |
| | Red "on" | SPDS0085 = 1 | |
| | Magenta | Validation failure | |

Table 6-1. Summary of Equipment Status Indicators (continued).

| Status Indicator Title | Allowed States | Condition | Use |
|---|---|---|---|
| RCIC pump | Green "off" | SPDS0086 = 0 | L2.4, L3.15 |
| | Red "on" | SPDS0086 = 1 | |
| | Magenta | Validation failure | |
| Drywell sump pump | Green "off" | SPDS0054=0 | L2.3 |
| | Red "on" | SPDS0054=1 | |
| | Magenta | Validation failure | |

6.1.1 Neutron Monitoring and Reactivity Control System ESIs

There are ten ESIs that provide status information on the neutron monitoring and reactivity control systems.
displays.

6.1.1.1 All APRM Downscale ESI

This ESI is controlled by external (real) point SPDS0080. Processing logic for this data point, and for the operation of this ESI is shown in Figure 6-1. The constant value of 2.5 percent shown in the logic diagram is the APRM downscale trip setpoint. This constant is not included as a warning or alarm limit in the PMIS data base definitions of any of the inputs to the SPDS0080 calculation. The downscale trip setpoint does not correspond to a high/low warning or alarm limit of the type that can be defined in the PMIS data base, therefore, it is treated as a constant in the SPDS0080 calculation. This ESI is displayed in RED when a downscale condition exists, otherwise it is GREEN.

6.1.1.2 Any APRM Upscale ESI

This ESI is controlled by field input point A527. An APRM "upscale" trip condition means that one of two trip systems in the Reactor Protection System (RPS) has been actuated by high APRM level. Both RPS trip systems must be actuated to cause a scram. This ESI is RED when an upscale condition exists, otherwise it is GREEN.

6.1.1.3 Any APRM Inoperative ESI

This ESI is controlled by field input point A528. An APRM "inoperative" condition means that one of two trip systems in the RPS has been actuated by virtue of being inoperative (i.e., an RPS failsafe design feature). This ESI is RED when an inoperative condition exists, otherwise it is GREEN.

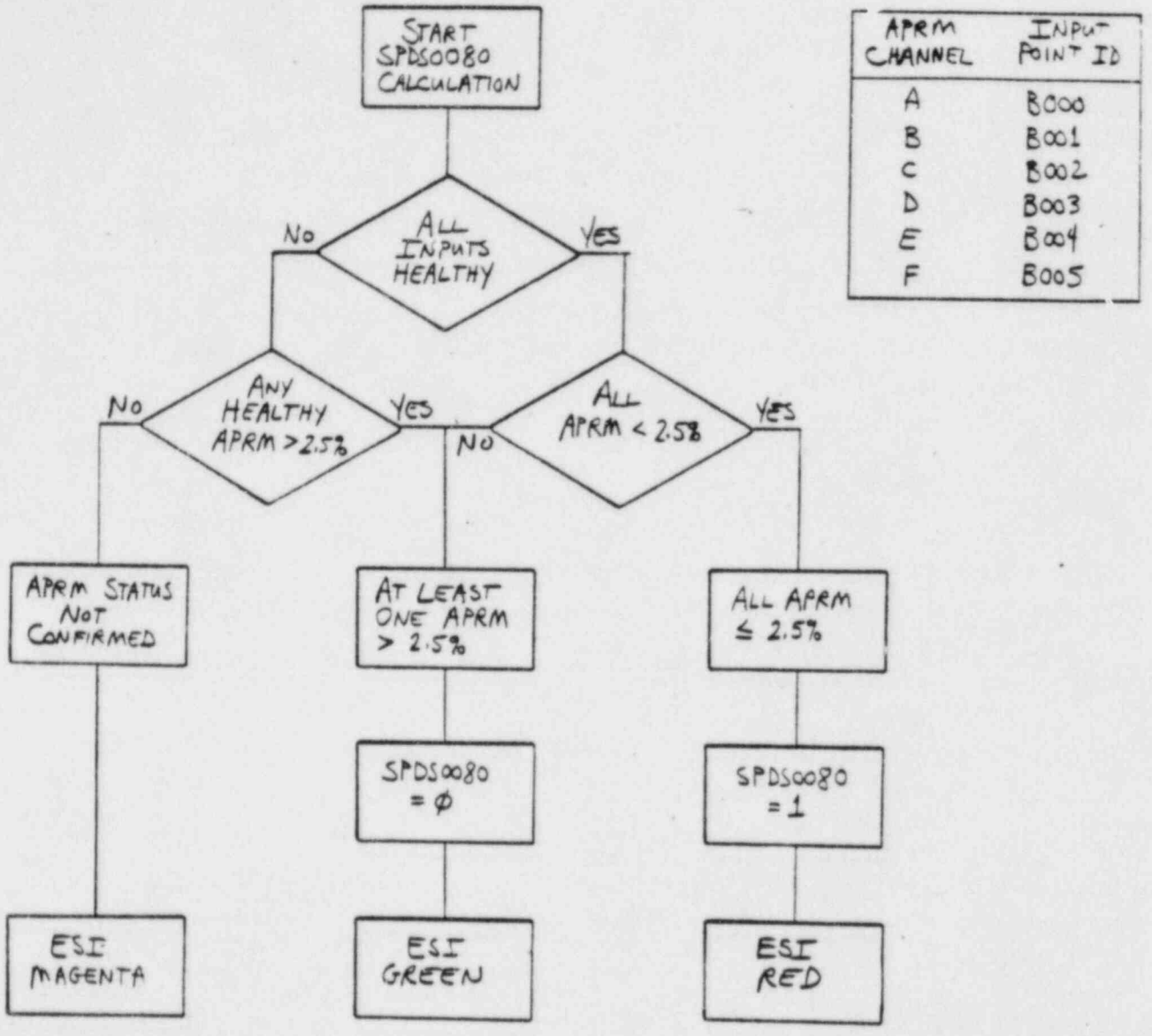



Figure 6-1. Processing Logic for Point SPDS0080 and Operation of the All APRM Downscale ESI.

6.1.1.4 Any APRM Bypassed ESI

This ESI is controlled by Boolean point SPDS0001 which is a healthy OR of the following individual APRM channel bypass signals:

| APRM Channel | Field Input Point ID |
|---|---|
| A | A535 |
| B | A536 |
| C | A537 |
| D | A538 |
| E | A539 |
| F | A540 |

Based on the healthy OR calculation, this ESI indicates when any APRM channel is bypassed by changing to a RED color fill. When no APRMs are bypassed, this ESI is GREEN.

6.1.1.5 SRM Position ESI

This ESI is controlled by field input point A519, and is used to indicate if the Source Range Monitors are inserted in the reactor core (A519 = 0) or retracted (A519 = 1). The text "IN" appears in this ESI block when the SRMs are inserted, and the text "OUT" appears when the SRMs are retracted. When the plant is in the RUN mode, the SRMs are normally retracted, and this ESI is displayed in GREEN. If the SRMs are inserted in the RUN mode, this ESI is displayed in RED to indicate that the SRMs are not in their normal position for this plant mode. In the STARTUP, SHUTDOWN and REFUEL plant modes, it is a normal condition for the SRMs to be inserted. In these plant modes, the SRM Position ESI is GREEN when the SRMs are inserted, and RED when they are retracted. This ESI is simply controlled by designating the alarm state for point A519 in the PMIS data base as follows: (a) alarm state = 1 in mode 1, (b) alarm state = 0 in modes 2 to 4.

6.1.1.6 Any SRM Upscale ESI

This ESI is controlled by field input point A520. An SRM "upscale" trip condition performs a control rod block function, but is bypassed in the RUN plant mode. This ESI is displayed in RED when an upscale condition exists, otherwise it is GREEN.

6.1.1.7 Any SRM Inoperative ESI

This ESI is controlled by field input point A521. An SRM inoperative condition causes a control rod block, but is bypassed in the RUN plant mode. This ESI is displayed in RED when an inoperative condition exists, otherwise it is GREEN.

6.1.1.8 Any SRM Bypassed ESI

This ESI is controlled by field input point A533. When a bypass condition exists, this ESI is displayed in RED, otherwise it is GREEN.

6.1.1.9 All Rods In ESI

This ESI is controlled by field input point N520. When all control rods are inserted, this ESI is displayed in RED, otherwise it is GREEN.

6.1.1.10 Reactor Scram ESI

This ESI is controlled by external (real) point SPDS0039. Processing logic for this data point, and for operation of this ESI is shown in Figure 6-2.

6.1.2 RPV and Containment Isolation System ESIs

There are seven RPV and containment isolation ESIs, one for each isolation group. Each ESI is driven by a Boolean point that is the healthy OR of the "A" and "B" isolation demand signals for the respective isolation group, as follows:

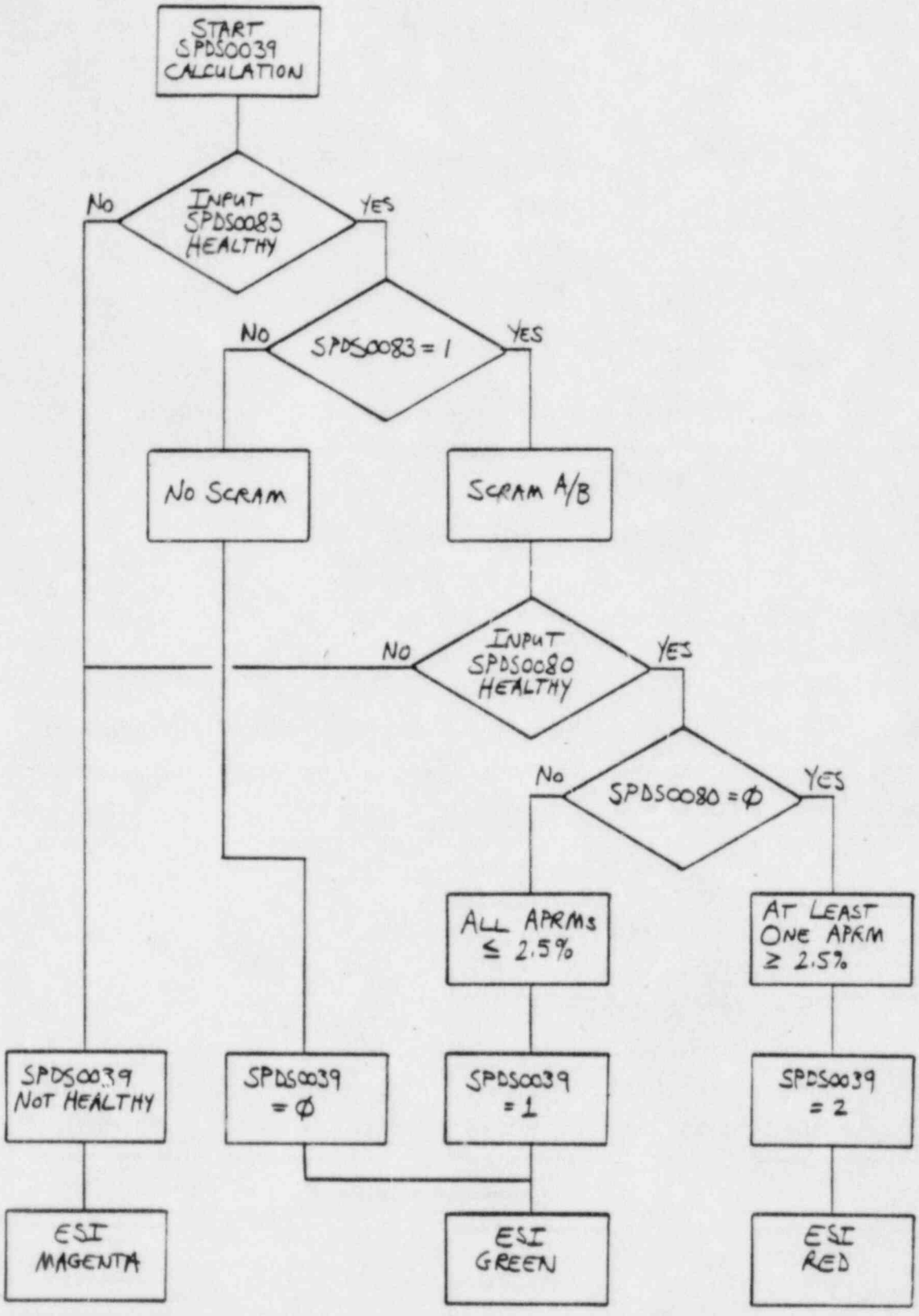



Figure 6-2. Processing Logic for Point SPDS0039 and Operation of the Reactor Scram ESI.

| Isolation Group | Input "A" Point ID | Input "B" Point ID | ESI Driver |
|---|---|---|---|
| 1 | D554 | D555 | SPDS0032 |
| 2 | N781 | N782 | SPDS0033 |
| 3 | N783 | N784 | SPDS0034 |
| 4 | N785 | N786 | SPDS0035 |
| 5 | N787 | N788 | SPDS0036 |
| 6 | N789 | N790 | SPDS0037 |
| 7 | N791 | N792 | SPDS0038 |

When an isolation demand signal is present, the respective ESI is RED (i.e., the associated actuation logic is in a tripped state). When the isolation demand signal is absent, the respective ESI is GREEN (i.e., the associated actuation logic is in a normal state).

### 6.1.3 Valve Position ESIs

There are thirteen ESIs that report the position of main steam safety relief valves (SRVs), code safety valves (SVs), and main steam isolation valves (MSIVs). The individual valve ESIs are displayed in GREEN when the respective valve is CLOSED, and in RED when the respective valve is OPEN.

#### 6.1.3.1 Safety Relief Valve ESIs

There are eight SRVs, designated "A" to "H", which are displayed as individual "bow-tie" valve mimics (i.e., similar in shape to valves in mimics on various control room panels). Each SRV mimic is controlled by its own external (real) data point, based on inputs from a valve position switch and a tailpipe temperature sensor. Processing logic for the SRV external (real) data points, and for the operation of the SRV ESIs is shown in Figure 6-3.

#### 6.1.3.2 Safety Valve ESIs

There are three code safety valves, designated "A" to "C" which are displayed as individual "bow-tie" valve mimics. Each SV mimic is controlled by its own external (real) data point, based on inputs from

| SRV | SPDSXXXX | Pos. Sw. Input A | Temp Input B |
|---|---|---|---|
| A | SPDS0089 | D556 | T142 |
| B | SPDS0093 | D557 | T143 |
| C | SPDS0094 | D558 | T144 |
| D | SPDS0095 | D559 | T145 |
| E | SPDS0096 | D560 | T146 |
| F | SPDS0097 | D561 | T147 |
| G | SPDS0098 | D562 | T148 |
| H | SPDS0099 | D563 | T149 |

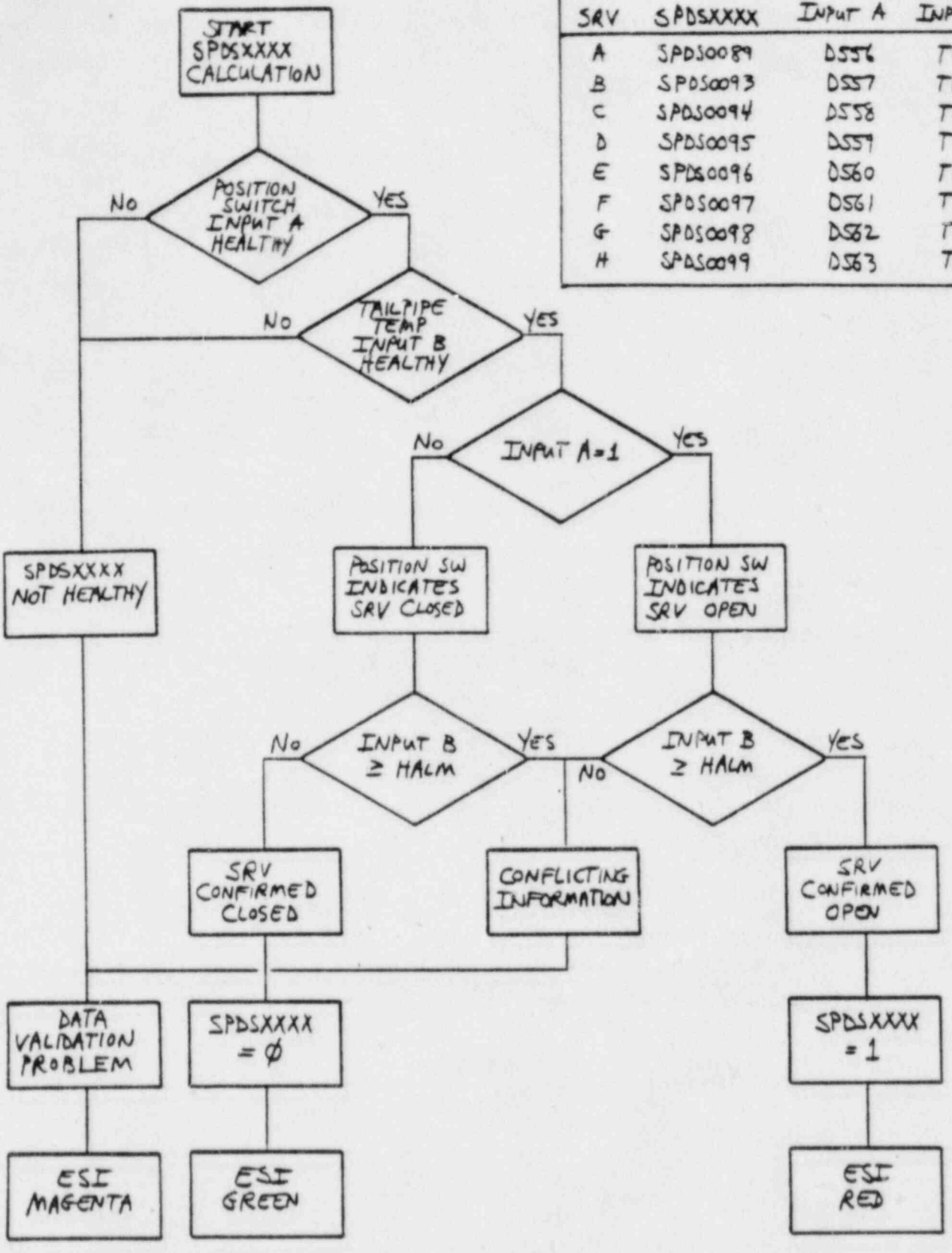



Figure 6-3. Processing Logic for Points SPDS0089, SPDS0093 to SPDS0099, and Operation of the SRV "A" to "H" ESIs.

redundant tailpipe temperature sensors. There is no direct indication of SV position. The SPDS therefore displays an inferred valve position. Processing logic for the SV external (real) data points, and for operation of the SV ESIs is shown in Figure 6-4.

6.1.3.3 SRV and SV Status ESI

This ESI is controlled by external (real) point SPDS0050. It is intended to give an overview of SV and SRV status. Processing logic for data point SPDS0050, and for operation of this ESI is shown in Figure 6-5. The text "CLOSED" appears in this ESI block when it is GREEN, and the text "OPEN" appears when it is RED.

6.1.3.4 MSIV Status ESI

This ESI is controlled by external (real) point SPDS0010. It is intended to provide an overview of MSIV status. Processing logic for data point SPDS0010, and for this ESI is shown in Figure 6-6. The text "CLOSED" appears in this ESI block when it is GREEN, and the text "OPEN" appears when it is RED.

6.1.4 Pump Status ESIs

There are nine ESIs that report the operating status of important pumps. A pump ESI is displayed in GREEN, with the text "OFF" inside the ESI block, when the respective pump is not running. The ESI is displayed in RED, with the text "ON" inside the ESI block, when the respective pump is running.

6.1.4.1 Residual Heat Removal (RHR) Pump ESIs

There are four RHR pumps, designated 1A, 1B, 2A and 2B. Each pump ESI is controlled by a field input point as listed below:

| SAFETY VALVE | SPDSXXXX | TEMP INPUT A | TEMP INPUT B |
|---|---|---|---|
| A | SPDS0040 | M186 | T139 |
| B | SPDS0041 | M187 | T140 |
| C | SPDS0042 | M188 | T141 |

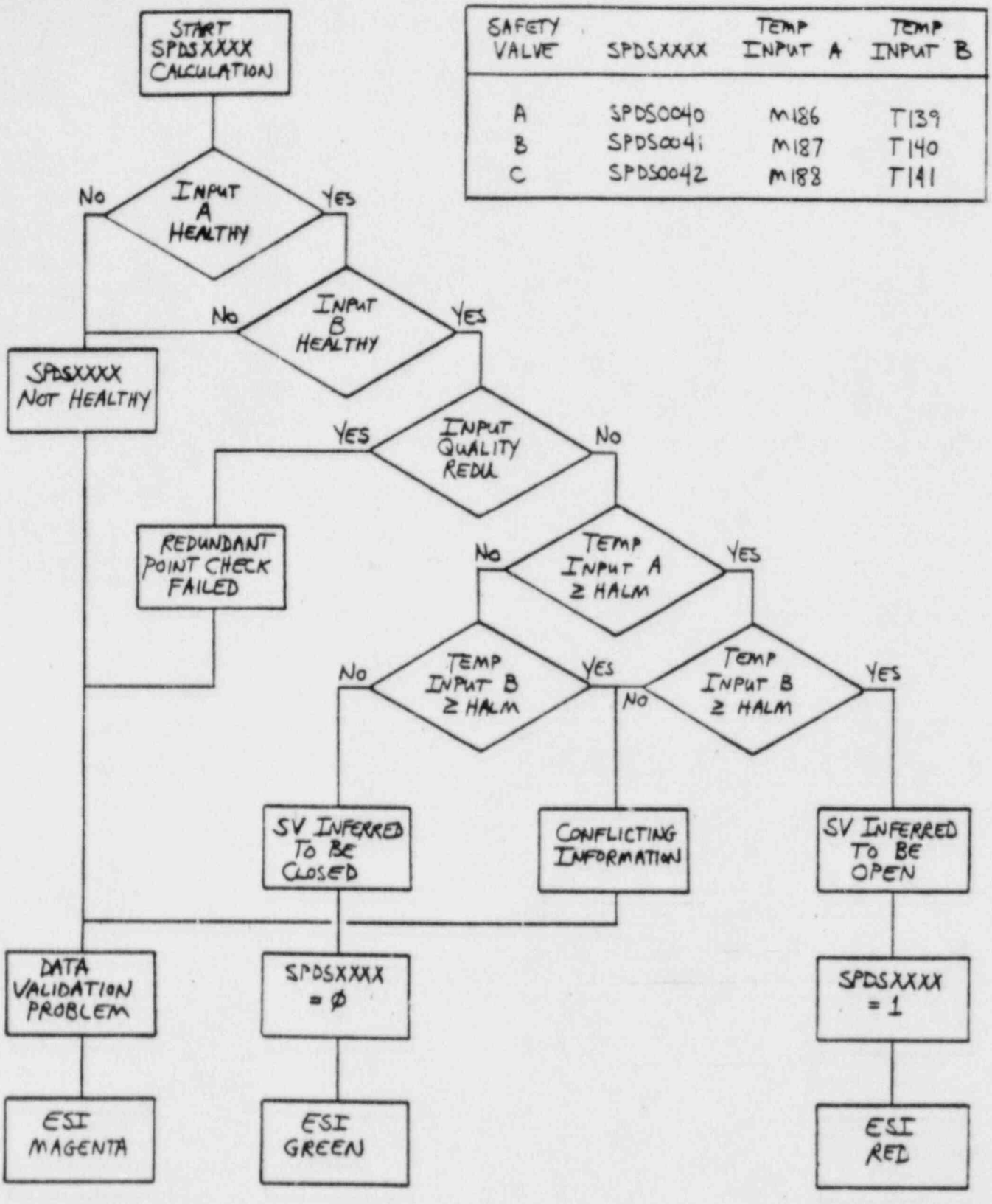
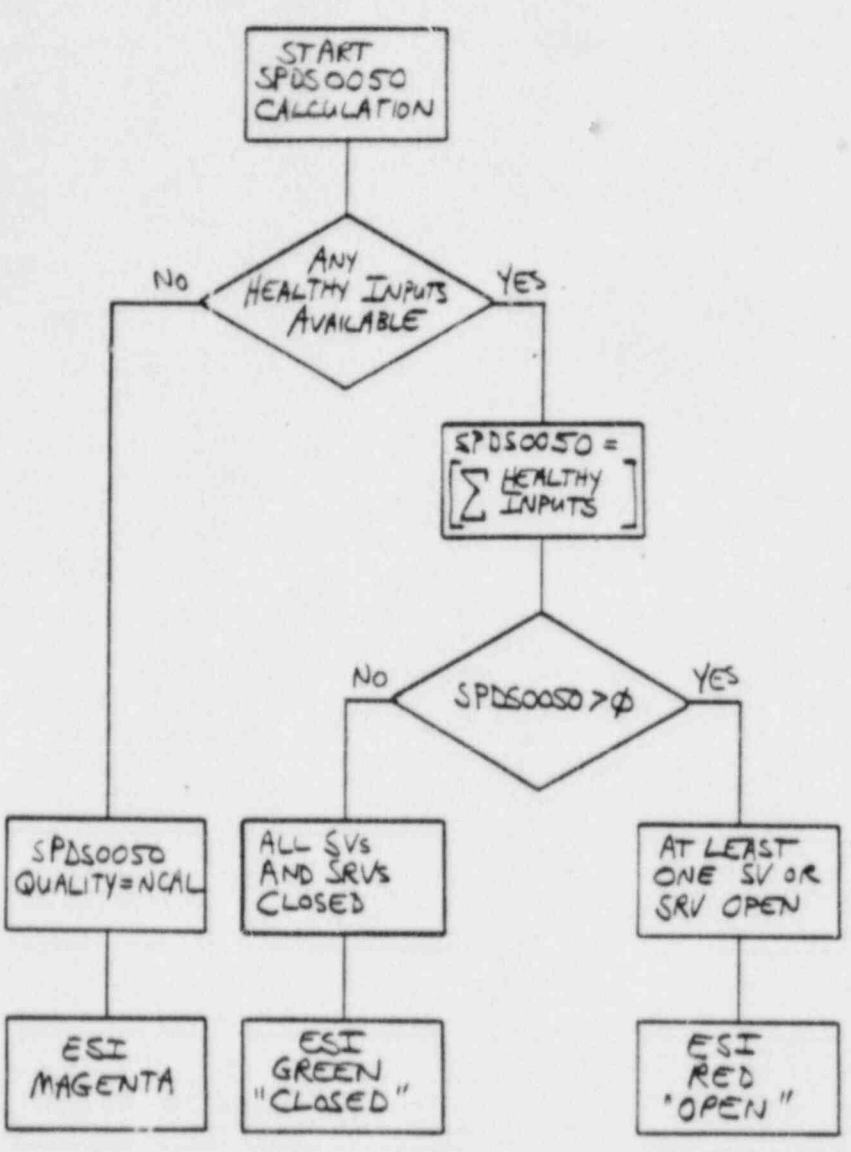



Figure 6-4. Processing Logic for Points SPDS0040 to SPDS0042 and Operation of the Safety Valve "A" to "C" ESIs.




| VALVE | INPUT POINT ID |
|---|---|
| SV "A" | SPDS0040 |
| "B" | SPDS0041 |
| "C" | SPDS0042 |
| SRV "A" | SPDS0059 |
| "B" | SPDS0093 |
| "C" | SPDS0094 |
| "D" | SPDS0095 |
| "E" | SPDS0096 |
| "F" | SPDS0097 |
| "G" | SPDS0098 |
| "H" | SPDS0099 |

Figure 6-5. Processing Logic for Point SPDS0050 and Operation of the SRV and SV Status ESI.

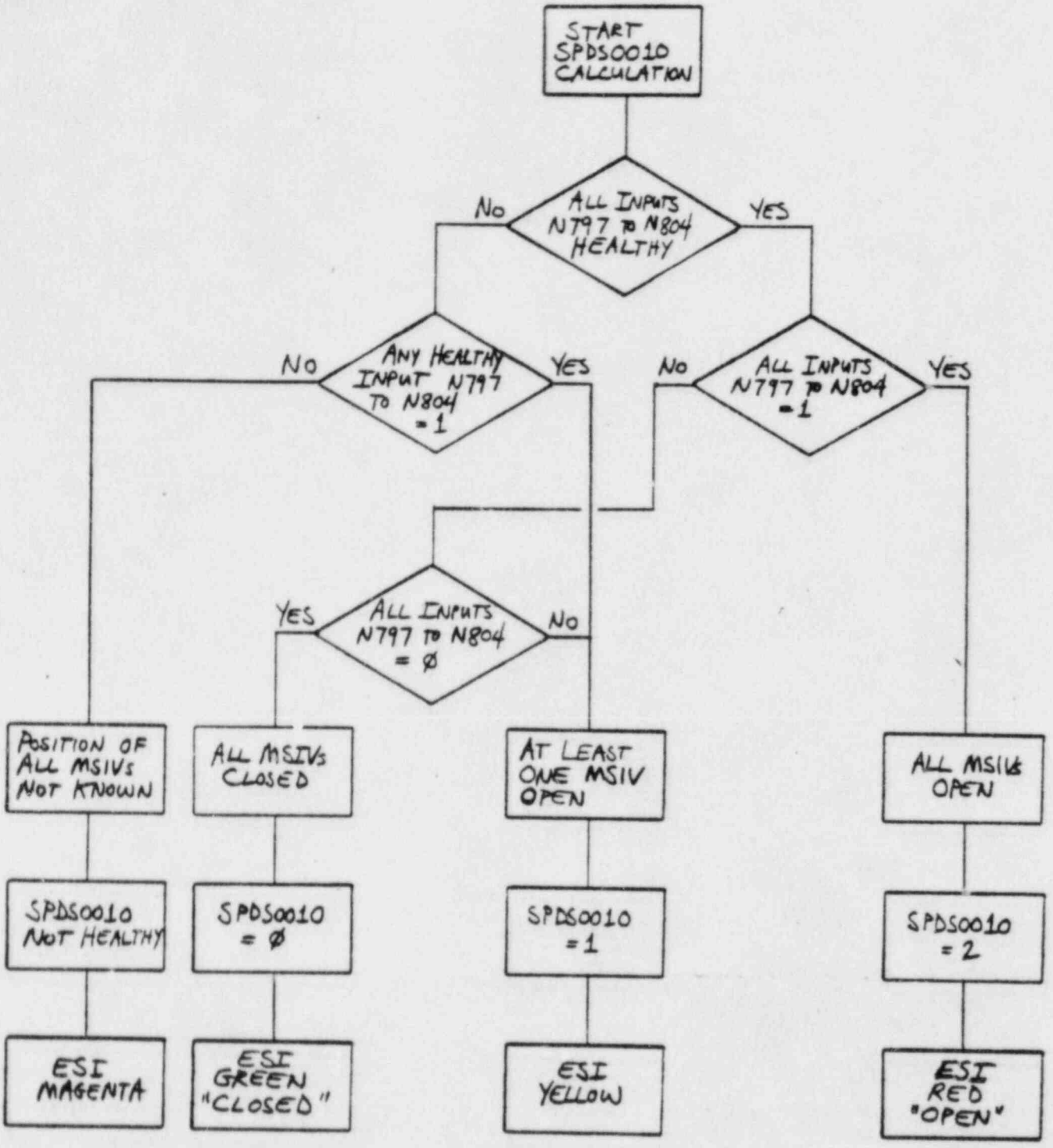



Figure 6-6. Processing Logic for Point SPDS010 and Operation of the MSIV Status ESI.

| RHR Pump | Field Input Point ID |
|---|---|
| 1A | N861 |
| 1B | N862 |
| 2A | N863 |
| 2B | N864 |

Tne RHR pump operating status does not consider the alignment of the RHR system.

6.1.4.2 Core Spray (CS) Pump ESIs

There are two CS pumps, designated 1A and 1B. Each pump ESI is controlled by a field input point as listed below:

| CS Pump | Field Input Point ID |
|---|---|
| 1A | M578 |
| 1B | M580 |

6.1.4.3 High Pressure Coolant Injection (HPCI) Pump ESI

The HPCI pump ESI is controlled by external (real) point SPDS0085. Processing logic for this data point, and for operation of this ESI is shown in Figure 6-7. HPCI pump status is inferred from a measurement of flow in the HPCI system.

6.1.4.4 Reactor Core Isolation Cooling (RCIC) Pump ESI

The RCIC pump ESI is controlled by external (real) point SPDS0086. Processing logic for this data point, and for operation of this ESI is shown in Figure 6-8. RCIC pump status is inferred from a measurement of flow in the RCIC system.

6.1.4.5 Drywell Sump Pump ESI

This ESI is controlled by external (real) point SPDS0054. Processing logic for this data point, and for operation of this ESI is shown in Figure 6-9. Drywell sump pump status is inferred from a measurement of discharge flow from the two sump pumps.

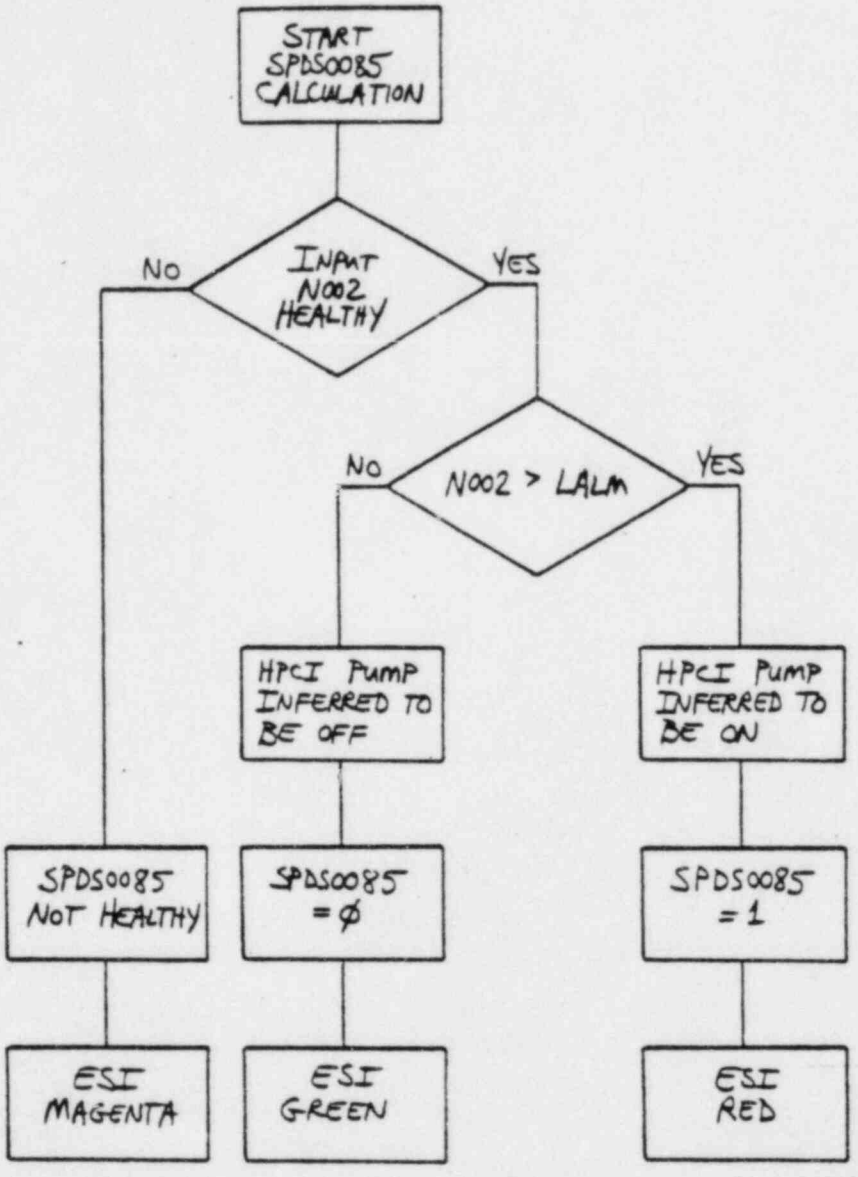



Figure 6-7. Processing Logic for Point SPDS0085 and Operation of the HPCI Pump ESI.

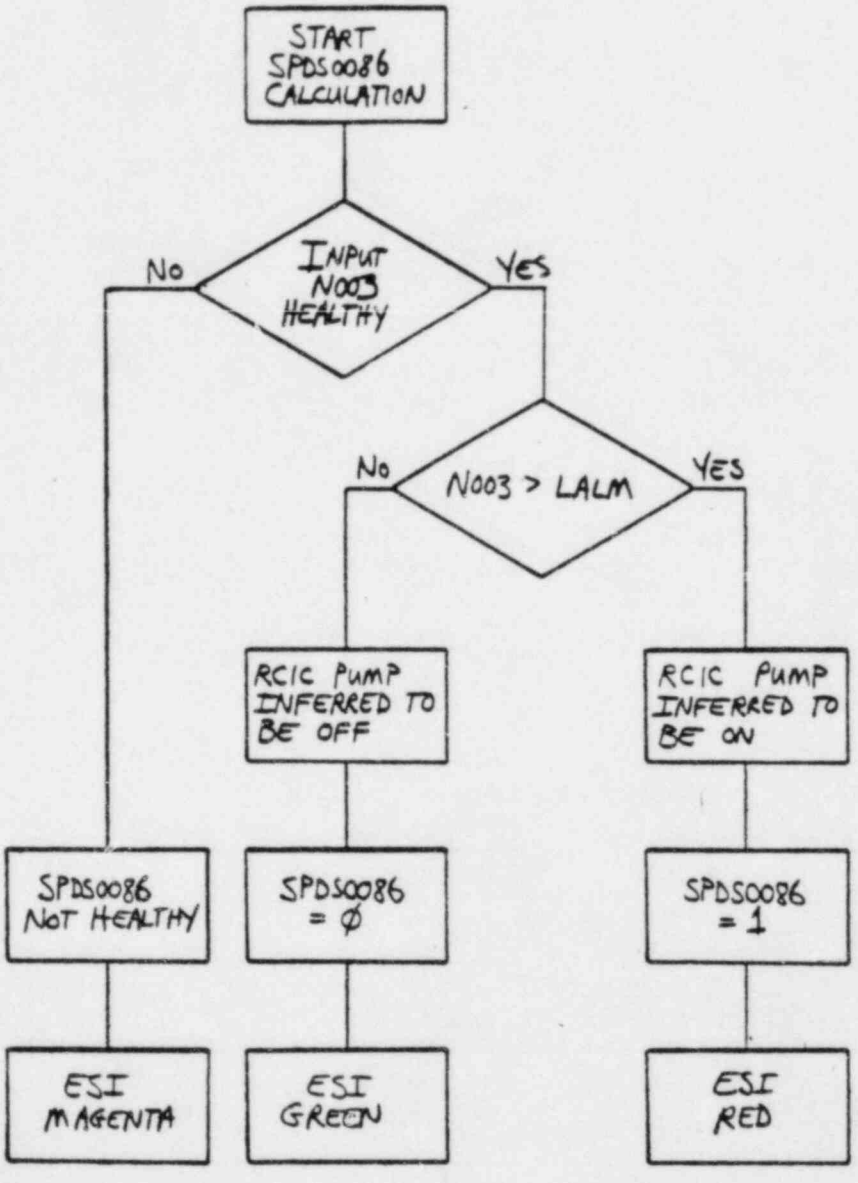



Figure 6-8. Processing Logic for Point SPDS0086 and Operation of the RCIC Pump ESI.

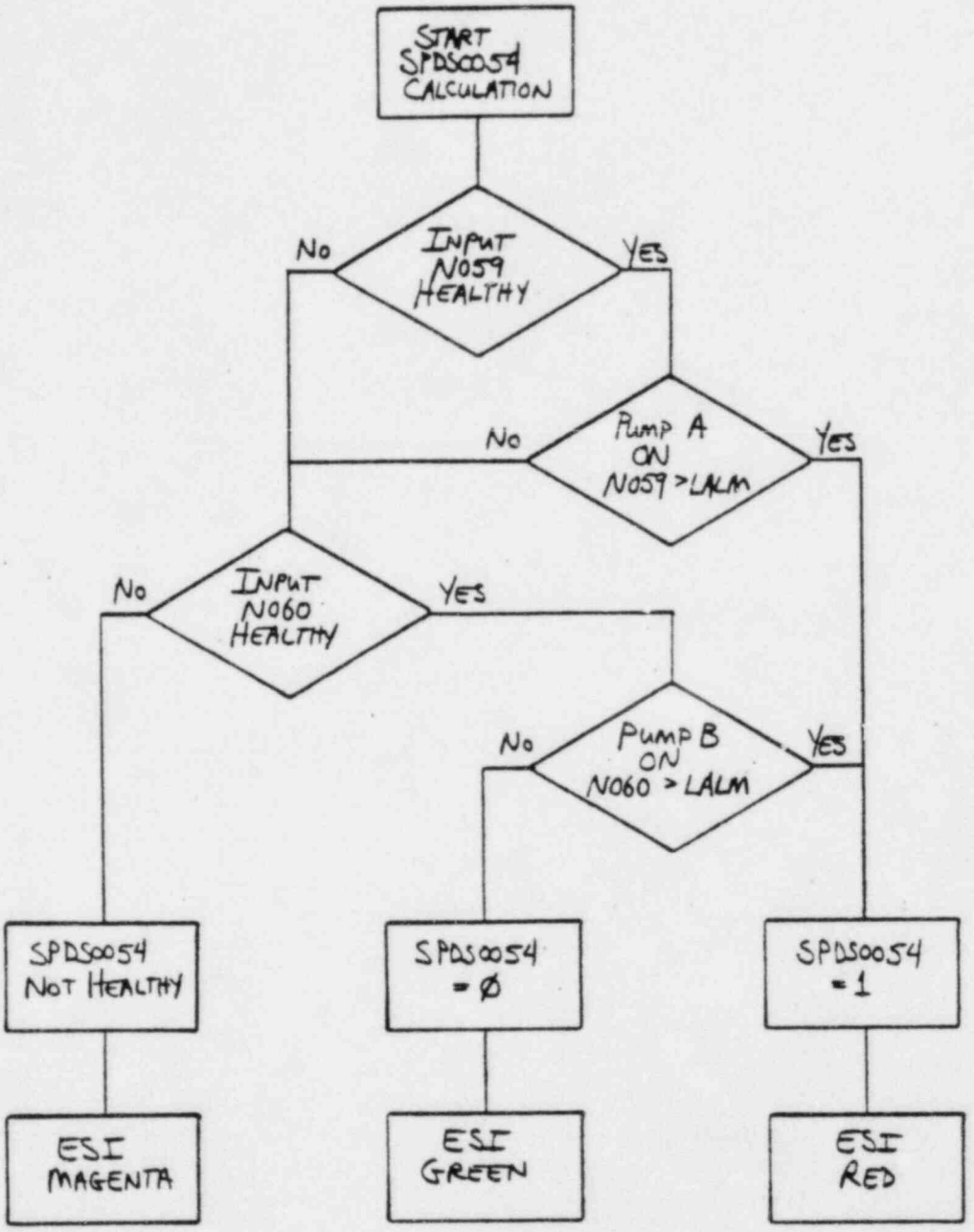



Figure 6-9. Processing Logic for Point SPDS0054 and Operation of the Drywell Sump Pump ESI.

## 6.2 EOP LIMIT STATUS INDICATORS

There are fifteen EOP Limit Status Indicators that are used to alert the operator to the status of the plant with respect to multi-parameter limits in the plant Emergency Operating Procedures. The primary purpose of the EOPSIs is to "close the loop" by providing a communications link from Level 3 displays back up to the associated Level 1 and Level 2 displays. The EOPSIs which appear in the SPDS displays are the following:

- Heat Capacity Temperature Limit
- Heat Capacity Level Limit
- Suppression Pool Load Limit
- Containment Pressure Limit
- Drywell Spray Initiation Pressure Limit
- Drywell Hydrogen Concentration Limit
- Drywell Oxygen Concentration Limit
- Suppression Chamber Oxygen Concentration Limit
- NPSH Limit
- RPV Saturation Temperature Limit
- RPV Pressure/Level Status Matrix (composed of five EOPSIs)

Each EOPSI is controlled by an external (real) data point based on processing logic which is described in detail in Section 9. A summary of the operation of the EOPSIs is presented in Table 6-2.

Table 6-2. Summary of EOP Limit Status Indicators.

| Status Indicator | Allowed States | Condition | Use | Calculation Described |
|---|---|---|---|---|
| Heat cap temp limit | Green<br>Red<br>Magenta | SPDS000B = 0<br>SPDS000B = 1<br>Validation failure | L2.4 | 9.1 |
| Heat cap level limit | Green<br>Red<br>Magenta | SPDS001B = 0<br>SPDS001B = 1<br>Validation failure | L2.4 | 9.2 |
| Supp pool load limit | Green<br>Red<br>Magenta | SPDS002B = 0<br>SPDS002B = 1<br>Validation failure | L2.4 | 9.3 |
| Cont. pressure limit | Green<br>Yellow<br>Red<br>Magenta | SPDS004B = 0<br>SPDS004B = 1<br>SPDS004B = 2<br>Validation failure | L2.4 | 9.4 |
| Drywell spray limit | Green<br>Red<br>Magenta | SPDS006B = 0<br>SPDS006B = 1<br>Validation failure | L2.4 | 9.5 |
| Drywell $H_2$ limit | Green<br>Red<br>Magenta | SPDS007B = 0<br>SPDS007B = 1<br>Validation failure | L2.4 | 9.6 |
| Drywell $O_2$ limit | Green<br>Red<br>Magenta | SPDS009B = 0<br>SPDS009B = 1<br>Validation failure | L2.4 | 9.6 |
| Supp chbr $O_2$ limit | Green<br>Red<br>Magenta | SPDS010B = 0<br>SPDS010B = 1<br>Validation failure | L2.4 | 9.7 |
| NPSH limit | Green<br>Red<br>Magenta | SPDS011B = 0<br>SPDS011B = 1<br>Validation failure | L2.2 | 9.8 |
| RPV saturation temperature limit | Green<br>Red<br>Magenta | SPDS028B = 0<br>SPDS028B = 1<br>Validation failure | L1.0,<br>L2.2,<br>L3.15 | 9.10 |
| RPV pressure high, level increasing* | Blank<br>Cyan<br>Magenta | SPDS023B = 0<br>SPDS023B = 1<br>Validation failure | L3.15 | 9.12 |

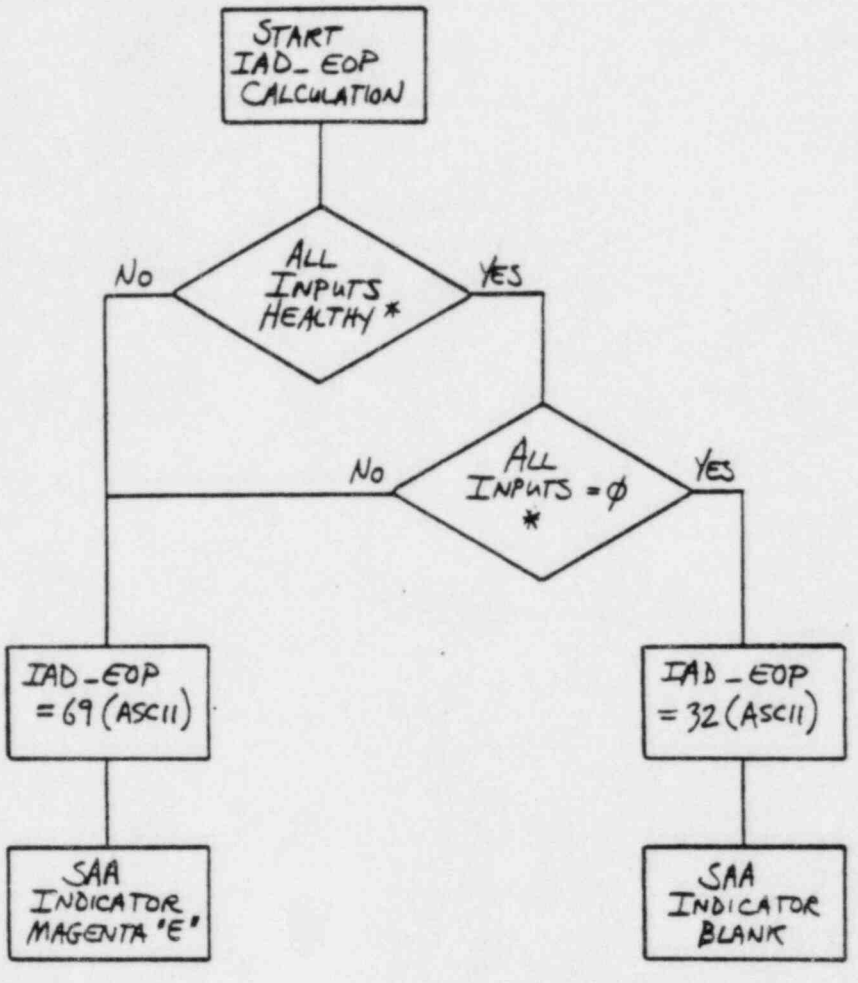
Table 6-2. Summary of EOP Limit Status Indicators (continued).

| Status Indicator | Allowed States | Condition | Use | Calculation Described |
|---|---|---|---|---|
| RPV pressure inter-mediate, level increasing* | Blank<br>Cyan<br>Magenta | SPDS024B = 0<br>SPDS024B = 1<br>Validation failure | L3.15 | 9.12 |
| RPV pressure low, level increasing* | Blank<br>Cyan<br>Magenta | SPDS025 = 0<br>SPDS025 = 1<br>Validation failure | L3.15 | 9.12 |
| RPV pressure high or intermediate, level decreasing* | Blank<br>Cyan<br>Magenta | SPDS026B = 0<br>SPDS026B = 1<br>Validation failure | L3.15 | 9.12 |
| RPV pressure low, level decreasing* | Blank<br>Cyan<br>Magenta | SPDS027B = 0<br>SPDS027B = 1<br>Validation failure | L3.15 | 9.12 |

*Part of RPV pressure/level status matrix

## 6.3 SYSTEM ALARM AREA INDICATOR

Another important linkage among Level 3 displays and all other SPDS displays is provided by the System Alarm Area Indicator which displays a MAGENTA "E" in the System Alarm Area (SAA) of the CRT screen whenever any data point which drives selected EOPSIs has: (a) a current value which corresponds to a warning or alarm state, or (b) a not-healthy data quality. When all relevant data points are healthy and have a current value which corresponds to a normal state, a "blank" is displayed in the SAA. Operation of the SAA indicator is controlled by global common variable IAD_EOP based on the processing logic shown in Figure 6-10.




* INPUT POINTS ARE: SPDS000B, SPDS001B, SPDS002B, SPDS004B, SPDS006B, SPDS007B, SPDS009B, SPDS010B, SPDS011B, SPDS028B.

Figure 6-10. Processing Logic for System Alarm Area (SAA) Indicator.

# 7. LEVEL 1 DISPLAY CHARACTERISTICS

There is a single Level 1 display designated L1.0. In addition to the five Safety Function Indicators (SFIs) found in all SPDS displays, this display contains other status indicators and the following four horizontal bar charts:

- APRM
- RPV pressure
- RPV water level (narrow range)
- Drywell pressure (narrow range)

This display is intended to provide an overview of plant safety status by means of the SFIs. The supplementary information in this display (i.e., the bar charts and other status indicators) provides the operator with current values of key plant variables and detailed status of the reactor scram function. To enhance the utility of this display during normal plant operations, narrow range instrument channels are used to drive the RPV water level and drywell pressure bar charts. Data from wide range instrument channels for these plant variables are presented in Level 2 displays.

General bar chart characteristics and conventions for establishing color fill for bar charts are described in Section 2. Simply stated, the color fill of the bar is dictated by the quality code of the data point which drives the bar. Warning and alarm limits for data points used in this display are defined in Section 4. Detailed characteristics the Level 1 display are shown in Figure 7-1, and are described in this section.

## 7.1 BAR CHARACTERISTICS

The four horizontal bar charts are arranged in the order listed below (i.e. Bar 1 at the top of the display). The order in which the bars are arranged is based on the normal order of pricrity that an operator assigns in checking these variables on the existing control room instrumentation.

7.1.1 Bar 1

a. Title: APRM
b. Range: 0 to 125
c. Units: Percent
d. Current value: SPDS0008, Average APRM
e. Rate-of-change: SPDS0009, in units of percent/minute
f. Labeled tic marks: 15, 100
g. Downscale indicator: SPDS01DS
h. NV indicator: SPDS01NV

7.1.2 Bar 2

a. Title: RPV pressure
b. Range: 0 to 1500
c. Units: psig
d. Current value: SPDS0030, Average RPV pressure
e. Rate-of-change: SPDS0031, in units of psi/minute
f. Labeled tic marks: 75, 500, 825, 1045
g. Downscale indicator: SPDS02DS
h. NV indicator: SPDS07NV

7.1.3 Bar 3

a. Title: RPV Level
b. Range: 0 to 60
c. Units: inches
d. Current value: SPDS0019, Average narrow range RPV level
e. Rate-of-change: SPDS0020, in units of inches/minute
f. Labeled tic marks: 12.5, 27.5, 42.5, 58.5
g. Downscale indicator: SPDS03DS
h. NV indicator: SPDS03NV. Also see RPV saturation temperature limit EOPSI in this display.

7.1.4 Bar 4

a. Title: Drywell pressure
b. Range: -5 to +5
c. Units: psig
d. Current value: SPDS0043, Average narrow range drywell pressure
e. Rate-of-change: SPDS0044, in units of psi/minute
f. Labeled tic marks: 0, +1.45, +2.0
g. Downscale indicator: SPDS04DS
h. NV indicator: SPDS08NV

7.2 EQUIPMENT AND EOP LIMIT STATUS INDICATORS

The ESIs and EOPSIs listed below are included in this display. The data point which drives each status indicator is shown in parentheses. In addition to these status indicators, the System Alarm Area (SAA) Indicator is also used in the Level 1 display. See Section 6 for further details on these status indicators.

a. ESIs
   - Reactor scram status (SPDS0039)
   - All-rods-in (N520)

b. EOPSIs
   - RPV saturation temperature limit (SPDS028B)

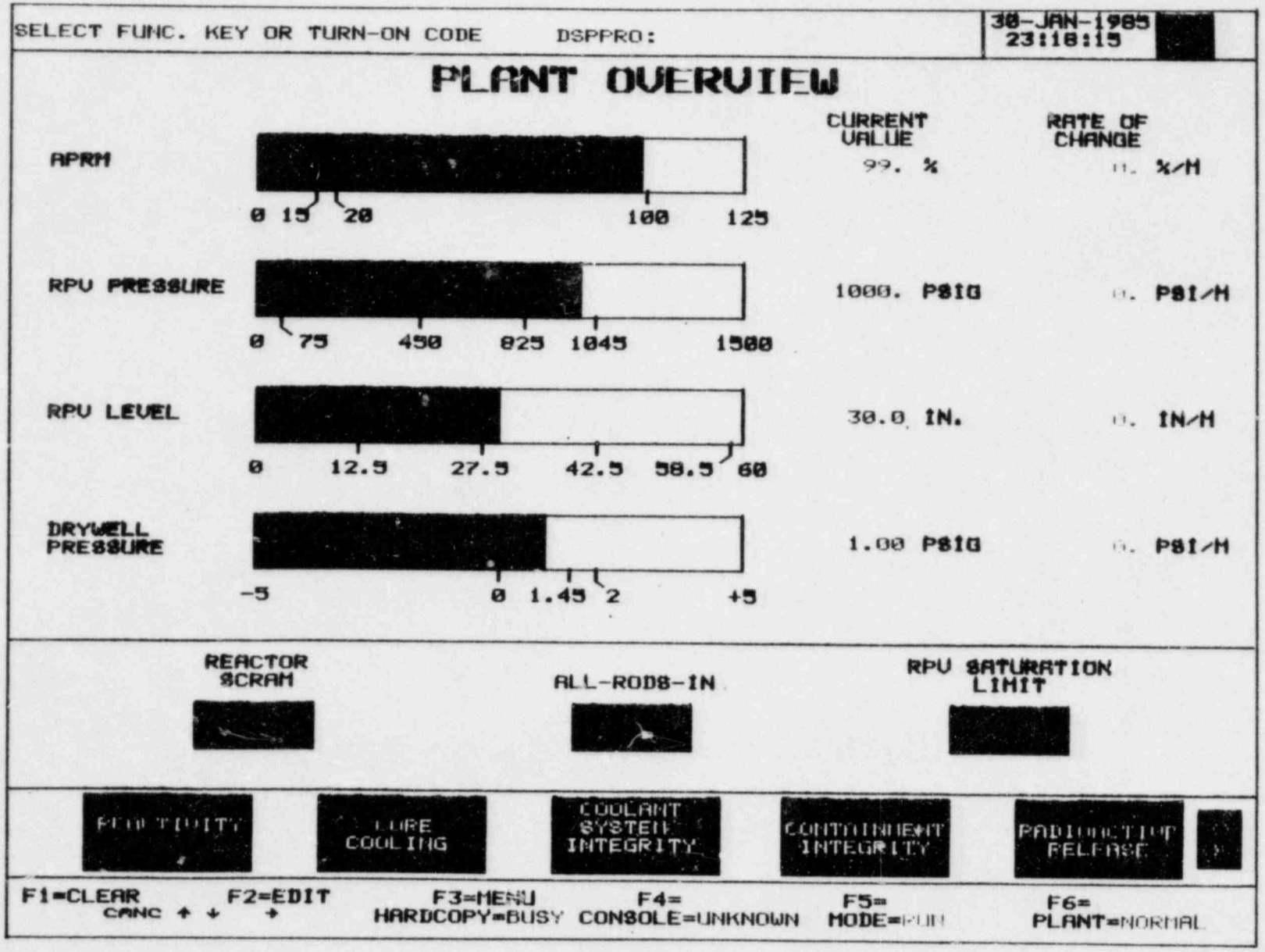



Figure 7-1. Display L1.0, Plant Overview.



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# 8. LEVEL 2 DISPLAY CHARACTERISTICS

There are twelve Level 2 displays designated L2.1.1 to L2.5.3. In addition to the five Safety Function Indicators found in all SPDS displays, the Level 2 displays contain bar charts, trend plots, and mimics. The purpose of the Level 2 displays is to provide detailed plant information related to the individual safety functions. General characteristics of these displays and conventions for establishing color fill of bar charts are described in Section 2. Simply stated, the color fill of the bar is dictated by the quality code of the data point which drives the bar. Warning and alarm limits for data points used in the Level 2 displays are defined in Section 4. Detailed characteristics of each Level 2 display is described in this section.

Most of the Level 2 displays include some or all of the following types of status indicators:

- Not-Valid Indicators (NVI)
- Downscale Indicators (DNSCI)
- Equipment Status Indicators (ESI)
- Emergency Operating Procedure Limit Status Indicators (EOPSI).
- System Status Area (SAA) Indicator

The Not-Valid and Downscale Indicators are described in Section 2, and the Equipment Status, EOP Limit Status, and SAA Indicators are described in Section 6.

## 8.1 DISPLAY L2.1.1, REACTIVITY CONTROL (BAR)

This display contains two horizontal bar charts, one for Average Power Range Monitors (APRM) and one for Source Range Monitors (SRM). Data from Intermediate Range Monitors (IRM) are not presented on the SPDS. As shown in Figure 8-1, the ranges of the APRM and SRM channels should be adequate for providing continuous, or nearly continuous indication of reactor power. Additional data from the IRM instruments are, therefore, not necessary.

In addition to the bar charts described above, the display contains a variety of equipment status and EOP status indicators. The detailed arrangement of the reactivity control bar display is shown in Figure 8-2.

### 8.1.1 Bar Chart Characteristics

#### 8.1.1.1 BAR 1

a. Title: APRM
b. Range: 0 to 125
c. Units: Percent
d. Current Value: SPDS0008, Average APRM
e. Rate-of-change: SPDS0009, in units of percent/minute
f. Labeled tic marks: 15, 100
g. Downscale indicator: SPDS01DS
h. NV indicator: SPDS01NV

#### 8.1.1.2 BAR 2

a. Title: SRM
b. Range: $10^{-1}$ to $10^{6}$
c. Units: Counts per second (CPS)
d. Current Value: SPDS0013, Log of average SRM (for driving the bar)
   SPDS0014, Average SRM (for current value)
e. Rate-of-change (period): SPDS0015, in units of $sec^{-1}$
f. Labeled tic marks: $10^{1}$, $10^{4}$
g. Downscale indicator: SPDS05DS

h. NV indicator: SPDS02NV

i. Notes: (1) The logarithm of the average SRM value (SPDS0013) is used to drive the SRM bar in this display and the SRM trend in display L2.1.2 (see Section 8.2). The digital display of the SRM current value is derived from point SPDS0014. The logarithm calculation for point SPDS0013 is performed using the pseudo-analog logarithm routine which is available on PMIS.

(2) The SRM rate-of-change is described in terms of the reactor period. The current value of reactor period is determined using the external (real) calculation described later in this section.

8.1.2 Equipment and EOP Limit Status Indicators

The ESIs and EOPSIs listed below are included in this display. The data point which drives each status indicator is shown in parentheses. See Section 6 for further details on these status indicators.

a. ESIs

- All APRM downscale trip (SPDS0080)
- Any APRM upscale (A527)
- Any APRM inoperative (A528)
- Any APRM bypassed (SPDS0001)
- SRM position (A519)
- Any SRM upscale (A520)
- Any SRM inoperative (A521)
- Any SRM bypassed (A533)
- Reactor scram status (SPDS0039)
- All-rods-in (N520)

b. EOPSIs

None

8.1.3 Calculation of External (Real) Data Point SPDS0015

The external calculation for point SPDS0015 uses the following algorithm to determine a rate-of-change of the average source range monitor (SRM) value (SPDS0014) in terms of reactor period:

$$\text{Period}(\text{sec}^{-1}) = \frac{26}{\text{Startup rate (decades/min)}}$$

In this algorithm, startup rate is a rate-of-change of the average SRM value (SPDS0014) in units of decades per minute. The startup rate is calculated from the SRM rate-of-change derived from the SPDS rate-of-change transform (SPDS0087). This external (real) calculation assumes that point SPDS0087 nas a processing frequency of once per second. If the processing frequency for point SPDS0087 is changed in the PMIS data base to any other value, the algorithm for SRM reactor period will compute an incorrect current value for reactor period.

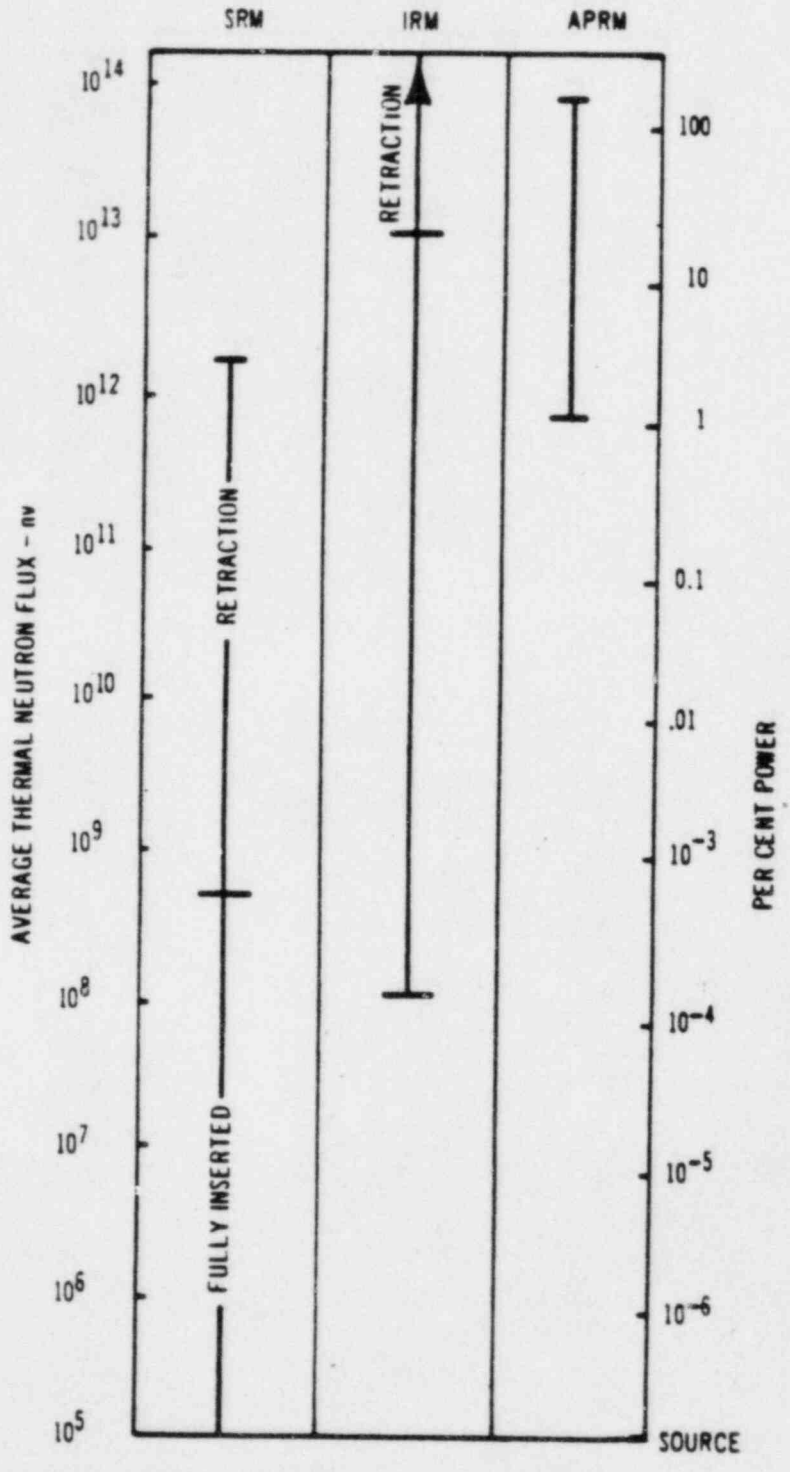


Figure 8-1. Ranges of CNS Neutron Monitoring System (SRM, IRM and APRM only).

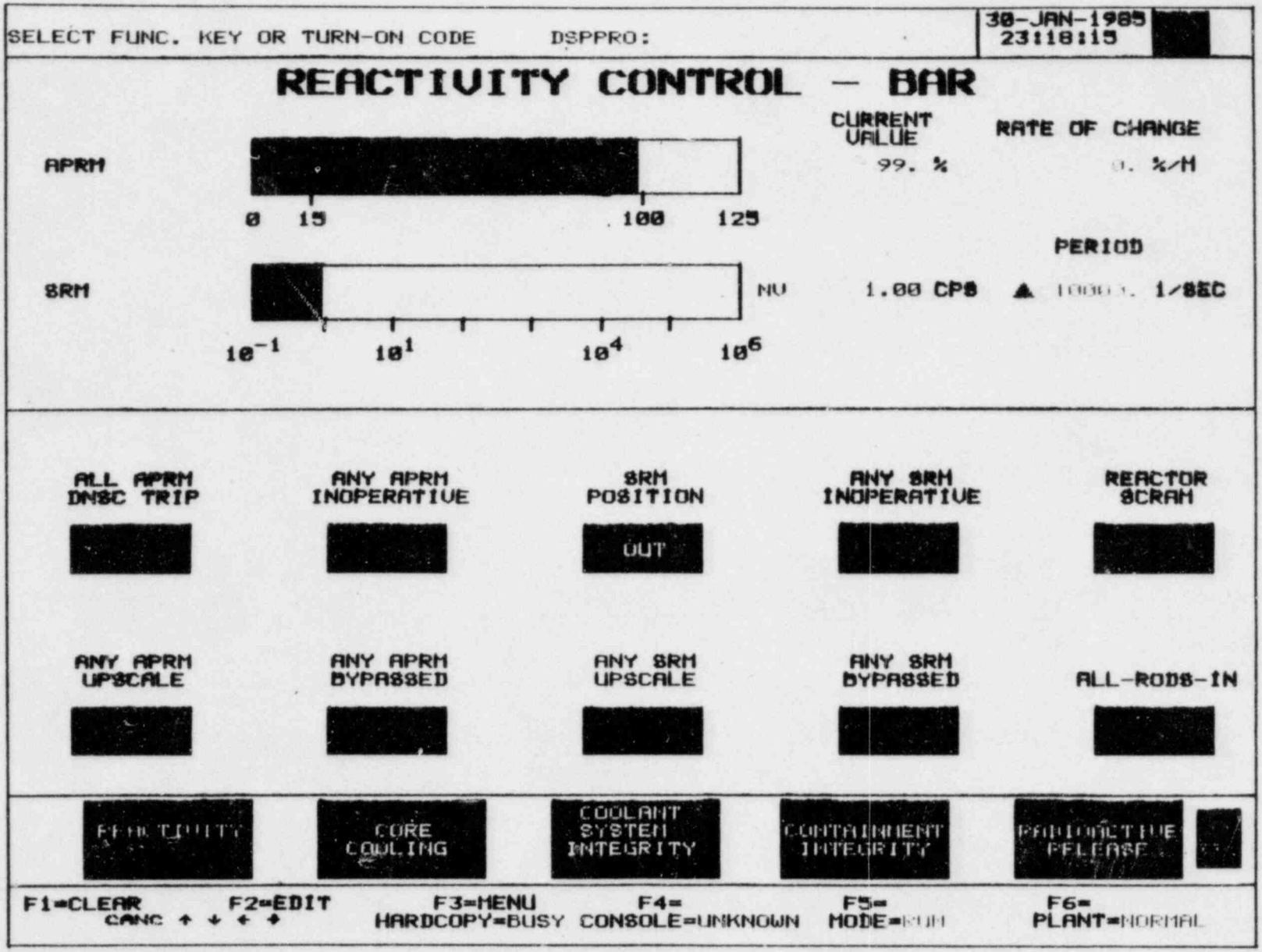


Figure 8-2. Display L2.1.1, Reactivity Control (Bar).

## 8.2 DISPLAY L2.1.2, REACTIVITY CONTROL (TREND)

This display contains two trend plots, one for APRM and one for SRM. In addition, the display contains a variety of equipment status and EOP status indicators. The x-axis (time axis) characteristics for all SPDS trend plots are described in Section 2. The detailed arrangement of the reactivity control trend display is shown in Figure 8-3.

### 8.2.1 Trend Plot Characteristics

#### 8.2.1.1 PLOT 1

The y-axis characteristics are the same as Bar 1 (APRM) described in Section 8.1.

#### 8.2.1.2 PLOT 2

The y-axis characteristics are the same as Bar 2 (SRM) described in Section 8.1.

### 8.2.2 Equipment and EOP Limit Status Indicators

Same as Reactivity Control Bar Display, see Section 8.1.

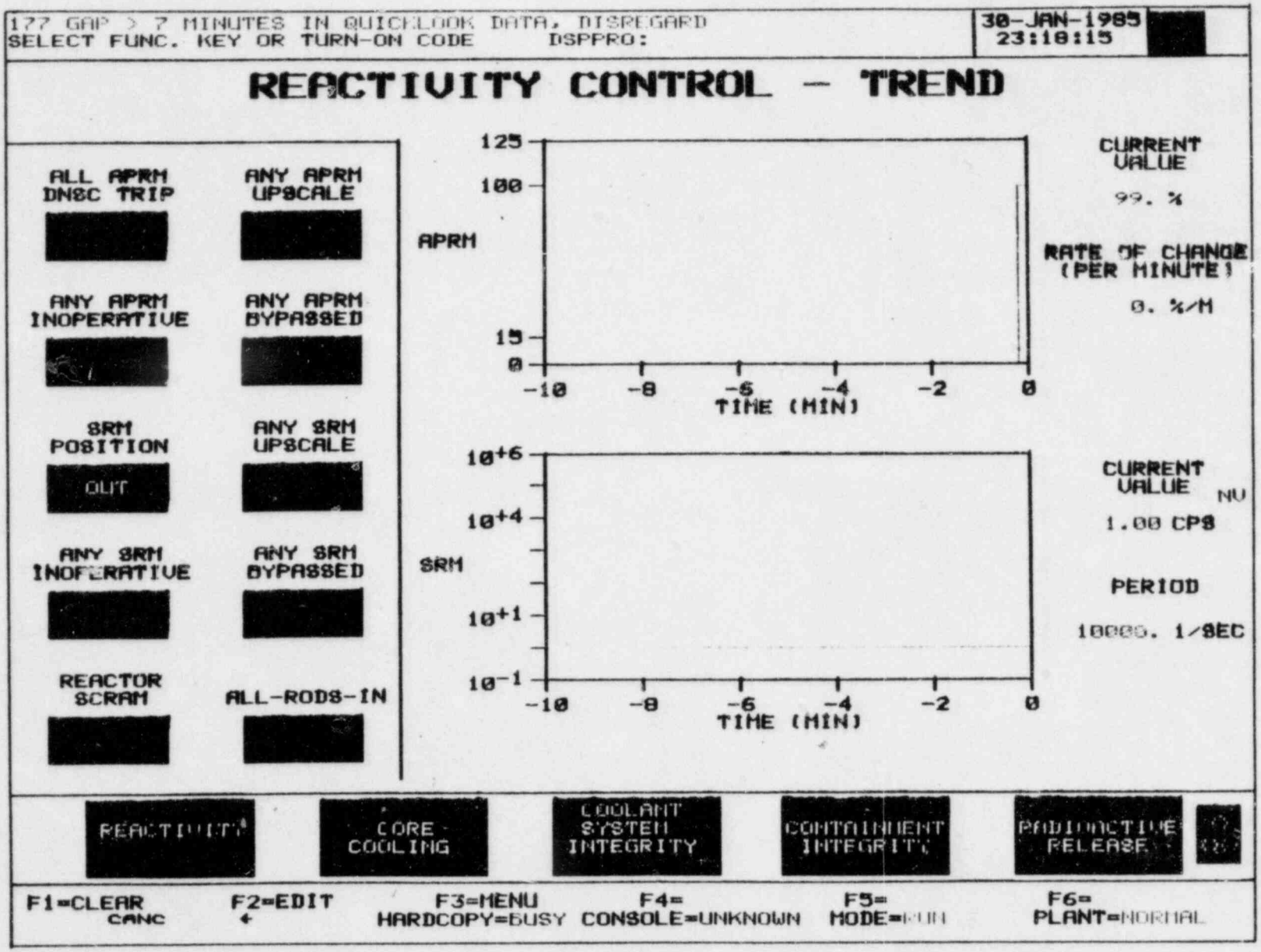


Figure 8-3. Display L2.1.2, Reactivity Control (Trend).

## 8.3 DISPLAY L2.2.1, RPV WATER LEVEL (BAR/RPV MIMIC)

This display contains eight vertical bar charts displaying values from three different ranges of RPV water level instruments as well as a composed water level that is used in conjunction with a mimic of a rector vessel. The correlation between the different RPV water level instrument ranges is shown in Figure 8-4 and is tabulated in Table 8-1. In addition to the vertical bar charts, the display contains reactor pressure current value information and a variety of equipment status and EOP status indicators. The detailed arrangement of the reactor core cooling bar/mimic display is shown in Figure 8-5.

### 8.3.1 Bar Chart Characteristics

The vertical bar charts are listed below in the order they appear in the SPDS display (i.e., from left to right). Note that there are three different reference zeros used to measure RPV water level: (a) narrow range (NR) and wide range (WR) reference zero, (b) fuel zone (FZ) range reference zero, and (c) the bottom of the reactor vessel. The physical relationships among these various RPV level measurement reference points can be readily seen in this display.

#### 8.3.1.1 BARS 1, 2, AND 3

a. Title: Bar 1: NR A
Bar 2: NR B
Bar 3: NR C

b. Range: 0 to 60

c. Units: Inches

d. Current Value: Bar 1: B021, RPV level narrow range A
Bar 2: N011, RPV level narrow range B
Bar 3: N012, RPV level narrow range C

e. Rate-of-change: Bar 1: SPDS0016, in units of inches/minute
Bar 2: SPDS0017
Bar 3: SPDS0018

f. Labeled tic marks: None

g. Downscale indicator: Bar 1: SPDS06DS
Bar 2: SPDS07DS
Bar 3: SPDS08DS

h. NV indicator: None. See RPV saturation limit EOPSI in this display.

8.3.1.2 BAR 4

a. Title: None

b. Range: The total range of Bar 4 is from 252.6 inches to 576.8 inches with reference zero at the bottom of the RPV. Initially, the fuel zone RPV level instruments will not be available on PMIS. Thus, the dynamic range of Bar 4 will be limited to the range of the wide range RPV level instruments, adjusted for a reference zero at the bottom of the RPV. The initial dynamic range is from 366.8 inches to 576.8 inches. When the fuel zone RPV level instruments become available on PMIS, Bar 4 will be dynamically driven over its entire range.

c. Units: Inches

d. Current Value: SPDS0029, RPV mimic water level

e. Rate-of-change: None

f. Labeled tic marks: "TAF" (top of active fuel at the 353-inch level), "INST 0" (reference zero for WR and NR level instruments at the 517-inch level).

g. Downscale indicator: None. See downscale indicators for other bar charts in this display.

h. NV indicator: None. See RPV saturation limit EOPSI in this display.

i. Note: This vertical bar appears on the centerline of a mimic of a reactor vessel, and is scaled to illustrate the proper relationship of water level to key RPV features (i.e., top of active fuel). The active fuel region of the RPV mimic has a CYAN color fill. The calculation to determine the value of external point SPDS0029 is described later in this section.

8.3.1.3 BARS 5 AND 6

a. Title: Bar 5: WR A
Bar 6: WR B

b. Range: -150 to 60

c. Units: Inches

d. Current Value: Bar 5: G032, RPV level wide range A
Bar 6: G033, RPV level wide range B

e. Rate-of-change: Bar 5: SPDS0021, in units of inches/minute
Bar 6: SPDS0022

f. Labeled tic marks: 0, 36 (Note that 36 inches on the wide range scale corresponds to the top of the fuel zone range (i.e., +200 inches). See Table 8-1).

g. Downscale indicator: Bar 5: SPDS09DS
Bar 6: SPDS10DS

h. NV indicator: None. See RPV saturation limit EOPSI in this display.

8.3.1.4 BARS 7 AND 8

a. Title: Bar 7: FZ A
Bar 8: FZ B

b. Range: -100 to +200

c. Units: Inches

d. Current Value: Bar 7: N009, RPV level fuel zone A (not currently available on PMIS)
Bar 8: N010, RPV level fuel zone B (not currently available on PMIS)

e. Rate-of-change: Bar 7: SPDS0025, in units of inches/minute
Bar 8: SPDS0026

f. Labeled tic marks: -39, 0, 14, 164 (Note that 14 and 164 inches on the fuel zone range scale correspond, respectively, to the bottom of the wide range and the reference zero for the wide and narrow ranges. The -39-inch tic mark corresponds to

the level of the top of the active fuel. See Table 8-1).

g. Downscale indicator: Bar 7: SPDS11DS
Bar 8: SPDS12DS

h. NV indicator: None. See RPV saturation limit EOPSI in this display.

8.3.2 Otner Plant Variables

This display includes of the current value of RPV pressure. Tne current value is provided by data point SPDS0030 and is displayed in the top (steam dome) of the reactor vessel mimic. This is an average value, with engineering units of "psig". The NV indicator is SPDS07NV.

8.3.3 Equipment Status and EOP Limit Indicators

The ESIs and EOPSIs listed below are included in this display. The data point which drives each status indicator is shown in parentheses. See Section 6 for further details on these status indicators.

a. ESIs
- SRV status (SPDS0050)
- MSIV status (SPDS0010)

b. EOPSIs
- RPV saturation temperature limit (SPDS028B)
- NPSH limit (SPDS011B)

8.3.4 Calculation of External (Real) Data Point SPDS0029

The external calculation for RPV mimic water level (SPDS0029) is a healthy average of onscale RPV water level data from field input points G032, G033, N009 and N010, after converting each to a reactor vessel level based on a common reference zero located at the bottom of the RPV. The wide range RPV level channels are G032 and G033. The fuel zone RPV level channels are N009 and N010. The correlations between these ranges and the RPV physical dimensions are shown in Table 8-2 and in Figure 8-4. The algorithm for computing the current value of RPV mimic water level is as follows:

$$SPDS0029 = \frac{(G032+516.8) + (G033+516.8) + (N009+352.6) + (N010+352.6)}{n(healthy)}$$

where n(healthy) = number of healthy input points used in the current calculation

516.8 = constant to convert wide range RPV level to RPV level with reference zero at vessel bottom

352.6 = constant to convert fuel zone range RPV level to RPV level with reference zero at vessel bottom

Note that an RPV water level channel that is offscale high, or low will be assigned a quality code of HRL or LRL by the PMIS, and thereby will be rejected from this healthy calculation.

Table 8-1. Reactor Water Level Scale Correlation.

| Reactor Vessel Level (inches) | | | |
|---|---|---|---|
| Narrow & Wide Ranges Instruments | Reactor Vessel Physical Dimensions | Fuel Zone Range Instruments | Remarks |
| | 850 | | Top of reactor vessel (inside) |
| 60 | 576.75 | | Top of narrow and wide range instruments and calculated mimic range |
| 58.5 | 575.25 | | Alarm high |
| 47.5 | 559.25 | | Warning high |
| 35.81 | 552.56 | 200 | Top of fuel zone range instruments |
| 27.5 | 544.25 | 191.69 | Warning low |
| 12.5 | 529.25 | 176.69 | Alarm low |
| 0 | 516.75 | 164.19 | Bottom of narrow range instruments, reference zero for narrow and wide ranges |
| -150 | 366.75 | 14.19 | Bottom of wide range instruments |
| | 352.56 | 0 | Top of active fuel, reference zero for fuel zone range |
| | 313.56 | - 39 | 2/3 core height |
| | 252.56 | -100 | Bottom of fuel zone range instruments and calculated mimic range |
| | 205.56 | | Bottom of active fuel |
| | 0 | | Bottom of reactor vessel (inside) |

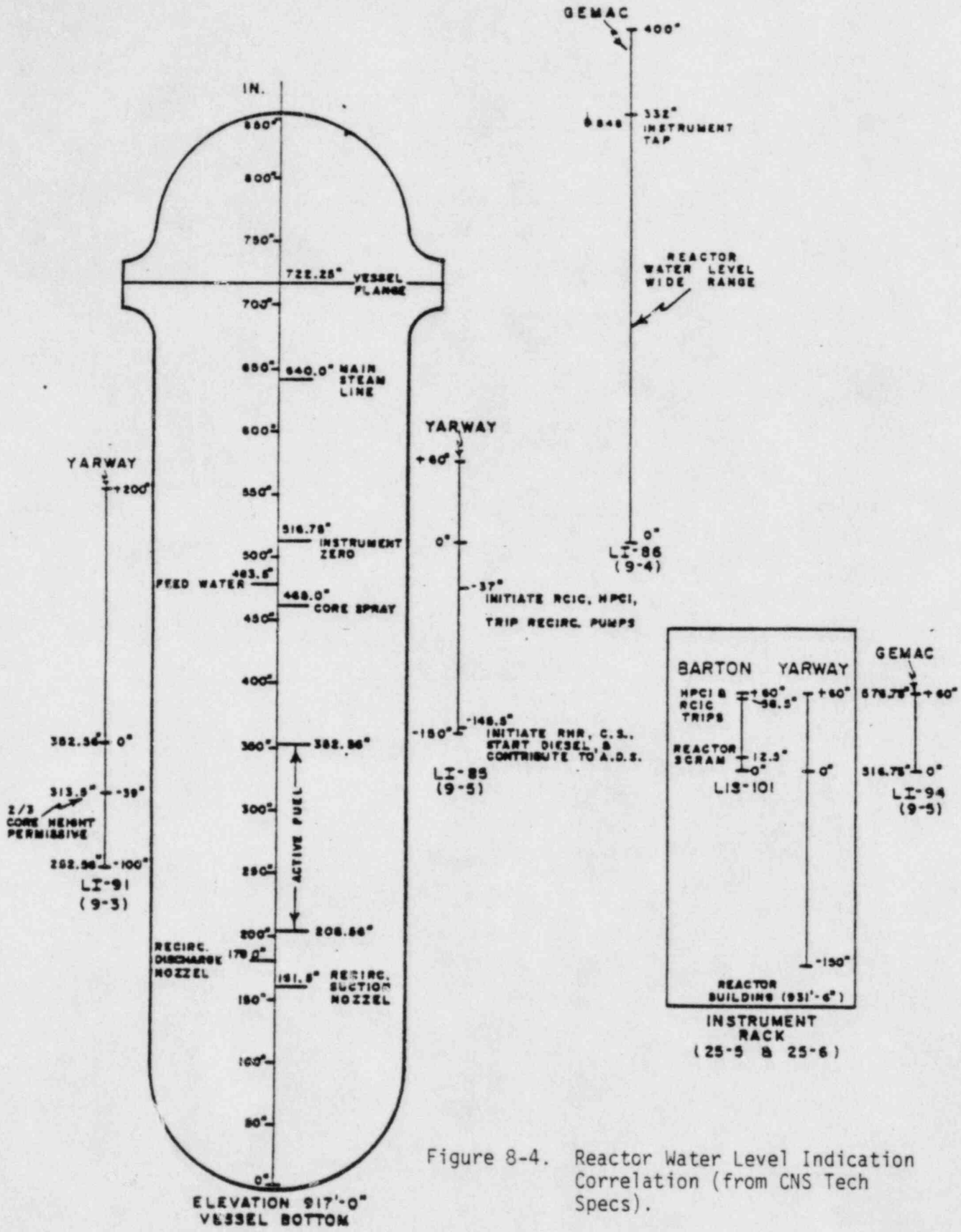


Figure 8-4. Reactor Water Level Indication Correlation (from CNS Tech Specs).

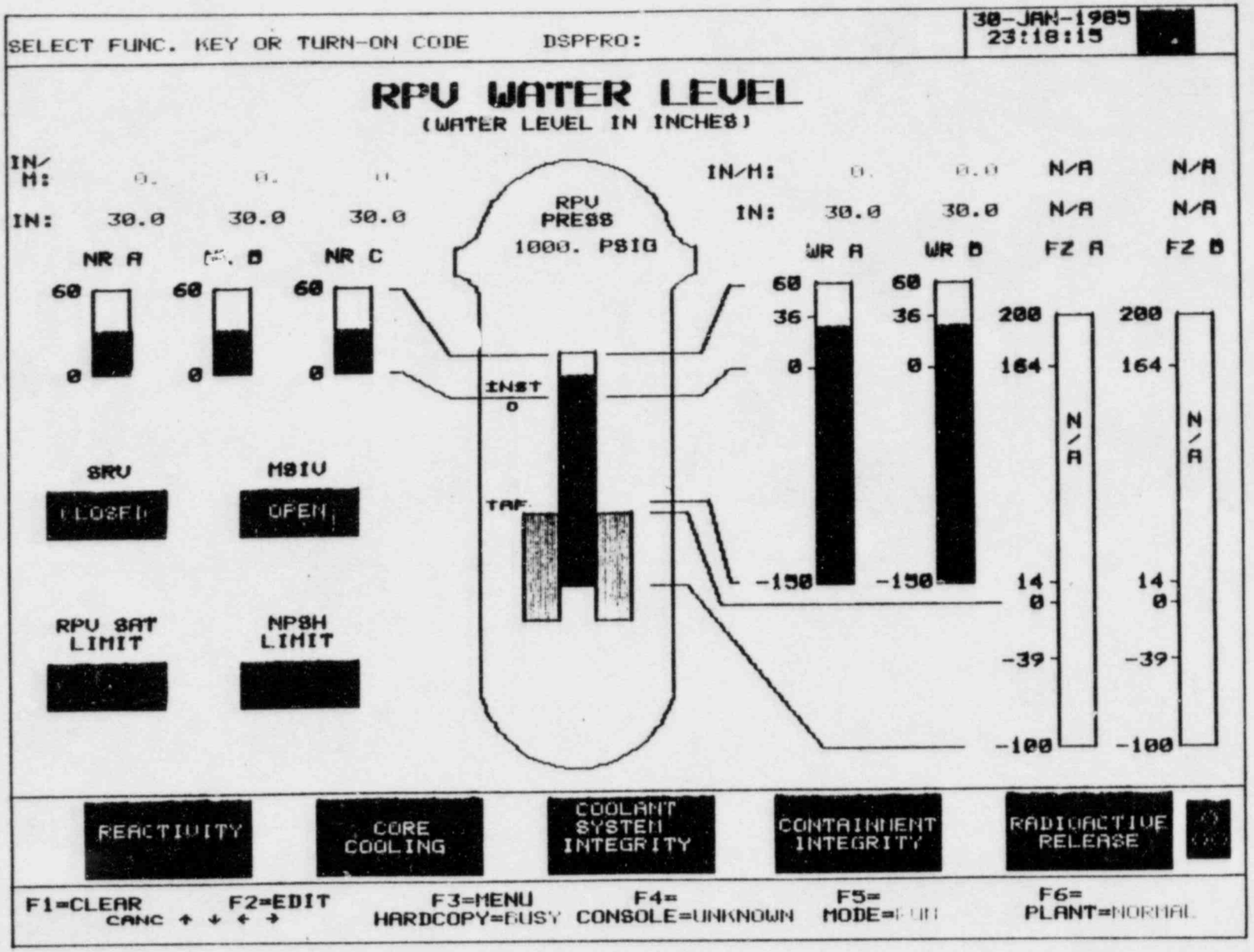


Figure 8-5. Display L2.2.1, RPV Water Level (Bar/Mimic).

## 8.4 DISPLAY LIMIT L2.2.2, CORE COOLING (TREND)

In this display, average wide range and fuel zone range RPV level trends are plotted on a common axis. These ranges overlap, and the two plots will provide the operator with RPV level trend information over the widest possible dynamic range. In addition, the display contains a variety of equipment status and EOP status indicators. The x-axis (time axis) characteristics for all SPDS trend plots are described in Section 2. The detailed arrangement of the reactor core cooling trend display is shown in Figure 8-6.

### 8.4.1 Trend Plot Characteristics

a. Title: RPV level (inches), with separate labels "WR" and "FZ" to denote, respectively, the wide range scale and the fuel zone scale. Note that these two scales have different reference zeros.

b. Range: -150 to +60 (wide range scale)
-100 to +200 (fuel zone scale)

c. Units: Inches

d. Current Value: SPDS0023, Average wide range RPV level
SPDS0027, Average FZ range RPV level

e. Rate-of-change: SPDS0024 (wide range scale), in units of inches/minutes
SPDS0028 (fuel zone scale)

f. Labeled tic marks: 0, 36, (wide range scale)
-39, 0, 14, 164 (fuel zone scale)

g. Downscale indicator: None

h. NV indicator: SPDS04NV (wide range scale)
SPDS05NV (fuel zone scale)

### 8.4.2 Other Plant Variables

This display includes a digital display of the current value of RPV pressure provided by data point SPDS0030. This is an average value, with engineering units of "psig". The NV indicator is SPDS07NV.

8.4.3 Equipment and EOP Limit Status Indicators

Same as RPV water level mimic display, see Section 8.3.

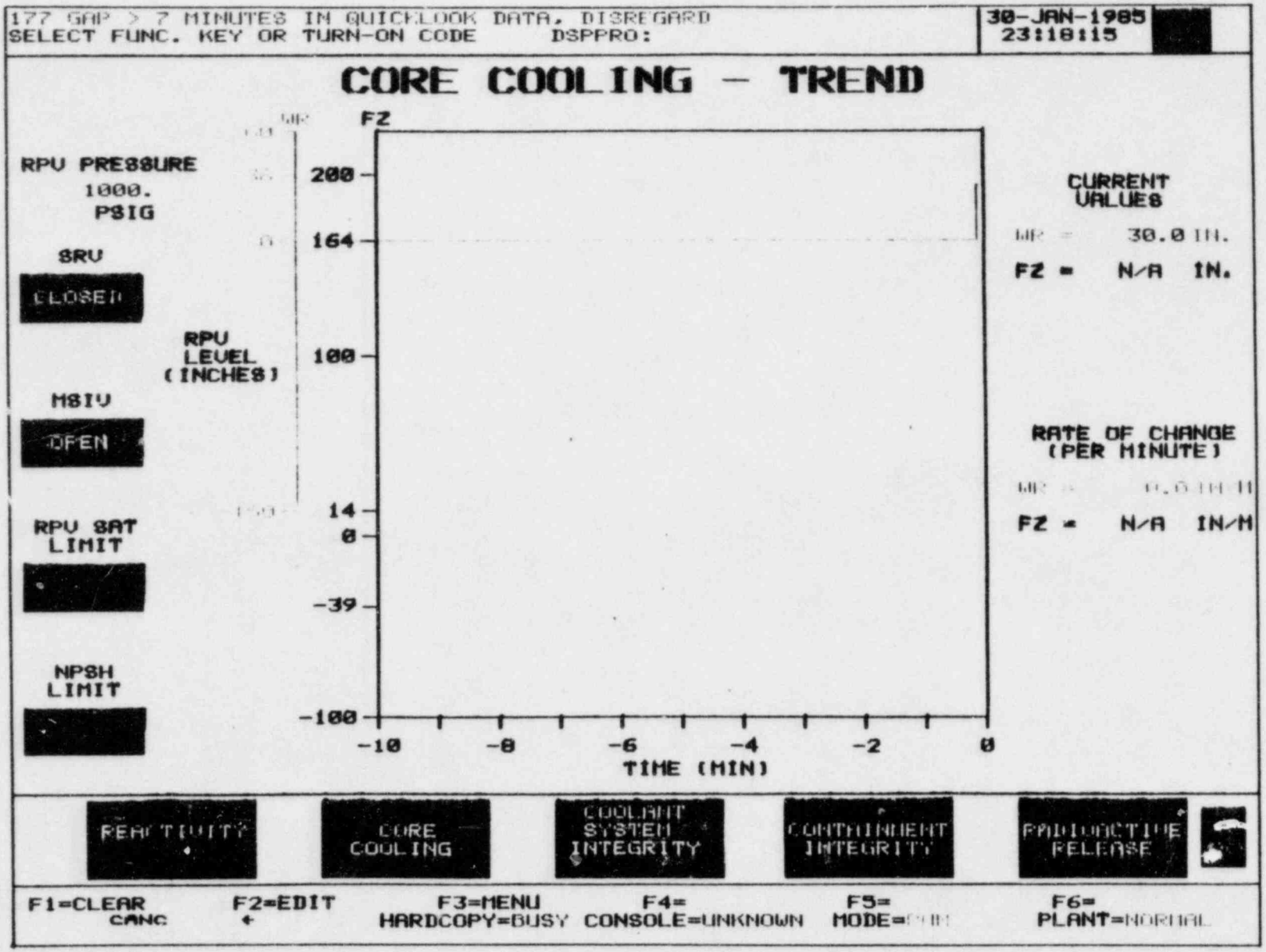


Figure 8-6. Display L2.2.2, Core Cooling (Trend).

## 8.5 DISPLAY L2.3.1, COOLANT SYSTEM INTEGRITY (BAR)

This display contains the following three horizontal bar charts: RPV pressure, drywell pressure, and containment area radiation level. In addition, the display contains a variety of equipment status indicators. The detailed arrangement of the reactor coolant system integrity bar display is shown in Figure 8-7.

### 8.5.1 Bar Chart Characteristics

#### 8.5.1.1 BAR 1

a. Title: RPV pressure
b. Range: 0 to 1500
c. Units: psig
d. Current Value: SPDS0030, average RPV pressure
e. Rate-of-change: SPDS0031, in units of psi/minute
f. Labeled tic marks: 75, 500, 825, 1045
g. Downscale indicator: SPDS02DS
h. NV indicator: SPDS07NV

#### 8.5.1.2 BAR 2

a. Title: Drywell pressure
b. Range: 0 to 80
c. Units: psia
d. Current Value: SPDS0045, average mid-range drywell pressure
e. Rate-of-change: SPDS0046, in units of psi/minute
f. Labeled tic marks: 20, 40, 60
g. Downscale indicator: SPDS13DS
h. NV indicator: SPDS09NV

#### 8.5.1.3 BAR 3

a. Title: Containment radiation
b. Range: $10^0$ to $10^7$
c. Units: Rad/hour

d. Current Value: SPDS0082, log of drywell area rad (for driving the bar)
N063, high range drywell airlock area rad monitor (for current value)

e. Rate-of-change: SPDS0049

f. Labeled tic marks: $10^2$, $10^5$

g. Downscale indicator: SPDS14DS

h. NV indicator: None

i. Note(s): (1) The digital display of the current containment radiation level is derived from point N063. The logarithm calculation for point SPDS0082 is performed using the pseudo-analog logarithm routine which is available on PMIS.
(2) The rate-of-change data point (SPDS0049) is used only to drive the direction-of-change arrow in this display. No digital display of the rate-of-change current value is provided because the value is not meaningful (i.e., engineering units would be rad/hour/min).

8.5.2 Equipment and EOP Limit Status Indicators

The ESIs and EOPSIs listed below are included in this display. The data point which drives each status indicator is shown in parentheses. See Section 6 for further details on these status indicators.

a. ESIs
- Isolation group demand status (Groups 1 to 7) (SPDS0032 to SPDS0038)
- SRV status (SPDS0050)
- MSIV status (SPDS0010)
- Drywell sump pump status (SPDS0054)

b. EOPSIs
None

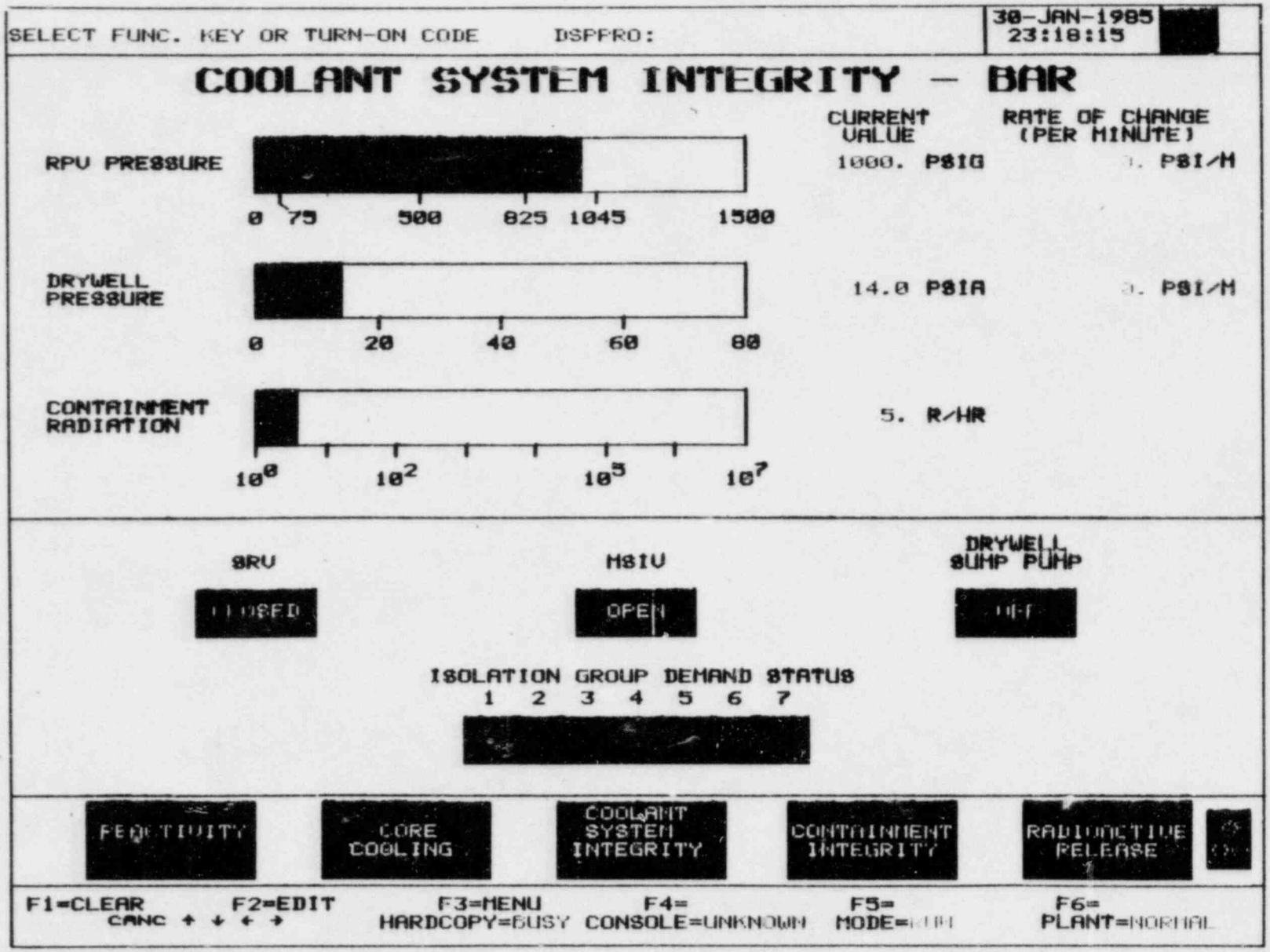


Figure 8-7. Display L2.3.1, Coolant System Integrity (Bar).

## 8.6 DISPLAY L2.3.2, COOLANT SYSTEM INTEGRITY (TREND)

This display contains the following three trend plots: RPV pressure, drywell pressure, and containment radiation. In addition the dispiay contains a variety of equipment status indicators. The x-axis (time axis) characteristics for all SPDS trend plots are described in Section 2. The detailed arrangement of the reactor coolant system integrity trend display is shown in Figure 8-8.

### 8.6.1 Trend Plot Characteristics

#### 8.6.1.1 PLOT 1

The y-axis characteristics are the same as Bar 1 (RPV pressure) described in Section 8.5.

#### 8.6.1.2 PLOT 2

The y-axis characteristics are the same as Bar 2 (drywell pressure) described in Section 8.5.

#### 8.6.1.3 PLOT 3

The y-axis characteristics are the same as Bar 3 (containment radiation) described in Section 8.5.

### 8.6.2. Equipment and EOP Limit Status Indicators

Same as Coolant System Integrity Bar display, see Section 8.5.

b. EOPSIs

- Heat cap temp lim (SPDS000B)
- Heat cap level lim (SPDS001B)
- Supp pool load lim (SPDS002B)
- Cont. press lim (SPDS004B)
- Drywell spray lim (SPDS006B)
- Drywell $H_2$ lim (SPDS007B)
- Drywell $O_2$ lim (SPDS009B)

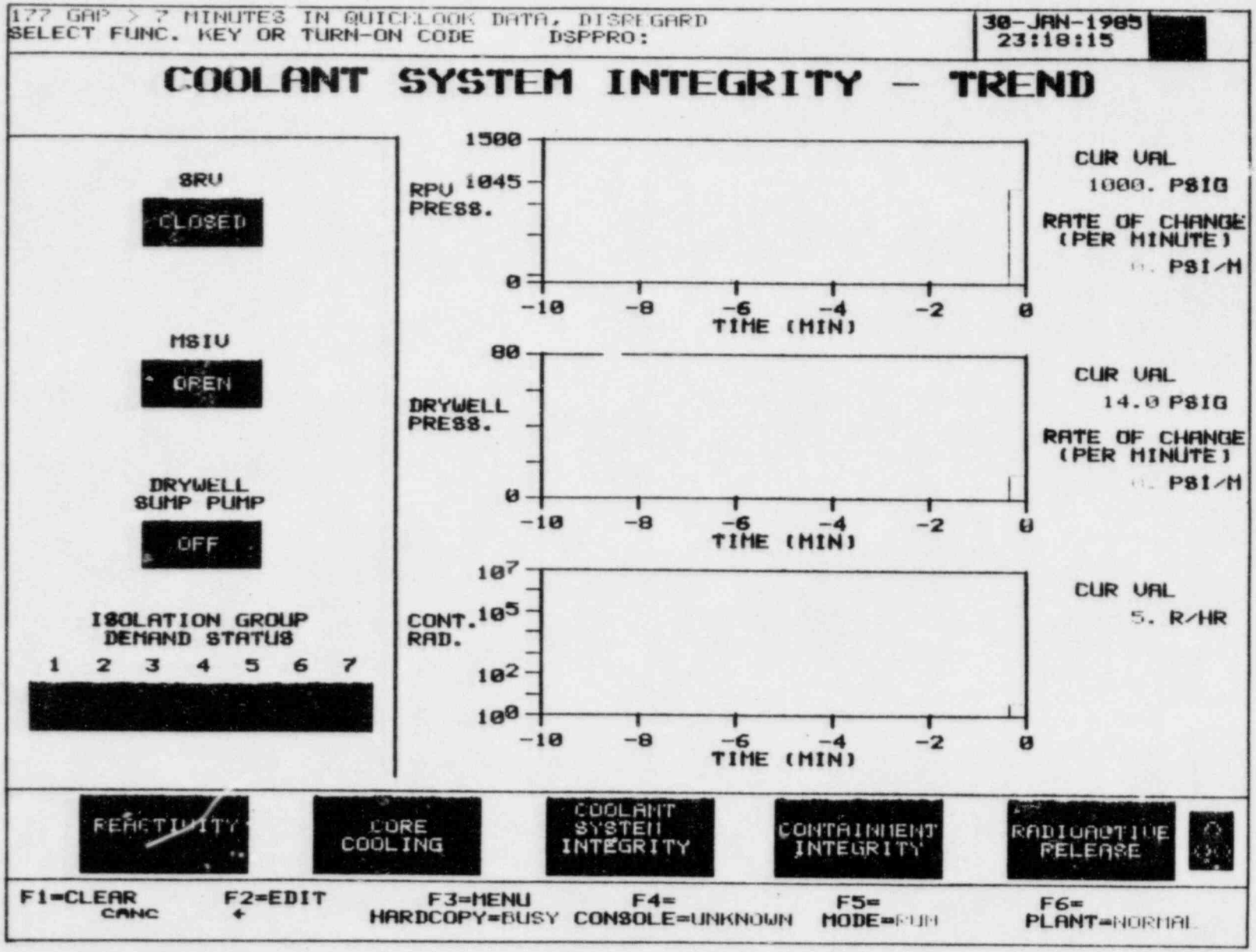


Figure 8-8. Display L2.3.2, Coolant System Integrity (Trend).

8.7 DISPLAY L2.4.1, CONTAINMENT INTEGRITY (BAR)

This display contains the following four horizontal bar charts: drywell pressure, drywell temperature, suppression pool water temperature, and suppression pool level. In addition, the display contains a variety of equipment status and EOP status indicators. The detailed arrangement of the containment integrity bar display is shown in Figure 8-9.

8.7.1 Bar Chart Characteristics

8.7.1.1 BAR 1

a. Title: Drywell pressure
b. Range: 0 to 80
c. Units: psia
d. Current Value: SPDS0045, average mid-range drywell pressure
e. Rate-of-change: SPDS0046, in units of psi/minute
f. Labeled tic marks: 20, 40, 60
g. Downscale indicator: SPDS13DS
h. NV indicator: SPDS09NV

8.7.1.2 BAR 2

a. Title: Maximum drywell temperature
b. Range: 50 to 400
c. Units: Degrees fahrenheit
d. Current Value: SPDS0051, calculated drywell temperature
e. Rate-of-change: SPDS0052, in units of degF/minute
f. Labeled tic marks: 100, 200, 300
g. Downscale indicator: SPDS15DS
h. NV indicator: SPDS06NV

8.7.1.3 BAR 3

a. Title: Average suppression pool temp
b. Range: 0 to 250
c. Units: Degrees fahrenheit

d. Current Value: SPDS0063, overall average suppression pool water temperature
e. Rate-of-change: SPDS0064, in units of degF/minute
f. Labeled tic marks: 95, 110, 200
g. Downscale indicator: SPDS17DS
h. NV indicator: None

8.7.1.4 BAR 4

a. Title: Suppression pool level
b. Range: 0 to 30
c. Units: Feet
d. Current Value: SPDS0065, average suppression pool wide range level
e. Rate-of-change: SPDS0066, in units of feet/minute
f. Labeled tic marks: 10, 20
g. Downscale indicator: SPDS16DS
h. NV indicator: SPDS18NV
i. Note: There are several different ranges of suppression pool water level instrumentation available in the CNS control room. The Level 2 SPDS displays utilize data from field input points N019 and N020, which have a 0 to 30 foot range. The correlation between these instruments and other suppression pool water level instruments is summarized in Table 8-2.

8.7.2 Equipment and EOP Limit Status Indicators

The ESIs and EOPSIs listed below are included in this display. The data point which drives each status indicator is shown in parentheses. See Section 6 for further details on these status indicators.

a. ESIs
- Isolation group demand status (Groups 1 to 7) (SPDS0032 to SPDS0038)

Table 8-2. Cooper Nuclear Station Suppression Pool Water Level Correlation.

| Instrument | PMIS Point | Range | | Elevation Of Instrument Reference Zero | Alarm/Warning Setpoints | | | |
|---|---|---|---|---|---|---|---|---|
| | | Indicated | Reference Elevation | | HALM | HWRN | LWRN | LALM |
| PC-DPT-3A1 & PC-DPT-3A2 | N019 N020 | 0 to 30' | 862 to 892' | 862' | 13'2" (13.17') | None | None | 12' 10.5" (12.88') |
| PC-LT-10 | None | -6' to +6' | 869 to 881' | 875' | +5" | None | None | -5" |
| PC-LT-11 | None | -4' to +6' | 871 to 881' | 875' | None | None | None | None |
| PC-LT-12 & PC-LT-13 | None | -10" to +10" | 874'2" to 875'10" | 875' | None | +1.5" | -1.0" | None |

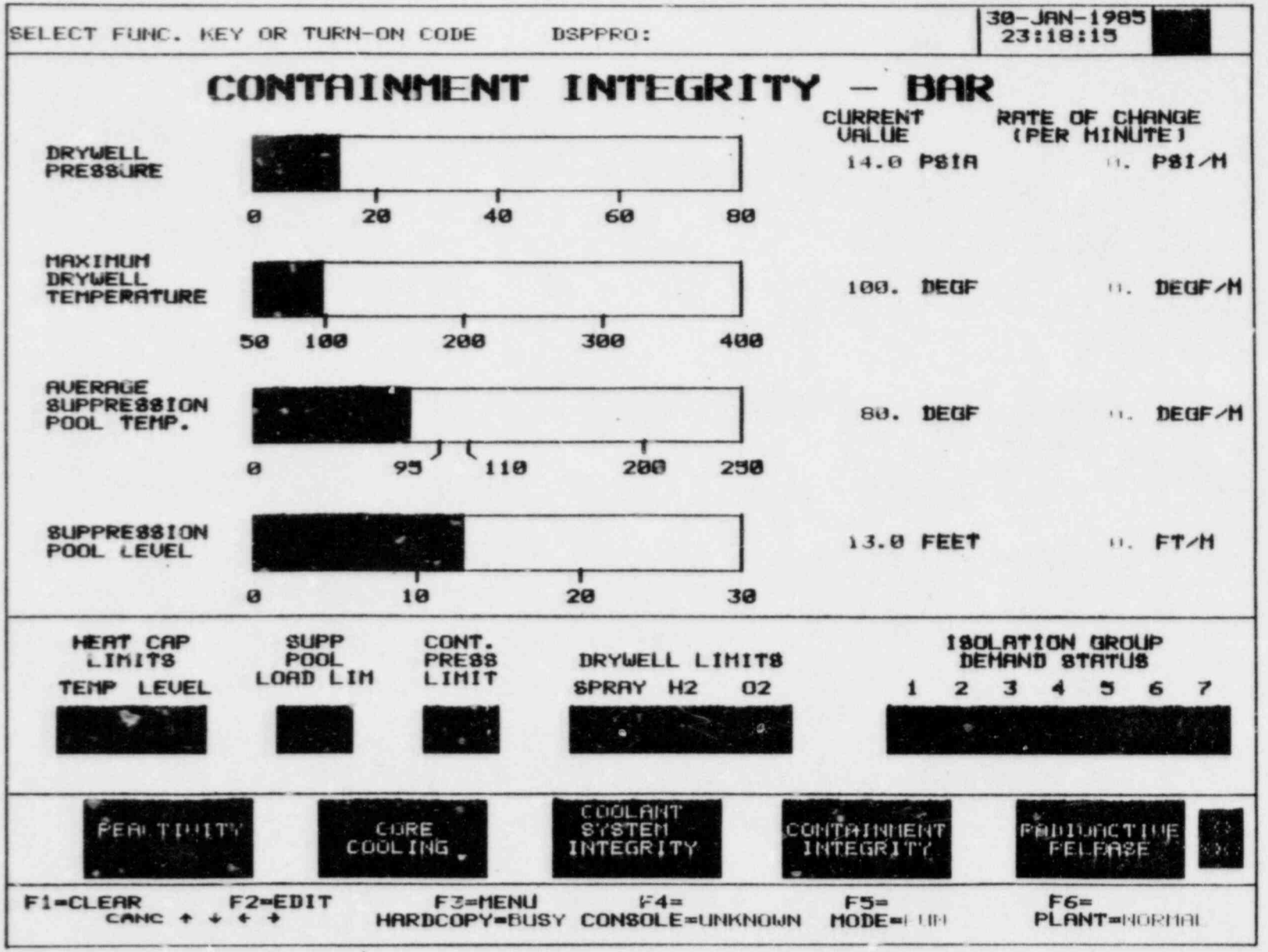


Figure 8-9. Display L2.4.1, Containment Integrity (Bar).

## 8.8 DISPLAY L2.4.2, CONTAINMENT INTEGRITY (TREND)

This display contains the following three trend plots: drywell pressure, drywell temperature, and suppression pool temperature. Suppression pool water level is expected to be a slowly varying parameter even during abnormal plant conditions, therefore, no trend plot is provided for this parameter. The bar chart, current value and rate of change of suppression pool level are available in the containment integrity (bar) display, L2.4.1.

The x-axis (time axis) characteristics for all SPDS trend plots are described in Section 2. In addition to the trend plots, the display contains a variety of equipment status and EOP status indicators. The detailed arrangement of the containment integrity trend display is shown in Figure 8-10.

### 8.8.1 Trend Plot Characteristics

#### 8.8.1.1 PLOT 1

The y-axis characteristics are the same as Bar 1 (drywell pressure) described in Section 8.7.

#### 8.8.1.2 PLOT 2

The y-axis characteristics are the same as Bar 2 (maximum drywell temperature) described in Section 8.7.

#### 8.8.1.3 PLOT 3

The y-axis characteristics are the same as Bar 3 (average suppression pool temperature) described in Section 8.7.

### 8.8.2 Equipment and EOP Limit Status Indicators

Same as Containment Integrity Bar display, see Section 8.7.

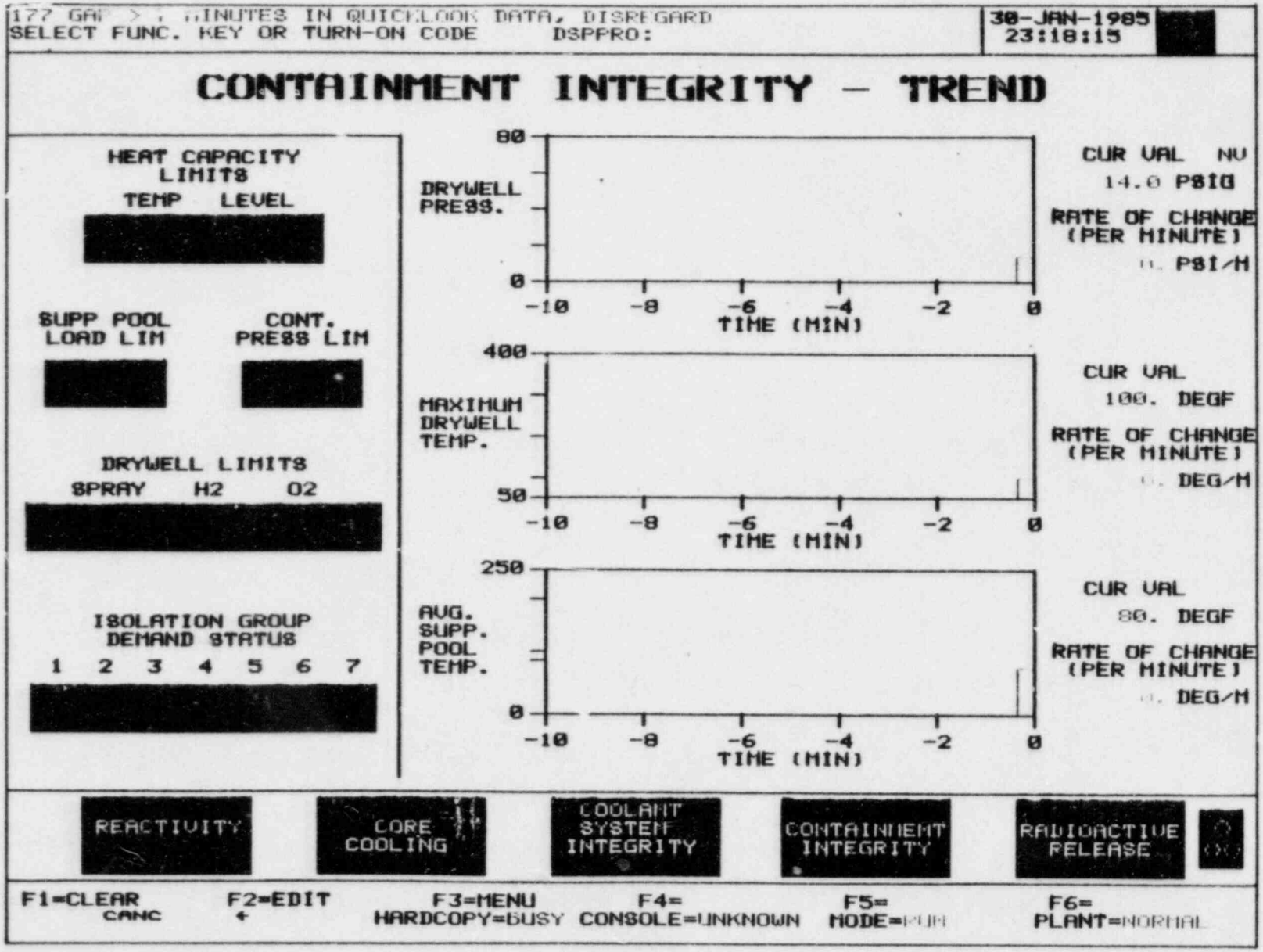


Figure 8-10. Display L2.4.2, Containment Integrity (Trend).

## 8.9 DISPLAY L2.4.3, SUPPRESSION CHAMBER MIMIC

This display contains a mimic of the containment (i.e., horizontal section of drywell and suppression chamber), and vertical bar charts showing suppression pool water temperature in eight sectors of the suppression pool. In addition, the mimic shows: (a) the position of the eight RPV safety/relief valves, (b) the position of the three RPV code safety valves, and (c) the operating status of the HPCI and RCIC pumps. This valve and pump status information is important to the operator because each valve and pump can exhaust steam to the suppression pool and cause a local increase in pool water temperature. Other EOP status indicators and current values of key plant variables also are provided in this display.

### 8.9.1 General Mimic Characteristics

The physical arrangement of the torus at CNS is shown in Figure 8-11. The detailed arrangement of the containment mimic display is shown in Figure 8-12. Each of the eight bar charts included in this display presents a healthy average of two water temperature readings made in the respective sectors of the suppression pool.

### 8.9.2 Bar Chart Characteristics

The positions of the eight bar charts in the mimic display are shown in Figure 8-12. To keep this display from becoming too cluttered, the bars are only labeled with a sector identifier (i.e., "A" to "H"). The bars contain no intermediate tic marks, and are displayed with only the current value of the temperature (i.e., no rate-of-change data). In summary, the eight vertical bar charts have the following characteristics.

a. Title: "A" to "H"
b. Range: 0 to 250
c. Units: Degrees fahrenheit
d. Current Value: A: SPDS0055, healthy avg 1A, 2A
   B: SPDS0056, healthy avg 1B, 2B
   C: SPDS0057, healthy avg 1C, 2C
   D: SPDS0058, healthy avg 1D, 2D
   E: SPDS0059, healthy avg 1E, 2E
   F: SPDS0060, healthy avg 1F, 2F

G: SPDS0061, healthy avg 1G, 2G

H: SPDS0062, healthy avg 1H, 2H

e. Rate-of-change: None. See rate-of-change of average suppression pool temperature in displays L2.4.1 and L2.4.2

f. Labeled tic marks: None

g. Downscale indicator: None. The eight bar charts in this display provide an adequate means for cross-checking to verify if a downscale condition actually exists.

h. NV indicator: A: SPDS10NV

B: SPDS11NV

C: SPDS12NV

D: SPDS13NV

E: SPDS14NV

F: SPDS15NV

G: SPDS16NV

H: SPDS17NV

8.9.3 Other Plant Variables

This display includes the current values of the following plant variables.

- Average suppression pool temperature (SPDS0063). This is a healthy average value of eight sector average temperatures, and has engineering units of "degF". There is no NV indicator for this data point.
- Suppression pool average temperature rate-of-change (SPDS0064), with engineering units of "degF/minute". There is no NV indicator for this data point.
- RPV pressure (SPDS0030). This is an average value with engineering units of "psig". The NV indicator is SPDS07NV.
- RPV pressure rate-of-change (SPDS0031), with engineering units of "psi/minute". There is no NV indicator for this data point.

8.9.4 Equipment and EOP Limit Status Indicators

a. ESIs
   - Individual safety/relief valve position (SRV A to SRV H) (D556 to D563)
   - Individual code safety valve position (SV A to SV C) (SPDS0040 to SPDS0042)
   - HPCI pump (SPDS0085)
   - RCIC pump (SPDS0086)

b. EOPSIs
   - Heat cap temp lim (SPDS000B)
   - Heat cap level lim (SPDS001B)
   - Supp pool load lim (SPDS002B)
   - Supp chbr $O_2$ lim (SPDS010B)
   - Supp chbr $H_2$ lim (None)*

* No data point is available on PMIS to drive this status indicator, thus the status indicator is inoperative. It is displayed with the characters "N/A" inside the status box.

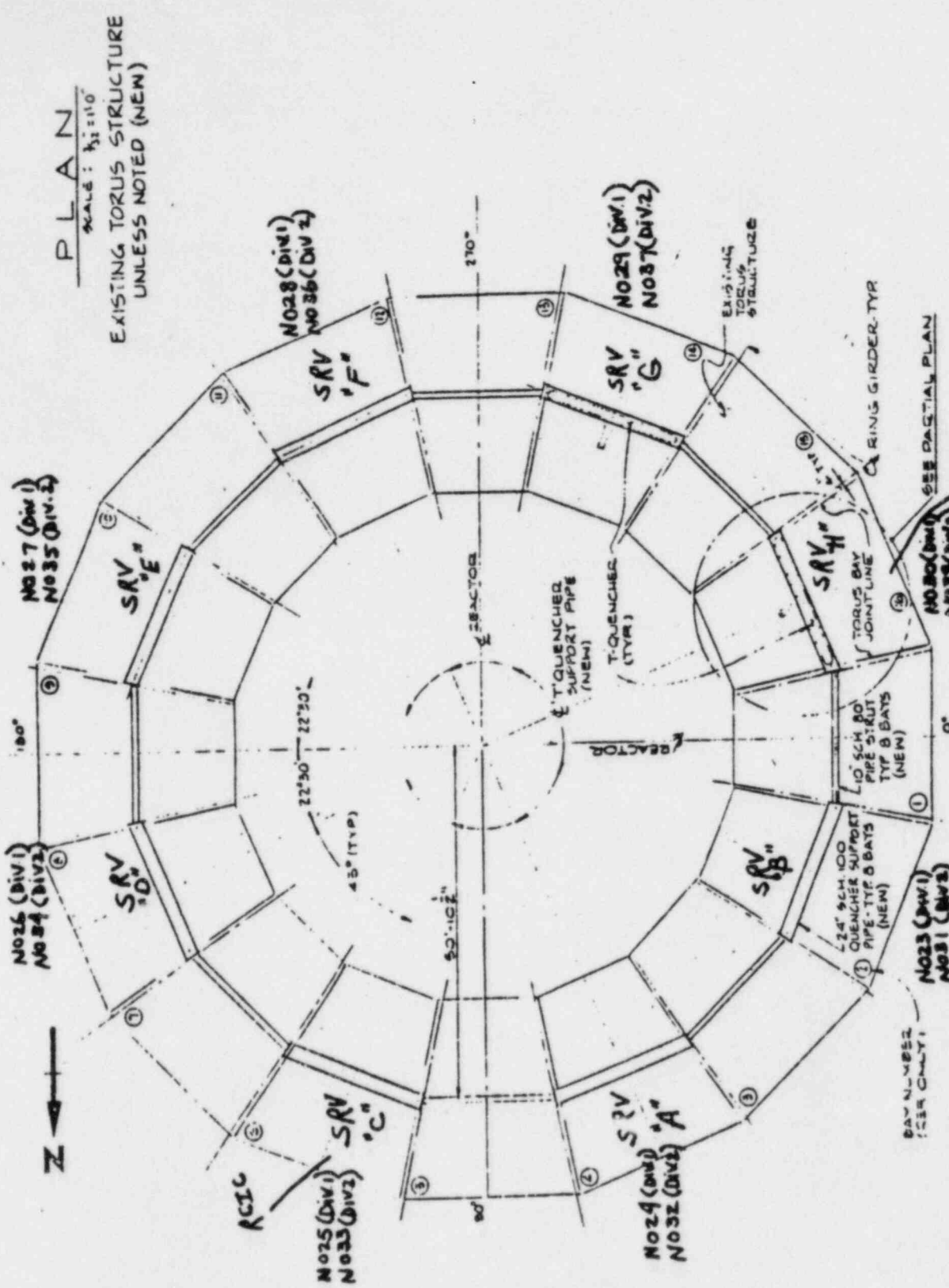


Figure 8-11. Physical Arrangement of Torus.

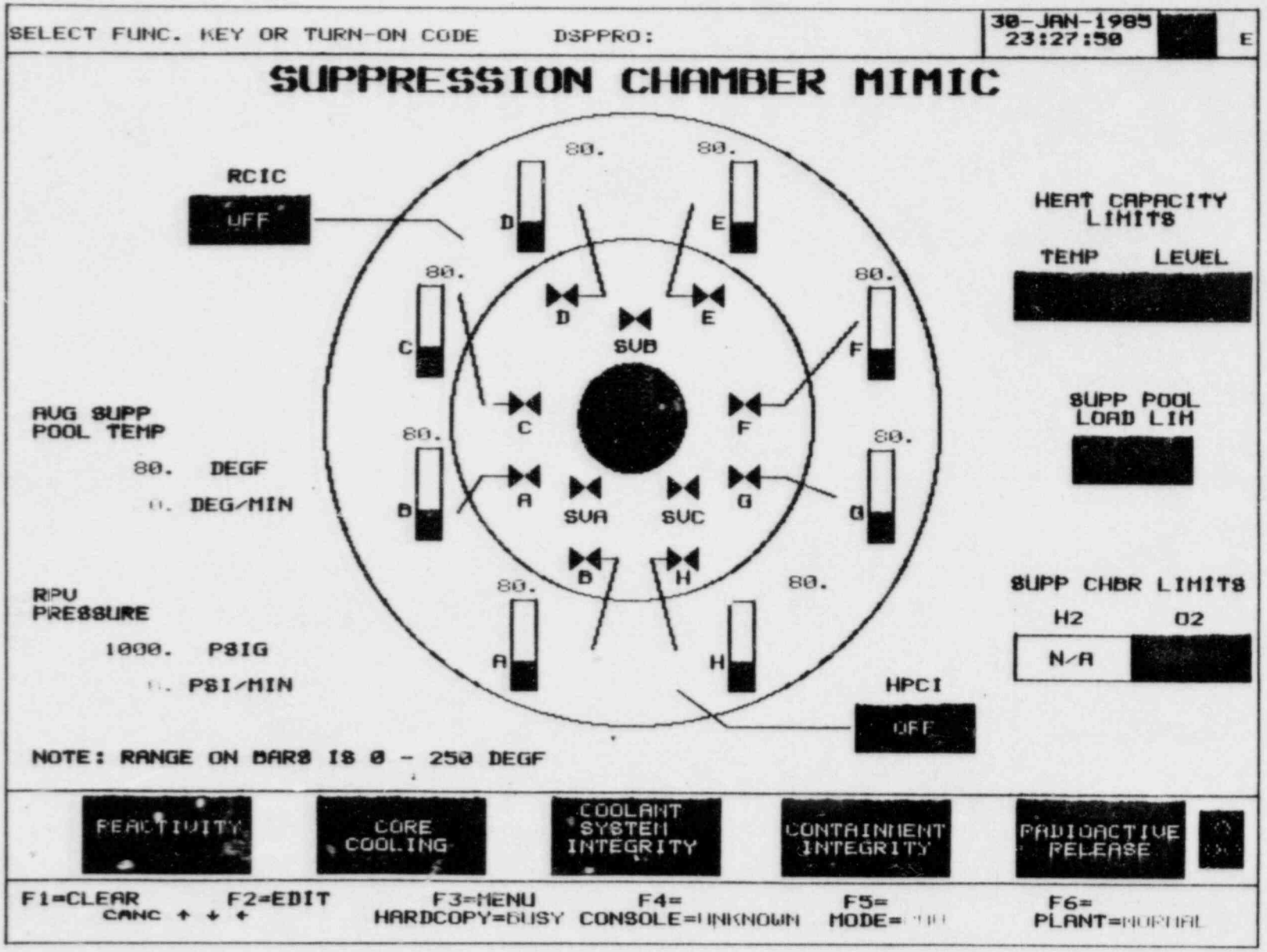


Figure 8-12. Display L.2.4.3, Suppression Chamber Mimic.

## 8.10 DISPLAY L2.5.1, RADIOACTIVE RELEASE (BAR)

This display contains five horizontal bar charts for various potential release points of radioactive material. The detailed arrangement of the radioactive release bar display is shown in Figure 8-13. In this display, the logarithm of the current value is used to drive the bar chart, while the actual current value is presented to the right of the bar. The logarithm calculation is performed using the pseudo-analog logarithm routine which is available on PMIS. Also of note in this display is that the rate-of-change data points are used only to drive direction-of-change arrows in the respective bar charts. No digital display of rate-of-change current value is provided because the value is not meaningful (i.e., engineering units would be microcuries/sec/min).

### 8.10.1 Bar Chart Characteristics

#### 8.10.1.1 BAR 1

a. Title: ERP effluents
b. Range: $10^{-4}$ to $10^{6}$
c. Units: microcuries/second (uCi/sec)
d. Current Value: SPDS0070, log of ERP normal range (for driving the bar)
   N079, ERP normal range rad monitor (for current value)
e. Rate-of-change: SPDS0071
f. Labeled tic marks: $10^{0}$, $10^{3}$
g. Downscale indicator: SPDS18DS
h. NV indicator: None

#### 8.10.1.2 BAR 2

a. Title: AOG and RW effluents
b. Range: $10^{-3}$ to $10^{7}$
c. Units: microcuries/second (uCi/sec)

d. Current Value: SPDS0072, log of AOG and RW normal range (for driving the bar)
N073, AOG and RW effluent normal range rad monitor (for current value)

e. Rate-of-change: SPDS0073

f. Labeled tic marks: $10^0$, $10^3$

g. Downscale indicator: SPDS19DS

h. NV indicator: None

8.10.1.3 BAR 3

a. Title: Reactor bldg effluents

b. Range: $10^{-3}$ to $10^7$

c. Units: microcuries/second (uCi/sec)

d. Current Value: SPDS0074, Log of Rx bldg rad monitor (for driving the bar)
N074, Rx bldg effluent rad monitor (for current value)

e. Rate-of-change: SPDS0075

f. Labeled tic marks: $10^0$, $10^3$

g. Downscale indicator: SPDS20DS

h. NV indicator: None

8.10.1.4 BAR 4

a. Title: Turbine bldg effluents

b. Range: $10^{-3}$ to $10^7$

c. Units: microcuries/second (uCi/sec)

d. Current Value: SPDS0076, Log of turbine bldg rad monitor (for driving the bar)
N069, Turbine bldg effluent normal range rad monitor (for current value)

e. Rate-of-change: SPDS0077

f. Labeled tic marks: $10^0$, $10^3$,

g. Downscale indicator: SPDS21DS

h. NV indicator: None

8.10.1.5 BAR 5

a. Title: SJAE effluents
b. Range: $10^0$ to $10^9$
c. Units: microcuries/second (uCi/sec)
d. Current Value: SPDS0081, Log of SJAE rad (for driving the bar)
SPDS0078, calculated SJAE effluent (for current value)
e. Rate-of-change: SPDS0079
f. Labeled tic marks: $10^3$, $10^6$
g. Downscale indicator: SPDS22DS
h. NV indicator: None

8.10.2 Equipment and EOP Limit Status Indicators

None

8.10.3 Calculation of External (Real) Data Points

The analog value of steam jet air ejector (SJAE) effluent release rate in microcuries per second is represented by external point SPDS0078. To calculate the value of SPDS0078, it is necessary to sum the air flow measurements in SJAE trains A and B, average the radiation readings in the common SJAE exhaust header, and apply a conversion factor to yield results with the proper engineering units. This is accomplished using the following algorithm:

uCi/sec = 1.90 (mr/hr)(cfm)

where:

uCi/sec = calculated value of SPDS0078
mr/hr = healthy average of N082 and N083
cfm = sum of N084 and N085

The factor 1.90 has the following engineering units which yield a value for SPDS0078 in uCi/sec:

$$\frac{\text{uCi/sec/cfm}}{\text{mr/hr}}$$

The processing for this calculation is shown in Figure 8-14.

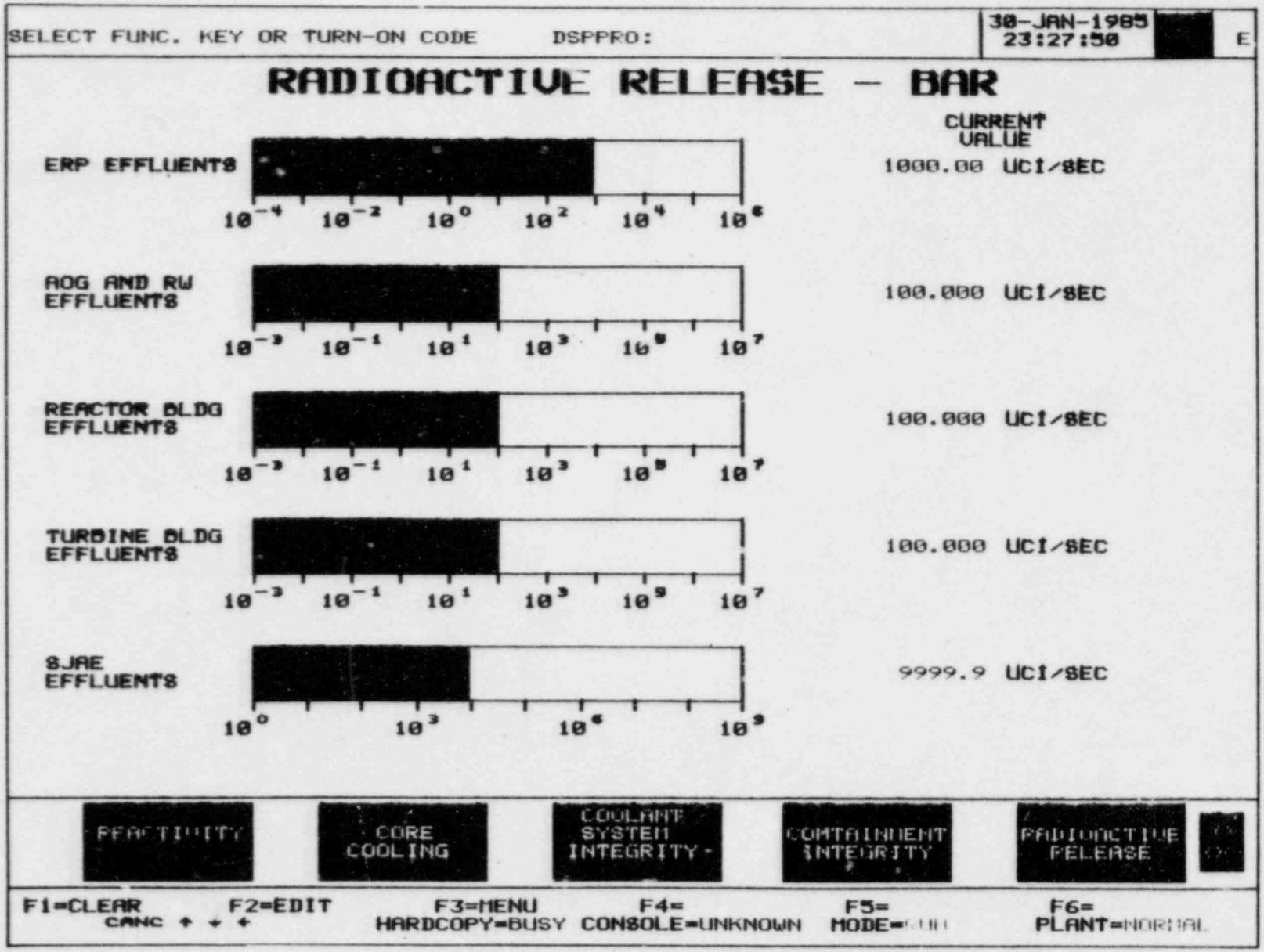


Figure 8-13. Display L2.5.1, Radioactive Release (Bar).

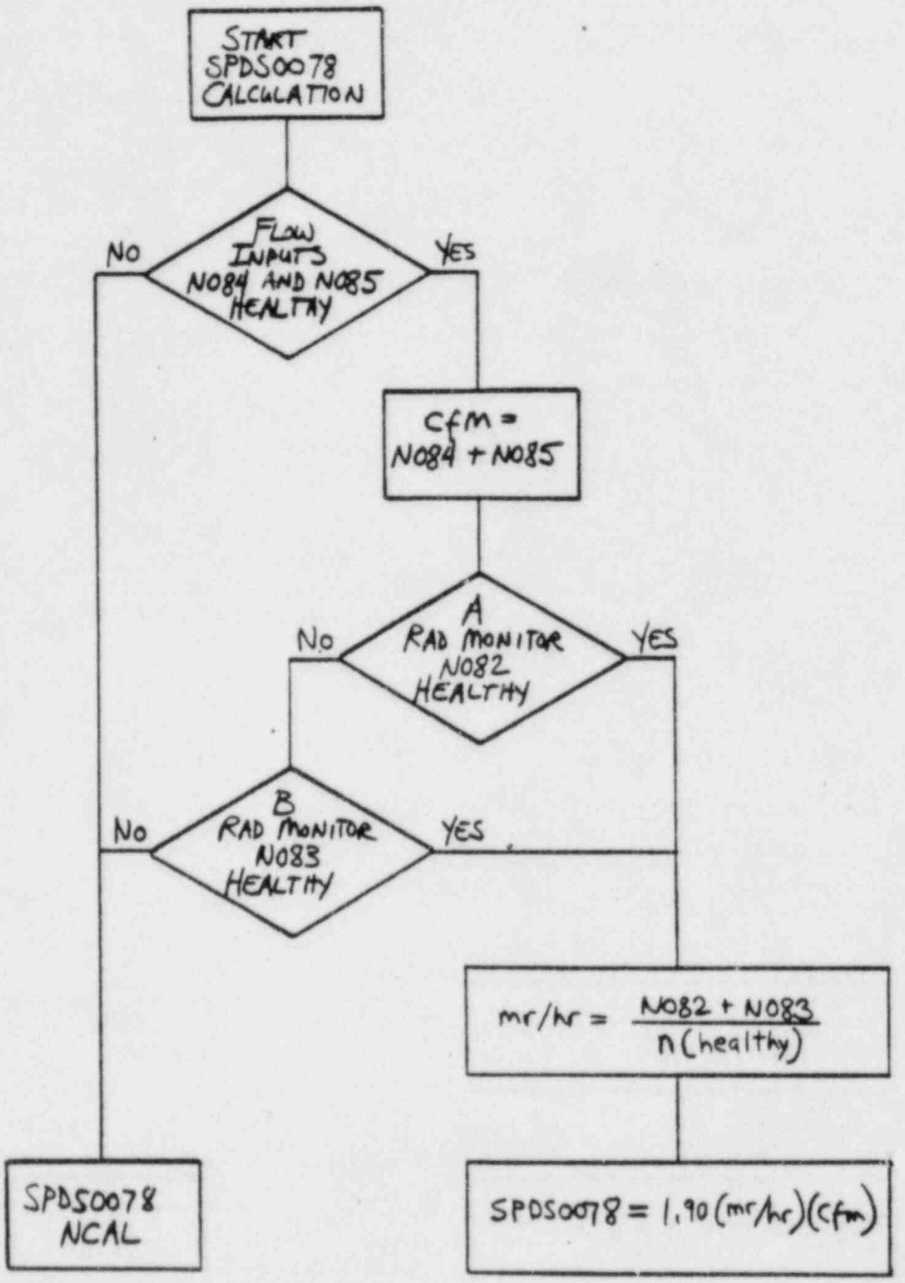


Figure 8-14. Processing Logic for Point SPDS0078.

## 8.11 DISPLAY L2.5.2, RADIOACTIVE RELEASE (TREND, PAGE 1/2)

This display contains three trend plots for potential release points of radioactive material. This display is continued in display L2.5.3, which contains two additional trend plots. The x-axis (time axis) characteristic for all SPDS trend plots are described in Section 2. The detailed arrangement of this first radioactive release trend display is shown in Figure 8-15. As in the case of the radioactive release bar display: (a) the logarithm of the current value is used to drive the graphic portion of the display, (b) the actual current value is displayed in digital form, and (c) the rate-of-change data points are used only to drive direction-of-change arrows.

### 8.11.1 Trend Plot Characteristics

#### 8.11.1.1 PLOT 1

The y-axis characteristics are the same as Bar 1 (ERP) described in Section 8.10.

#### 8.11.1.2 PLOT 2

The y-axis characteristics are the same as Bar 2 (AOG and RW) described in Section 8.10.

#### 8.11.1.3 PLOT 3

The y-axis characteristics are the same as Bar (Reactor Building described in Section 8.10.

### 8.11.2 Equipment and EOP Limit Status Indicators

None

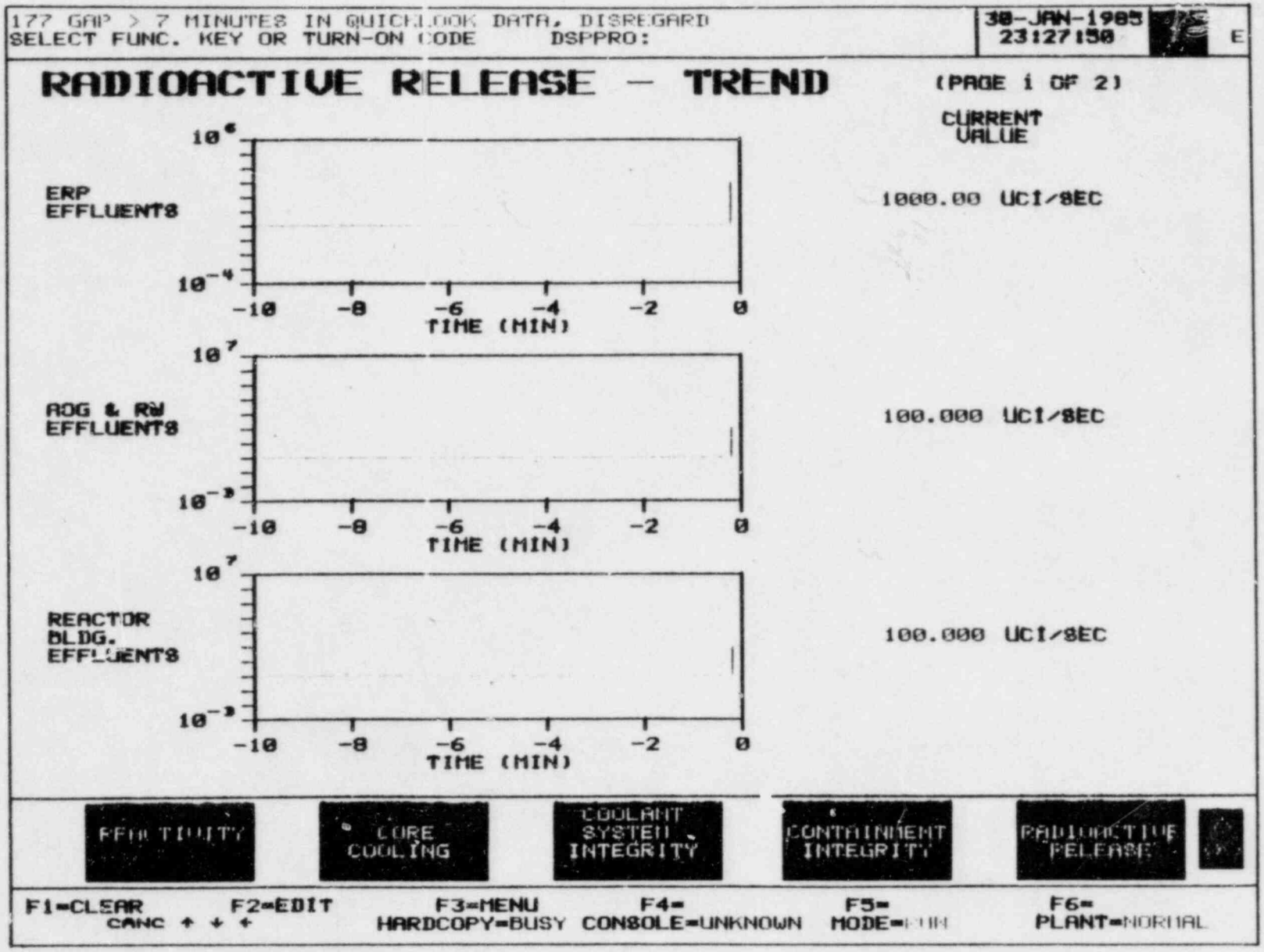


Figure 8-15. Display L2.5.2, Radioactive Release (Trend, Page 1/2).

## 8.12 DISPLAY L2.5.3 RADIOACTIVE RELEASE (TREND, PAGE 2/2)

This display contains two trend plots for potential release points of radioactive material, and is a continuation of display L2.5.2 (see Section 8.11). The x-axis characteristics for all SPDS trend plots are described in Section 2. The detailed arrangement of this second radioactive release trend display is shown in Figure 8-16. As in the case of the radioactive release bar display: (a) the logarithm of the current value is used to drive the graphic portion of the display, (b) the actual current value is displayed in digital form, and (c) the rate-of-change data points are only used to drive direction of change arrows.

### 8.12.1 Trend Plot Characteristics

#### 8.12.1.1 PLOT 1

The y-axis characteristics are the same as Bar 4 (Turbine Building) described in Section 8.10.

#### 8.12.1.2 PLOT 2

The y-axis characteristics are the same as Bar 5 (SJAE) described in Section 8.10.

### 8.12.2 Equipment and EOP Limit Status Indicators

None

### 8.12.3 Calculation of External (Real) Data Points

Calculation of and SJAE effluent release rate (SPDS0078) is described in Section 8.10.

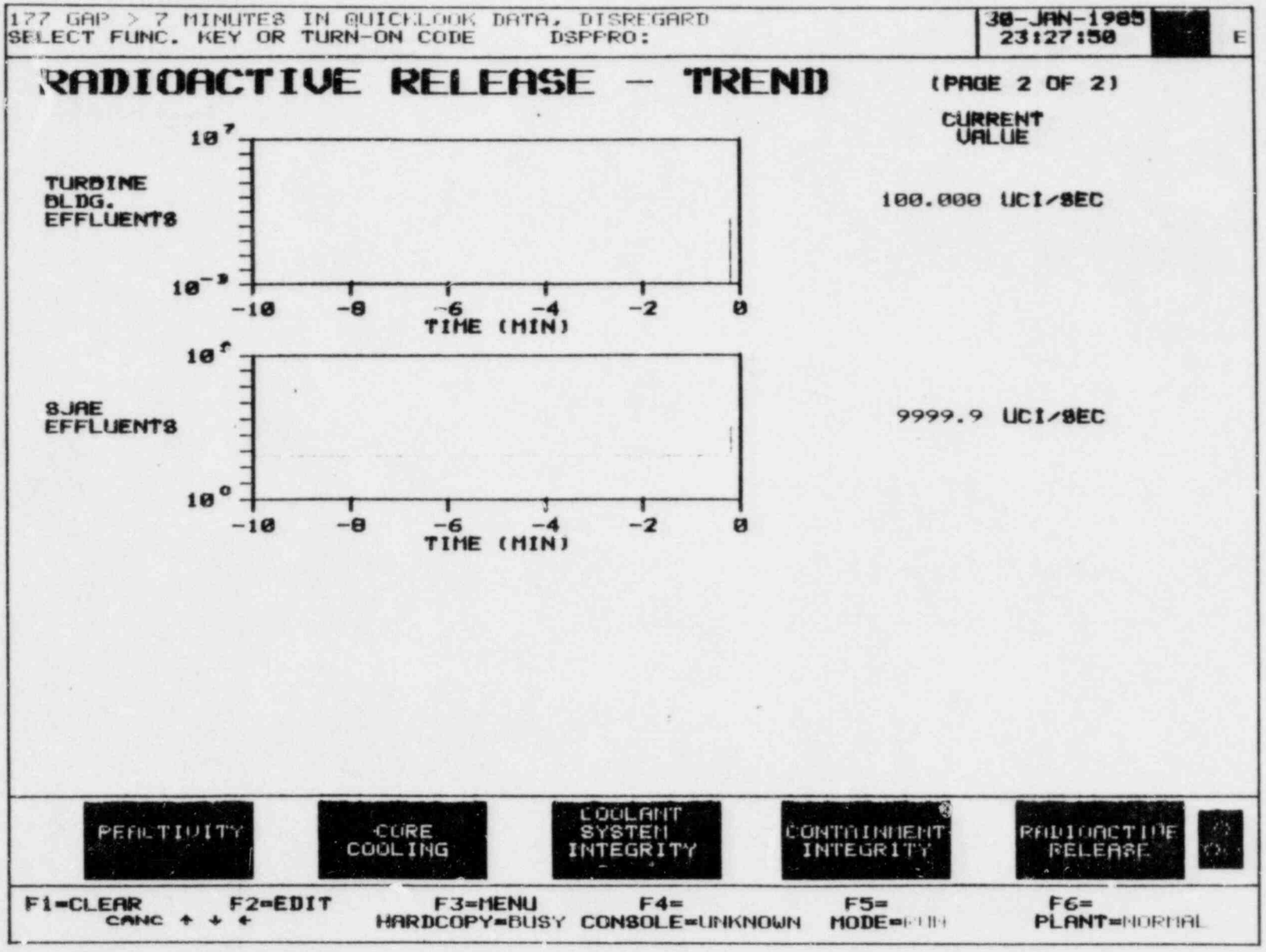


Figure 8-16. Display L2.5.3, Radioactive Release (Trend, Page 2/2).

# 9. LEVEL 3 DISPLAY CHARACTERISTICS

There are twelve Level 3 displays which contain a variety of x-y plots of current plant status with respect to multi-parameter limits defined in the symptom-oriented plant Emergency Operating Procedures (EOPs). These displays present data to the operator in a form that is not currently available in the control room. As with all SPDS displays, the Safety Function Indicators (SFIs) described in Section 5 are included in the Level 3 displays. The primary purpose of the Level 3 displays is to assist the operator in implementing the EOPs. General characteristics of x-y plots are described in Section 2. Detailed characteristics of each Level 3 display are described in this section.

An important feature of the SPDS display hierarchy is that communications linkages are provided between display levels. The Level 3 displays communicate up to the Level 1 and 2 displays by means of the following linkages:

- EOP Limit Status Indicators
- System Alarm Area Indicator

In an x-y plot, the proximity of the current value of f(x,y) to a limit curve is often used to determine the current value of an external (real) data point. The external (real) data point is calculated by SPDS software using algorithms described in this section, and then is used to drive an EOP Limit Status Indicator (EOPSI) in related Level 1 or Level 2 displays. The primary purpose of the EOP Status Indicators is to "close the loop" and provide communication of important summary information between the Level 3 EOP displays and the Level 1 and 2 displays. A summary of EOPSIs is provided in Section 6.

Another important linkage between Level 3 displays and other SPDS displays is provided by the System Alarm Area Indicator which displays a MAGENTA "E" Area (SAA) of the CRT screen whenever any data point which drives selected EOPSIs has: (a) a current value which corresponds to a

warning or alarm state, or (b) a not-healthy data quality. Operation of this SAA Indicator is described more fully in Section 6.

## 9.1 EOP DISPLAY L3.1, HEAT CAPACITY TEMPERATURE LIMIT

The purpose of this display is to show present plant status with respect to a multi-parameter limit that the operator must remain below in order to maintain sufficient heat capacity in the suppression pool to assure continuous, stable steam condensation during blowdown of safety/relief valves (SRVs) at some point following an Automatic Depressurization System (ADS) actuation. Coordinates of the limit curve are listed in Table 9-1. The detailed arrangement of this display is shown in Figure 9-1.

A. Input Variables Required

1. SPDS0030, average RPV pressure
2. SPDS0063, overall average suppression pool water temperature

B. Graph Characteristics

1. X-Axis
   a. Title: RPV Pressure
   b. Variable: SPDS0030
   c. Range: 0 to 1500
   d. Units: psig
   e. NV indicator: SPDS07NV

2. Y-Axis
   a. Title: Average Suppression Pool Temperature
   b. Variable: SPDS0063
   c. Range: 0 to 250
   d. Units: degrees fahrenheit
   e. NV indicator: None

C. Calculations for External (Real) Data Points SPDS0084 and SPDS000B.

1. External (Real) Point SPDS0084

The processing logic for this point is shown in Figure 9-2. The difference between f(x,y) and the heat capacity temperature limit at the current value of RPV pressure (SPDS0063) defines a temperature margin called Delta T Heat Capacity which is designated as data point SPDS0084. The current value of this temperature margin is used in EOP Display L3.2, Suppression Pool Heat Capacity Level Limit (see Section 9.2)

2. External (Real) Point SPDS000B

The processing logic for this point is shown in Figure 9-2 The difference between f(x,y) and the limit curve controls the status of external point SPDS000B. When f(x,y) < limit, acceptable conditions exist and SPDS000B = 0. When f(x,y) $\geq$ limit, SPDS000B = 1.

D. Operation of the Heat Capacity Temperature Limit EOPSI

External point SPDS000B is used to drive the heat capacity temperature limit status indicator in the L2.4 containment displays (see Section 8). Operation of this EOPSI is defined in Figure 9-2.

Table 9-1. Coordinates of the Heat Capacity Temperature Limit Curve.

| X-Axis | Y-Axis |
|---|---|
| RPV Pressure (psig) | Suppression Pool Temperature (°F) |
| 75 | 250.00 |
| 75 | 196.00 |
| 285 | 177.41 |
| 485 | 169.27 |
| 685 | 163.31 |
| 885 | 158.58 |
| 1080 | 154.87 |
| 1080 | 0 |
| 1500 | 0 |

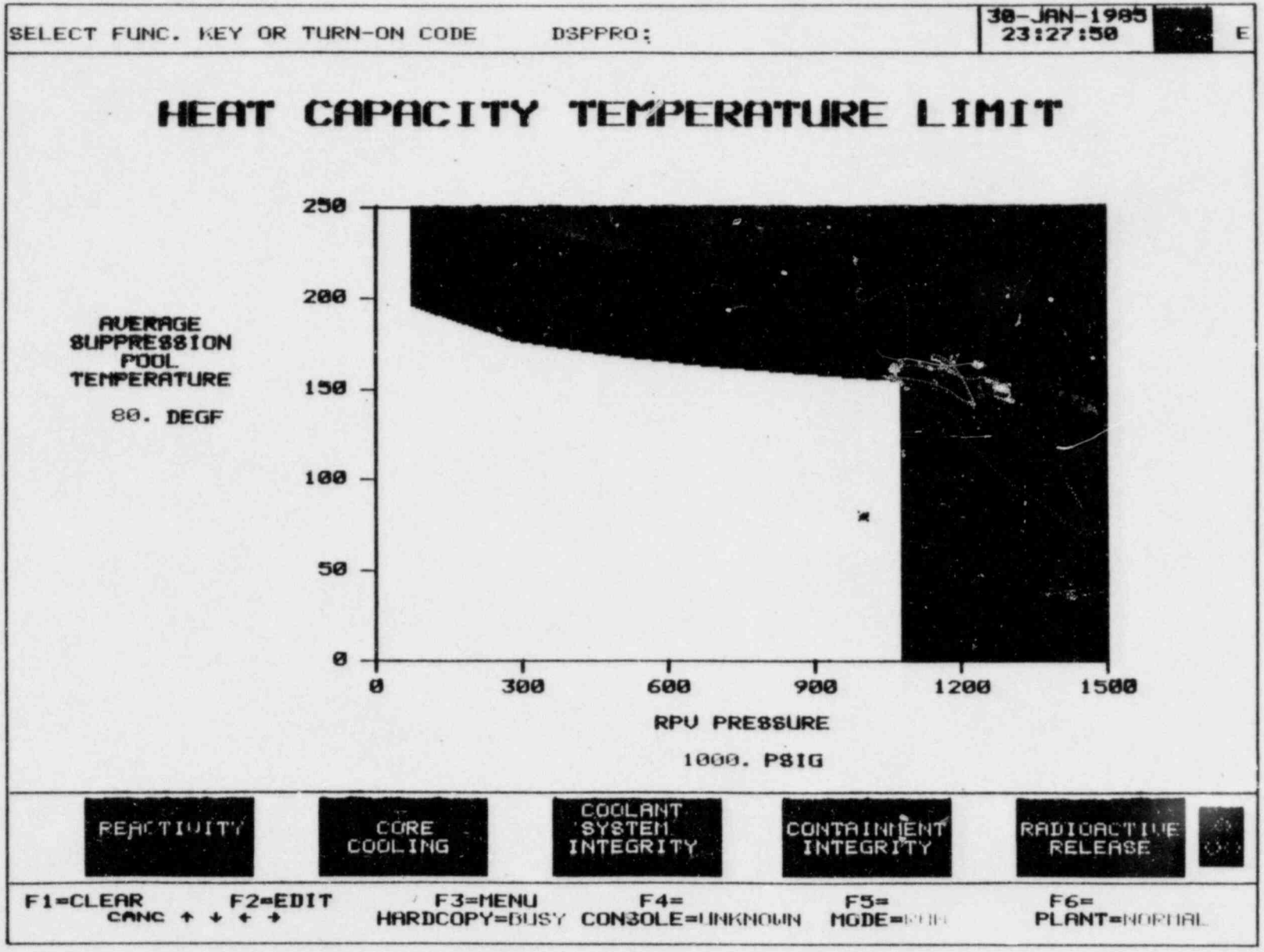


Figure 9-1. Display L3.1, Heat Capacity Temperature Limit.

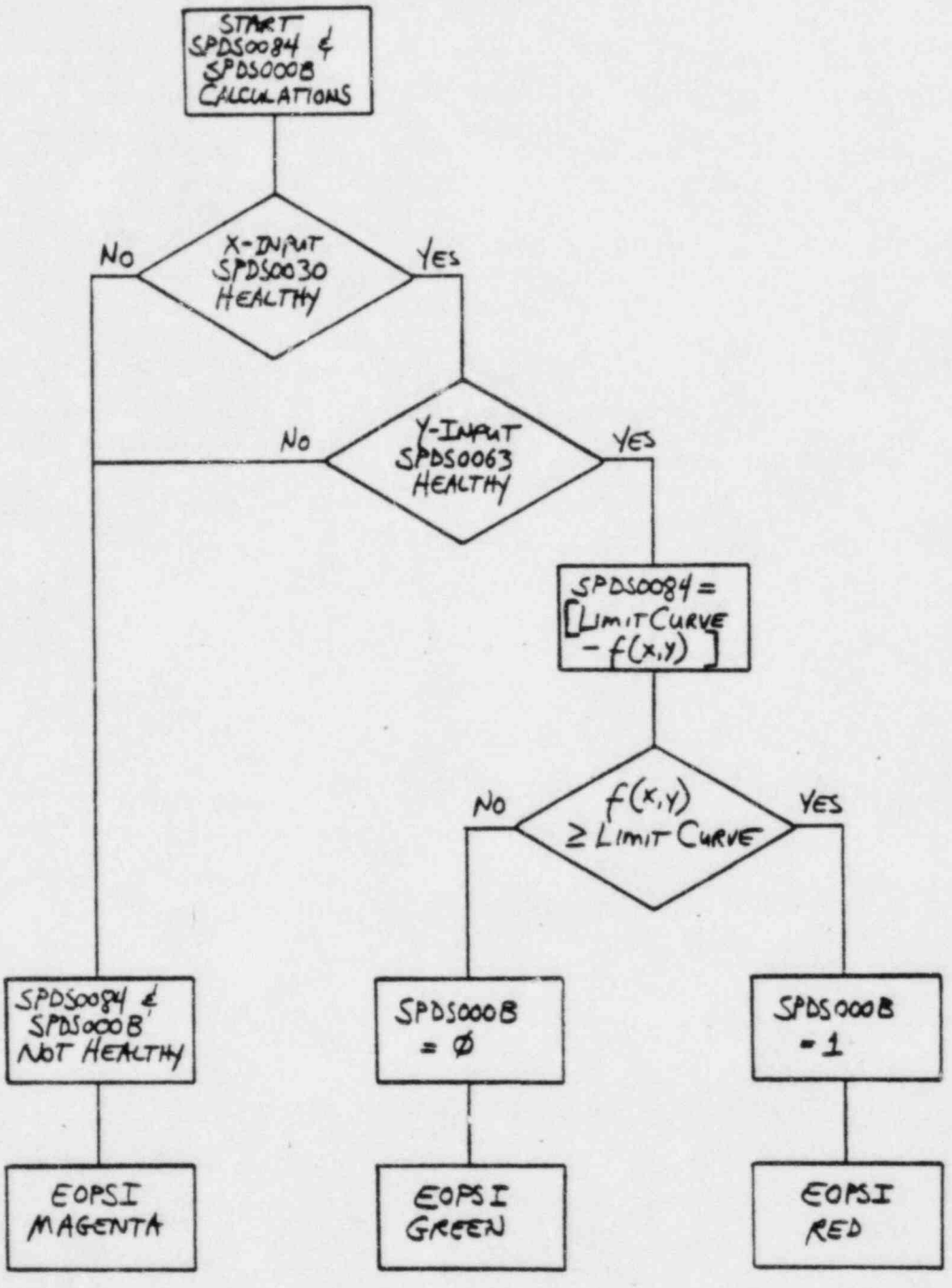


Figure 9-2. Processing Logic for Points SPDS0084, SPDS000B and Operation of the Heat Capacity Temperature Limit EOPSI.

9.2 EOP DISPLAY L3.2, HEAT CAPACITY LEVEL LIMIT

The purpose of this display is to show present plant status with respect to a multi-parameter limit that the operator must remain above in order to maintain sufficient heat capacity in the suppression pool to assure continuous, stable steam condensation during SRV blowdown at some point following ADS actuation. Coordinates of the limit curve are listed in Table 9-2. The detailed arrangement of this display is shown in Figure 9-3.

A. Input Variables Required

1. SPDS0065, average suppression pool narrow range level
2. SPDS0084, delta T heat capacity

B. Graph Characteristics

1. X-Axis

a. Title: Delta T Heat Capacity
b. Variable: SPDS0084
c. Range: 0 to 50
d. Units: degrees fahrenheit
e. NV indicator: None
f. Note: Derivation of the variable SPDS0084 is described in Section 9.1.

2. Y-Axis

a. Title: Suppression Pool Water Level
b. Variable: SPDS0065
c. Range: 0 to 30
d. Units: feet
e. NV indicator: SPDS18NV

C. Calculations for External (Real) Data Point SPDS001B

The processing logic for this point is shown in Figure 9-4. The difference between f(x,y) and the limit curve controls the status of external point SPDS001B. When f(x,y) > limit, acceptable

conditions exist and SPDS001B = 0. When $f(x,y) \leq$ limit, SPDS001B = 1.

D. Operation of the Heat Capacity Level Limit EOPSI

External point SPDS001B is used to drive the heat capacity level limit status indicator in the L2.4 containment displays (see Section 8). Operation of this EOPSI is defined in Figure 9-4.

Table 9-2. Coordinates of the Heat Capacity Level Limit Curve.

| X-Axis | Y-Axis |
|---|---|
| Delta T Heat Capacity (°F) | Suppression Pool Water Level (ft) |
| 0.00 | 12.80 |
| 0.97 | 12.50 |
| 2.81 | 12.00 |
| 8.05 | 11.00 |
| 14.56 | 10.00 |
| 18.56 | 9.58 |
| 50.00 | 9.58 |

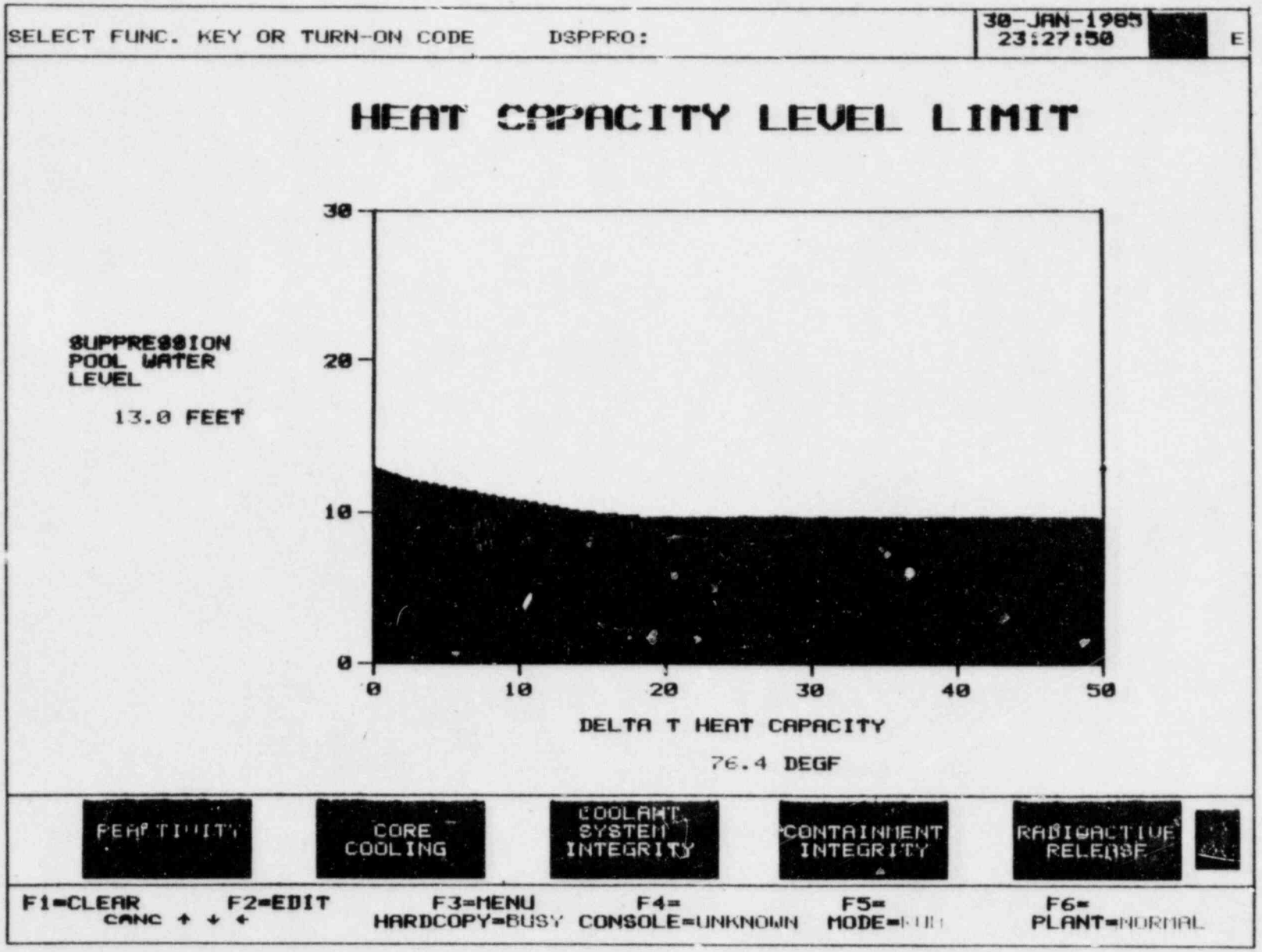


Figure 9-3. Display L3.2, Heat Capacity Level Limit.

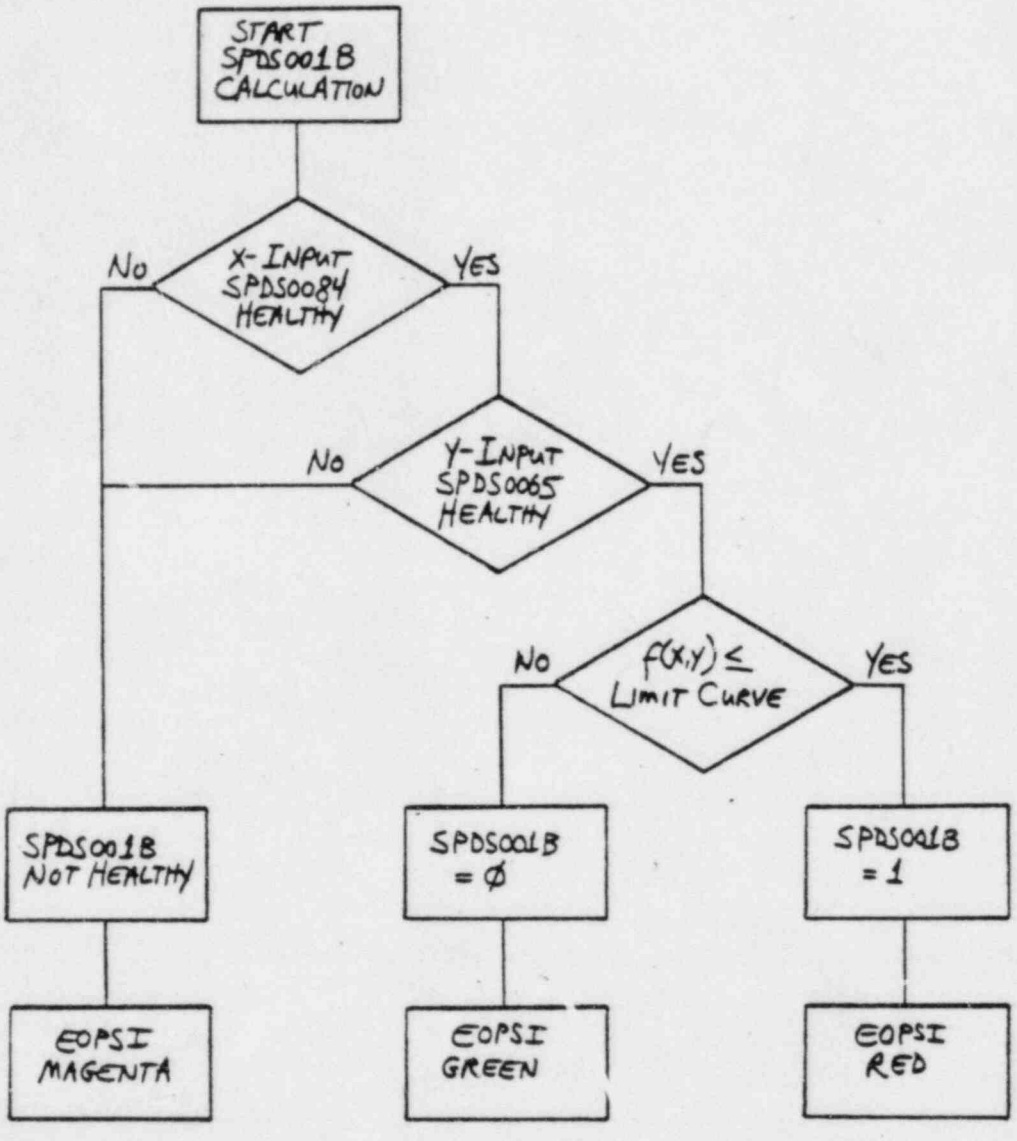


Figure 9-4. Processing Logic for Point SPDS001B and Operation of the Heat Capacity Level Limit EOPSI.

## 9.3 EOP DISPLAY L3.3, SUPPRESSION POOL LOAD LIMIT

The purpose of this display is to show present plant status with respect to a multi-parameter limit that the operator must remain below in order to ensure that the containment can withstand the dynamic load which results from single or multiple SRV actuations. Coordinates of the limit curve are listed in Table 9-3. The detailed arrangement of this display is shown in Figure 9-5.

A. Input Variables Required

1. SPDS0030, average RPV pressure
2. SPDS0065, average suppression pool wide range level

B. Graph Characteristics

1. X-Axis

   a. Title: RPV Pressure
   b. Variable: SPDS0030
   c. Range: 0 to 1500
   d. Units: psig
   e. NV indicator: SPDS07NV

2. Y-Axis

   a. Title: Suppression Pool Water Level
   b. Variable: SPDS0065
   c. Range: 0 to 30
   d. Units: feet
   e. NV indicator: SPDS18NV

C. Calculations for External (Real) Data Point SPDS002B

The processing logic for this point is shown in Figure 9-6. The difference between f(x,y) and the limit curve controls the status of external point SPDS002B. When f(x,y) < limit, acceptable conditions exist and SPDS002B = 0. When f(x,y) $\geq$ limit, SPDS002B = 1.

D. Operation of the Suppression Pool Load Limit EOPSI

External point SPDS002B is used to drive a suppression pool load limit status indicator in the L2.4 containment displays (see Section 8). Operation of this EOPSI is defined in Figure 9-6.

Table 9-3. Coordinates of the Suppression Pool Load Limit Curve.

| X-Axis | Y-Axis |
|---|---|
| RPV Pressure (psig) | Suppression Pool Water Level (ft) |
| 0 | 16.34 |
| 627 | 16.34 |
| 687 | 16.00 |
| 865 | 15.00 |
| 1036 | 14.00 |
| 1250 | 12.70 |
| 1250 | 0 |
| 1500 | 0 |

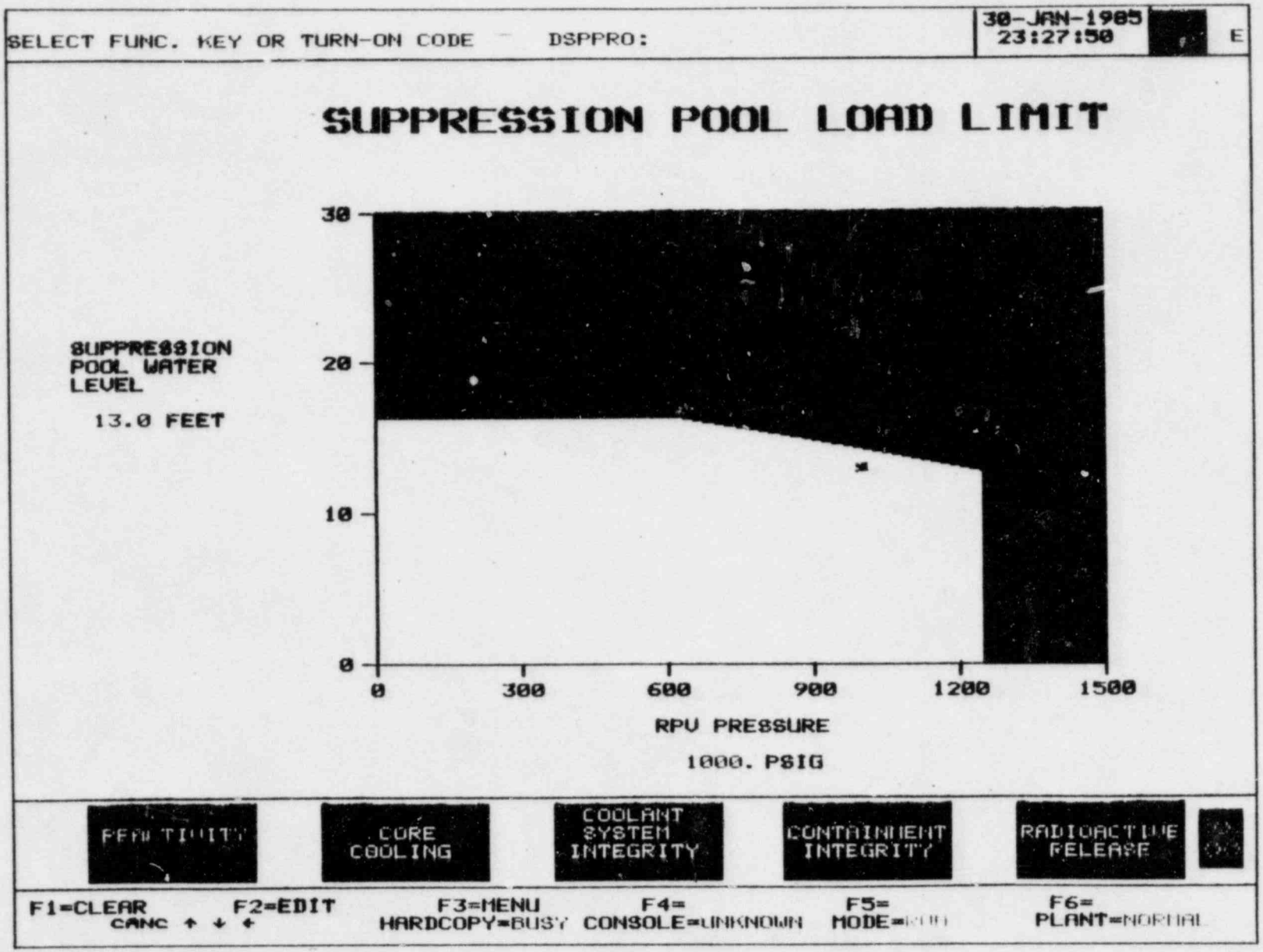


Figure 9-5. Display L3.3, Suppression Pool Load Limit.

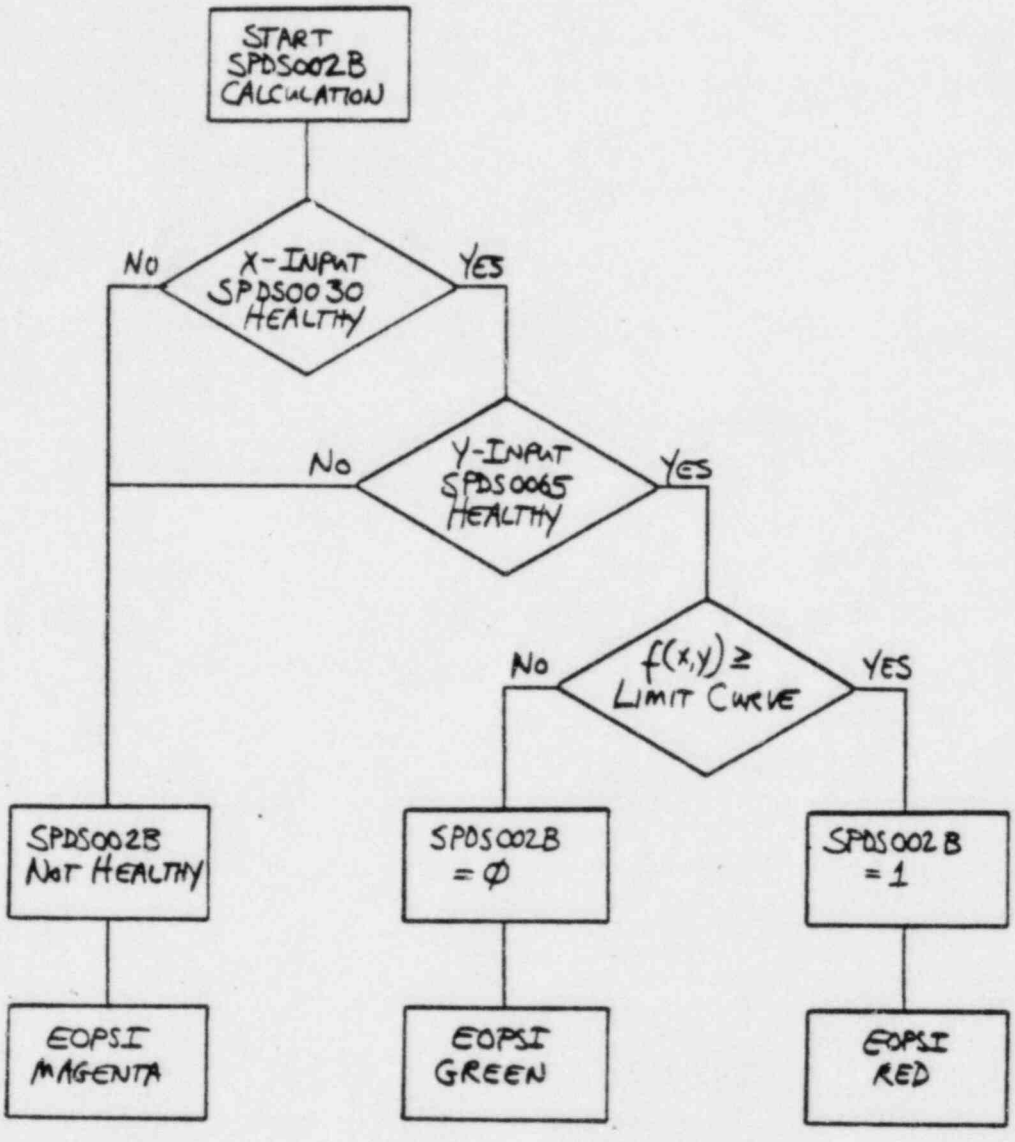


Figure 9-6. Processing Logic for Point SPDS002B and Operation of the Suppression Pool Load Limit EOPSI.

## 9.4 EOP DISPLAY L3.4, CONTAINMENT PRESSURE LIMITS

The purpose of this display is to show present plant status with respect to the following three different multi-parameter containment pressure limits: (a) pressure suppression limit (limit 1), (b) primary containment pressure limit (limit 2), and (c) containment design pressure limit (limit 3). Coordinates of these limit curves are listed in Table 9-4. The detailed arrangement of this display is shown in Figure 9-7.

A. Input Variables Required

1. SPDS0045, average mid-range drywell pressure
2. SPDS0067, average cont. wide range level

B. Graph Characteristics

1. X-Axis

   a. Title: Primary Containment Water Level
   b. Variable: SPDS0067
   c. Range: 0 to 100
   d. Units: feet
   e. NV indicator: SPDS19NV

2. Y-Axis

   a. Title: Drywell Pressure
   b. Variable: SPDS0045
   c. Range: 0 to 80
   d. Units: psia
   e. NV indicator: SPDS09NV

C. Calculations for External (Real) Data Point SPDS004B

The processing logic for this point is shown in Figure 9-8. The difference between f(x,y) and the limit curves control the status of external point SPDS004B. When f(x,y) < limit 1, acceptable conditions exist and SPDS004B = 0. When limit 1 $\leq$ f(x,y) < limit

2, SPDS004B = 1 and a warning condition exists. When $f(x,y) \geq$ limit 2, When $f(x,y) \geq$ limit 3, the alarm condition continues.

D. Operation of the Containment Pressure Limit EOPSI

External point SPDS004B is used to drive a containment pressure limit status indicator in the L2.4 containment displays (see Section 8). Operation of this EOPSI is defined in Figure 9-8.

Table 9-4. Coordinates of the Containment Pressure Limit Curves.

| X-Axis | Y-Axis | | |
|---|---|---|---|
| Primary Containment Water Level (ft) | Drywell Pressure (psia) | | |
| | Limit 1* | Limit 2* | Limit 3* |
| 0 | 31.99 | 56.00 | 62.00 |
| 12.88 | 31.99 | 56.00 | 62.00 |
| 14.00 | 34.18 | | |
| 16.00 | 39.70 | | |
| 18.00 | 47.81 | | |
| 56.83 | 28.78 | 37.00 | 42.97 |
| 65.00 | 28.78 | | |
| 100.00 | 28.78 | 37.00 | 42.97 |

* Limit 1 = pressure suppression limit
Limit 2 = primary containment pressure limit
Limit 3 = containment design pressure limit

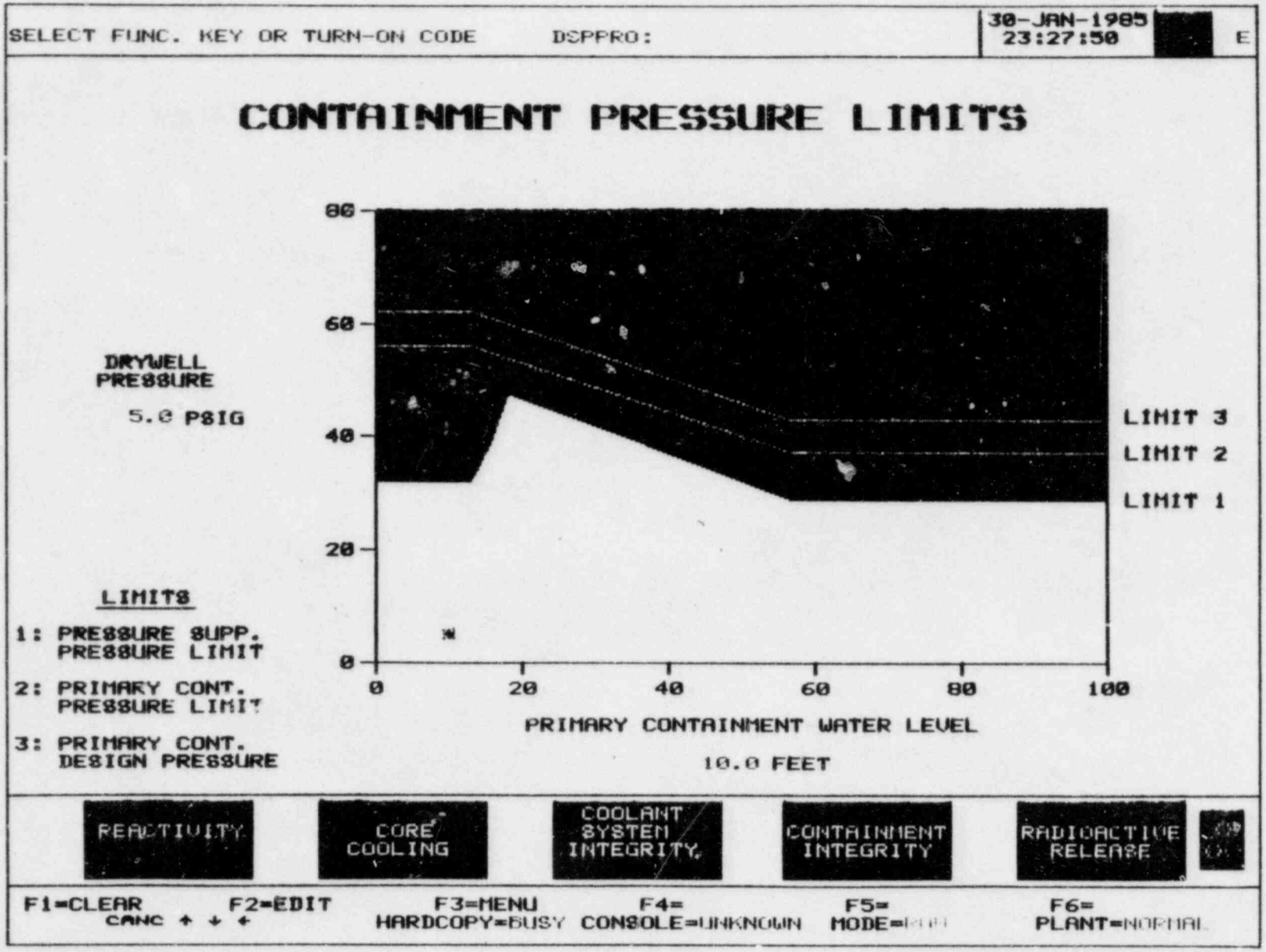


Figure 9-7. Display L3.4, Containment Pressure Limits.

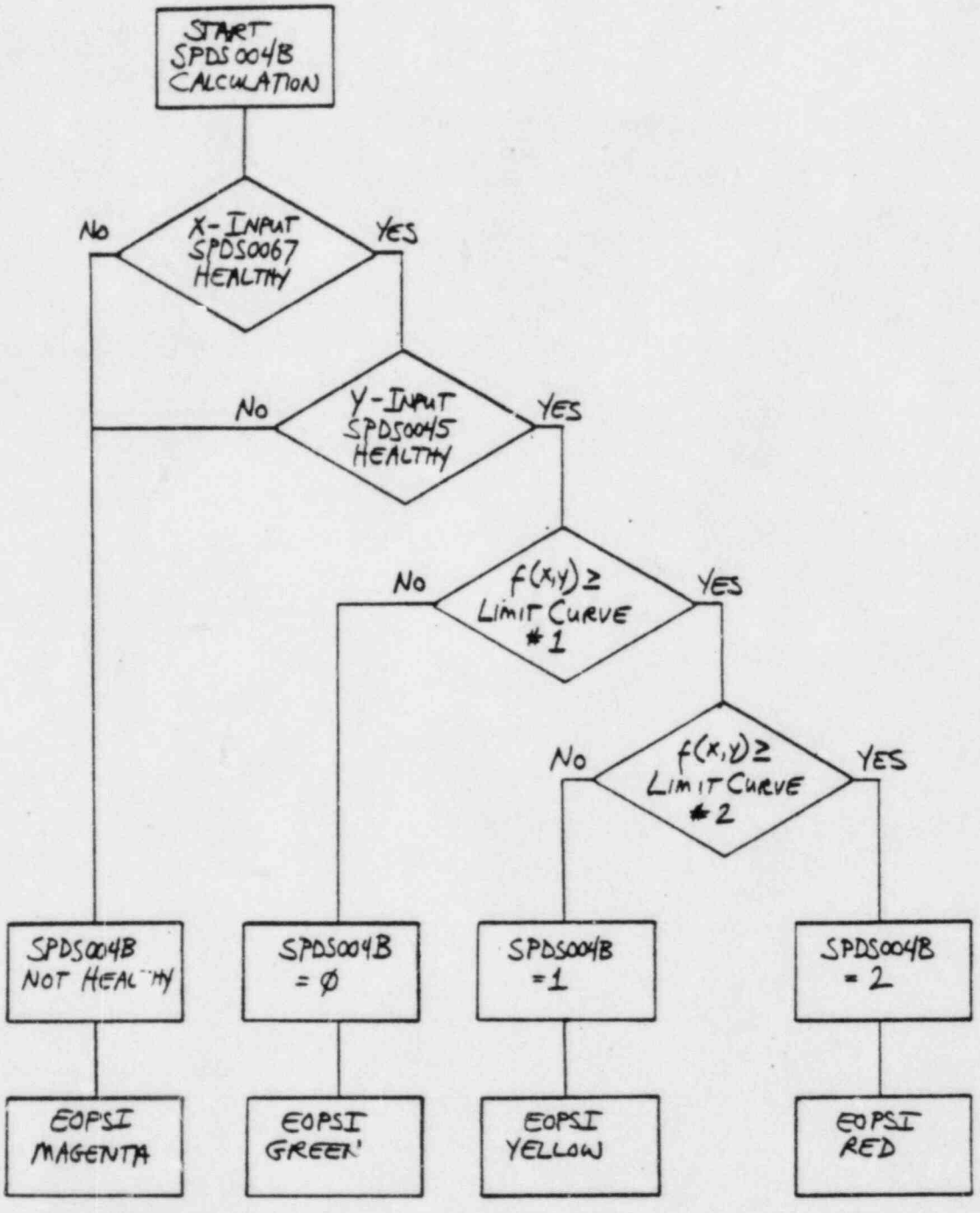


Figure 9-8. Processing Logic for Point SPDS004B and Operation of the Containment Pressure Limit EOPSI.

## 9.5 EOP DISPLAY L3.5, DRYWELL SPRAY INITIATION PRESSURE LIMIT

The purpose of this display is to show present plant status with respect to a multi-parameter limit that the operator must remain below in order to ensure an acceptable total air mass in the containment prior to the use of drywell sprays. Coordinates of the limit curve are listed in Table 9-5. The detailed arrangement of this display is shown in Figure 9-9.

A. Input Variables Required

1. SPDS0045, average mid-range drywell pressure
2. SPDS0063, overall average suppression pool water temperature

B. Graph Characteristics

1. X-Axis

   a. Title: Drywell Pressure
   b. Variable: SPDS0045
   c. Range: 0 to 80
   d. Units: psia
   e. NV indicator: SPDS09NV

2. Y-Axis

   a. Title: Average Suppression Pool Temperature
   b. Variable: SPDS0063
   c. Range: 0 to 250
   d. Units: degrees fahrenheit
   e. NV indicator: None

C. Calculations for External (Real) Data Point SPDS006B

The processing logic for this point is shown in Figure 9-10. The difference between f(x,y) and the limit curve controls the status of external point SPDS006B. When f(x,y) < limit, acceptable conditions exist and SPDS006B = 0. When f(x,y) $\geq$ limit, SPDS006B = 1.

D. Operation of the Drywell Spray Initiation Pressure EOPSI

External point SPDS006B is used to drive a drywell spray initiation pressure status indicator in the L2.4 containment displays (see Section 8). Operation of this EOPSI is defined in Figure 9-10.

Table 9-5. Coordinates of the Drywell Spray Initiation Presssure Limit Curve.

| X-Axis | Y-Axis |
|---|---|
| Drywell Pressure (psia) | Suppression Pool Temperature (°F) |
| 0 | 0 |
| 7.8 | 0 |
| 7.8 | 100 |
| 11.3 | 140 |
| 17.5 | 180 |
| 28.7 | 220 |
| 42.7 | 250 |

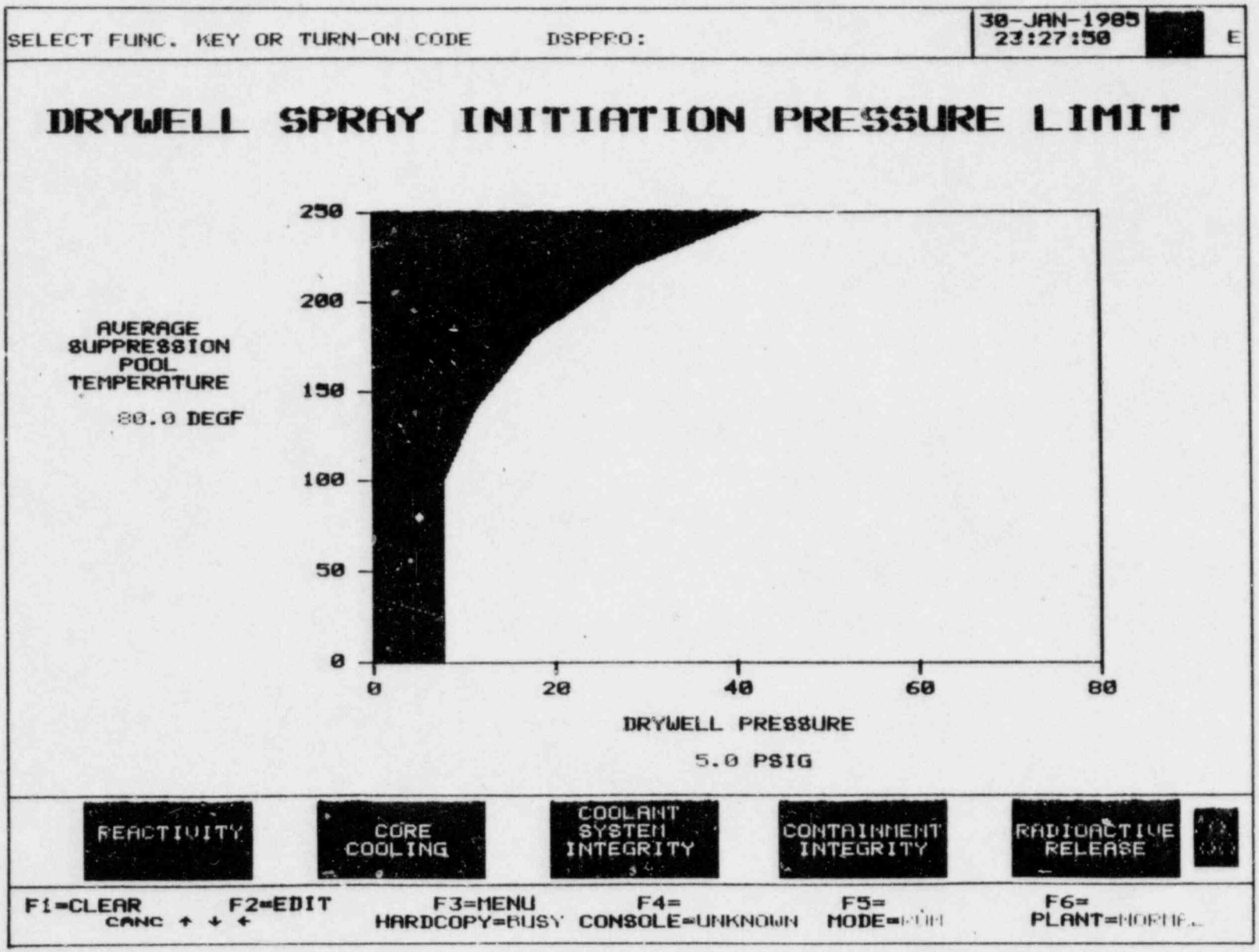


Figure 9-9. Display L3.5, Drywell Spray Initiation Pressure Limit.

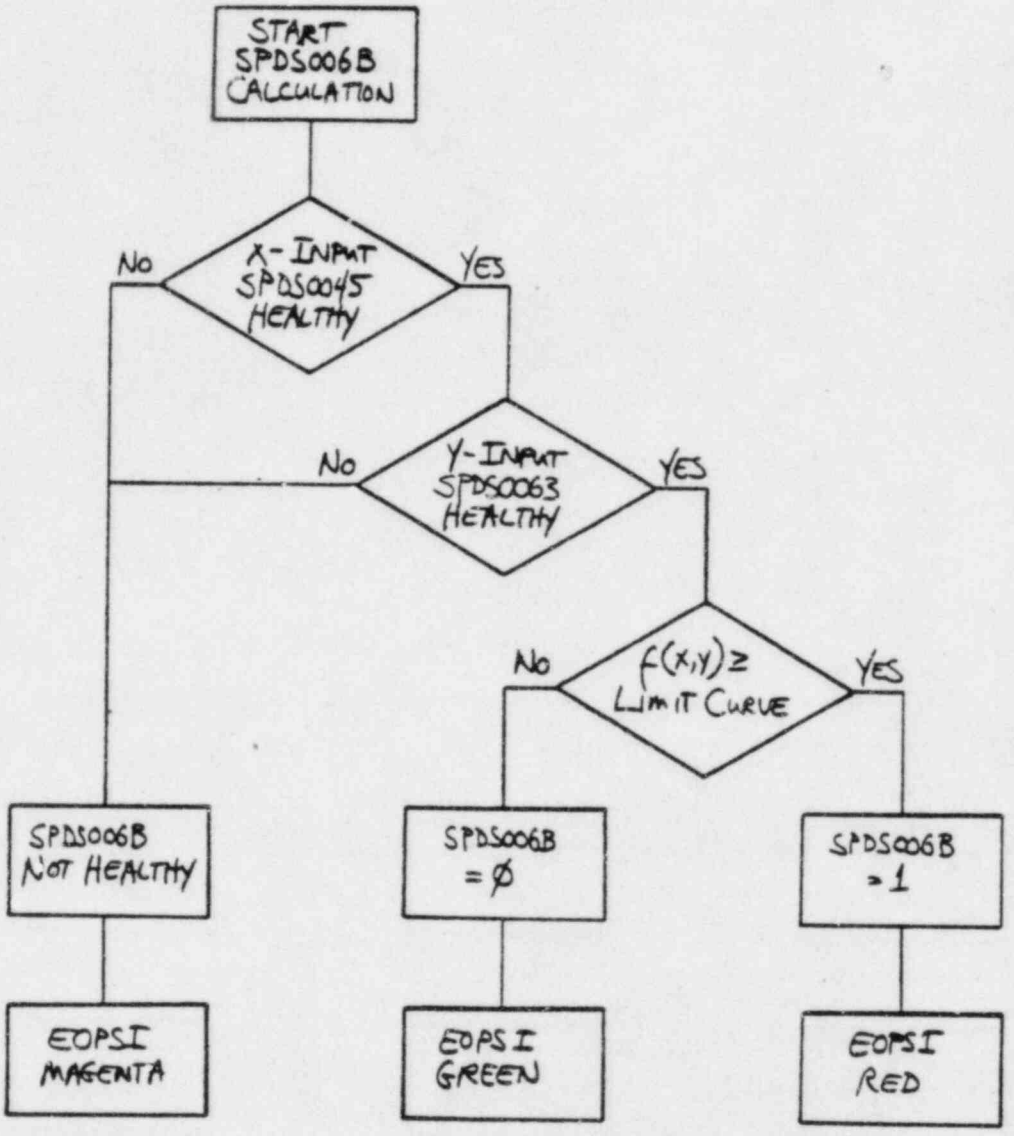


Figure 9-10. Processing Logic for Point SPDS006B and Operation of the Drywell Spray Initiation Pressure Limit EOPSI.

9.6 EOP DISPLAY L3.6, DRYWELL HYDROGEN AND OXYGEN STATUS

The purpose of this display is to show current drywell status with respect to hydrogen and oxygen limits for combustible gas control. The hydrogen limit applies during all modes of plant operation and the oxygen limit applies during RUN and STARTUP plant modes, when the containment is inerted. Coordinates of the hydrogen and oxygen limit curves are listed in Table 9-6. The detailed arrangement of this display is shown in Figure 9-11.

A. Input Variables Required

1. T122, drywell hydrogen level
2. SPDS0045, average mid-range drywell pressure
3. SPDS0100, healthy maximum drywell oxygen

B. Graph Characteristics

This display contains two x-y plots, one for drywell hydrogen limits and one for drywell oxygen limits. The hydrogen graph is plotted above the oxygen graph, with the x-axis of both graphs aligned. It should be noted in Table 9-6 that the hydrogen and oxygen limits currently are defined as constants, and therefore are independent of drywell pressure. Drywell hydrogen and oxygen status are displayed as x-y plots in anticipation of future flammability limits which may be defined as functions of drywell pressure.

1. X-Axis (both graphs)

a. Title: Drywell Pressure
b. Variable: SPDS0045
c. Range: 0 to 80
d. Units: psia
e. NV indicator: SPDS09NV

2. Y-Axis (hydrogen graph)

   a. Title: Drywell $H_2$ Concentration
   b. Variable: T122
   c. Range: 0 to 10
   d. Units: percent
   e. NV indicator: None

3. Y-Axis (oxygen graph)

   a. Title: Maximum Drywell $O_2$ Concentration
   b. Variable: SPDS0100
   c. Range: 0 to 25
   d. Units: percent
   e. NV indicator: None

C. Calculation for External (Real) Data Point SPDS0069, SPDS0090, SPDS0091 and SPDS0092

At CNS, a single monitoring instrument is used to sample the oxygen concentration at three drywell points and a single suppression chamber point. Each sample point is monitored in turn, and the instrument has a significant dwell time at each point.

The point being sampled is identified by means of the following digital points which have a value of "1" when the respective sample point being monitored, and a value of "0" when any other sample point is being monitored.

| Sample Point | Point ID of Sample Point Identifier |
|---|---|
| Drywell point #1 | N627 |
| Drywell point #2 | N628 |
| Drywell point #3 | N629 |
| Torus | N630 |

Once it is known which sample point is being monitored, it is necessary to determine the range setting of the oxygen instrument. The range setting is identified by means of the digital points listed below. The digital point for the range currently in use has a value of "1", and the other two digital points have a value of "0". These digital points determine the PMIS data point which is used to store the current value of oxygen concentration for the point being sampled.

| Instrument Range | Point ID Range Identifier | Point ID to Store Current Value |
|---|---|---|
| 0 to 5% (range 1) | N631 | N061 |
| 0 to 10% (range 2) | N632 | N062 |
| 0 to 25% (range 3) | N633 | N065 |

Data point N061, N062 or N065 (as determined by range setting) is assigned the current value of whatever sample point is being monitored. To assist in managing containment oxygen data, the following external (real) data points are assigned for the purpose of updating and archiving oxygen data from each separate sample point:

| Sample Point | Point ID for Analog Oxygen Data |
|---|---|
| Drywell point #1 | SPDS0090 |
| Drywell point #2 | SPDS0091 |
| Drywell point #3 | SPDS0092 |
| Torus | SPDS0069 |

The processing logic for these SPDS data points is shown in Figure 9-12.

Another calculation performed for drywell oxygen concentration is the determination of the healthy maximum of points SPDS0090 to SPDS0092. The healthy maximum value is assigned to point SPDS0100, and represents an upper bound on drywell oxygen, based on the most recent sampling cycle.

D. Calculations for External (Real) Points SPDS007B and SPDS009B

In this Level 3 display, the difference between f(x,y) and the hydrogen limit curve (limit 1) controls the status of external point SPDS007B. When f(x,y) < limit 1, acceptable hydrogen conditions exist and SPDS007B = 0. When f(x,y) $\geq$ limit 1, SPDS007B = 1. The processing logic for this point is shown in Figure 9-13. Note that SPDS0100, which is an input to the SPDS007B calculation, is the healthy maximum drywell oxygen concentration determined from the three drywell oxygen samples (SPDS0090, SPDS0091 and SPDS0092).

The difference between g(x,y) and the oxygen limit curve (limit 2) controls the status of external point SPDS009B. When g(x,y) < limit 2, acceptable oxygen conditions exist and SPDS009B = 0. When g(x,y) $\geq$ limit 2, SPDS009B = 1. Processing logic for this point is shown in Figure 9-14.

E. Operation of the Drywell Hydrogen and Oxygen EOPSIs

External points SPDS007B and SPDS009B are used to drive drywell hydrogen and oxygen status indicators, respectively, in the L2.4 containment displays (see Sections 8). Operation of the drywell hydrogen EOPSI is defined in Figure 9-13, and the drywell oxygen EOPSI is defined in Figure 9-14.

Table 9-6. Coordinates of Containment* Hydrogen and Oxygen Limit Curves.

| X-Axis | Y-Axis | |
|---|---|---|
| Drywell Pressure (psia) | Hydrogen Concentration (%) | Oxygen Concentration (%) |
| 0 | 2.5 | 4.0 |
| 80 | 2.5 | 4.0 |

* These limits apply for both the drywell and suppression chamber.

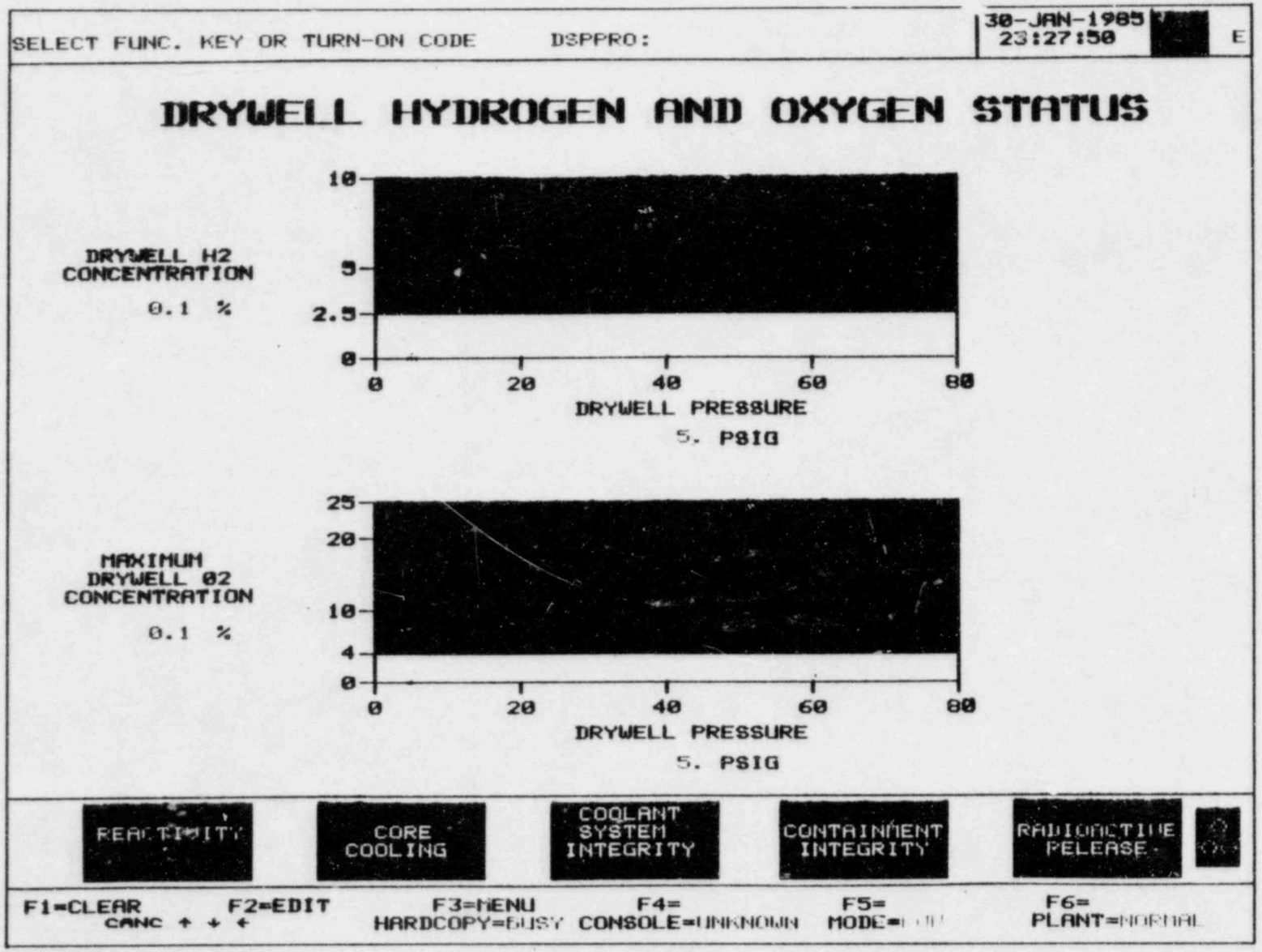


Figure 9-11. Display L3.6, Drywell Hydrogen and Oxygen Status.

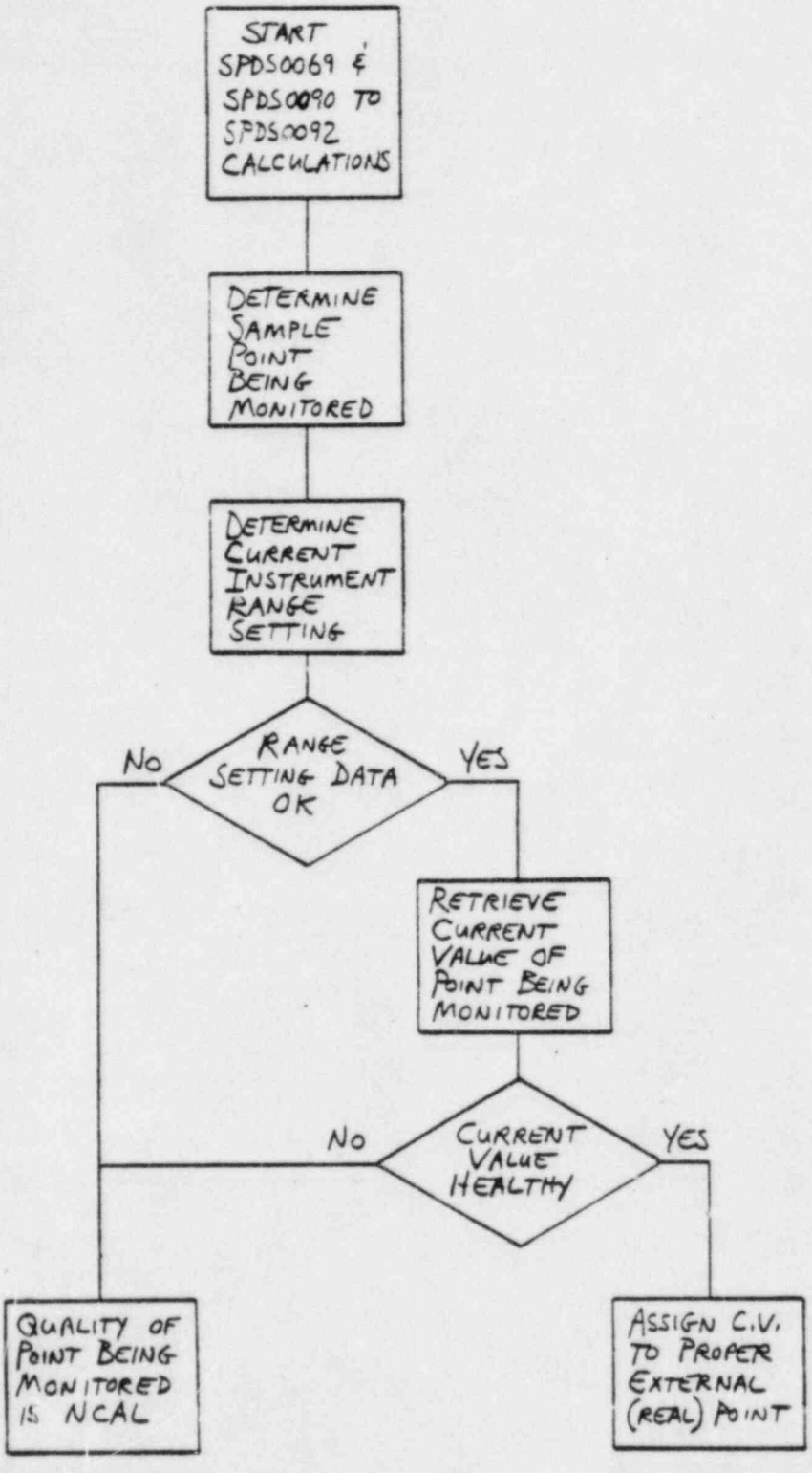


Figure 9-12. Processing Logic for Points SPDS0069, SPDS0090, SPDS0091, and SPDS0092.

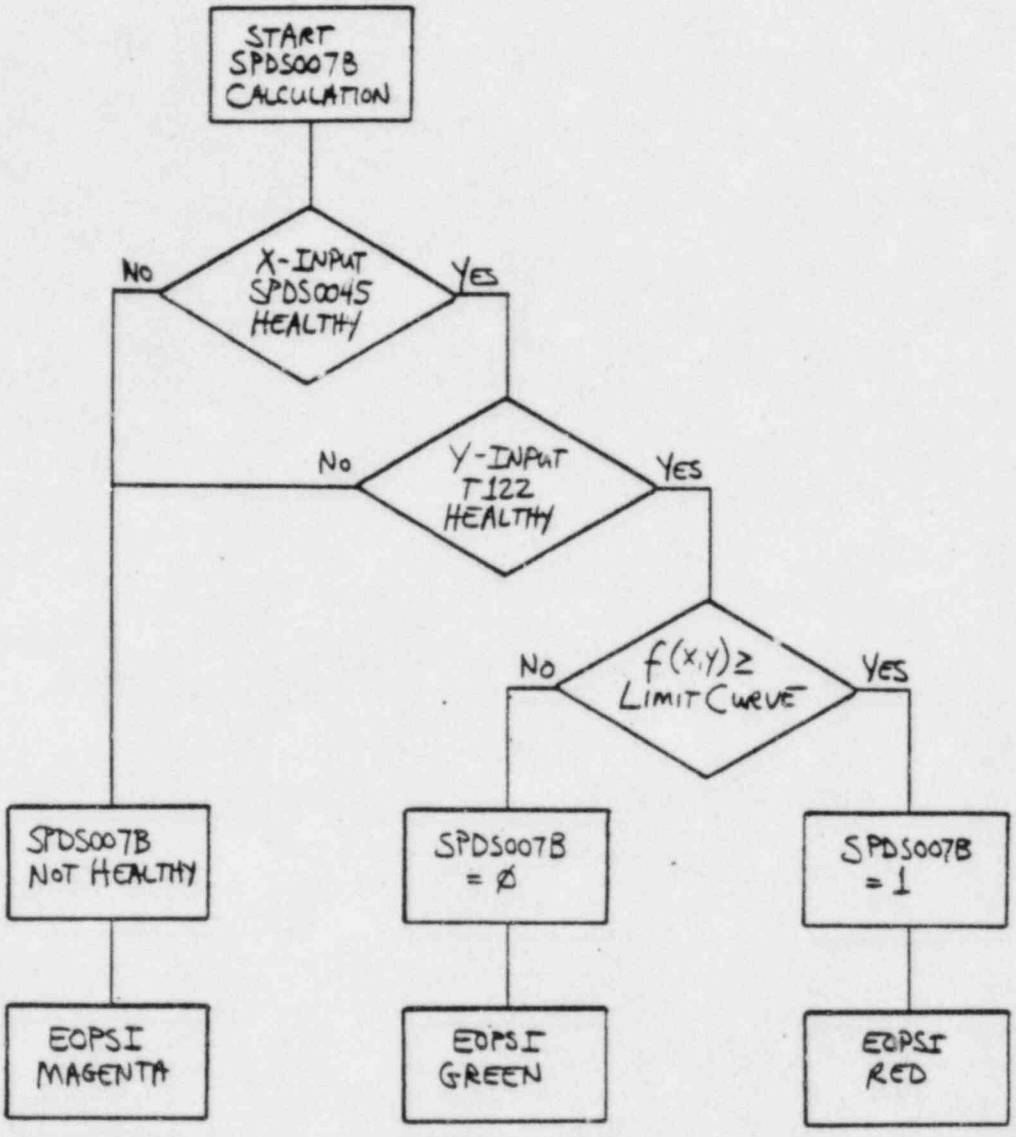


Figure 9-13. Processing Logic for Point SPDS007B and Operation of the Drywell Hydrogen Concentration Limit EOPSI.

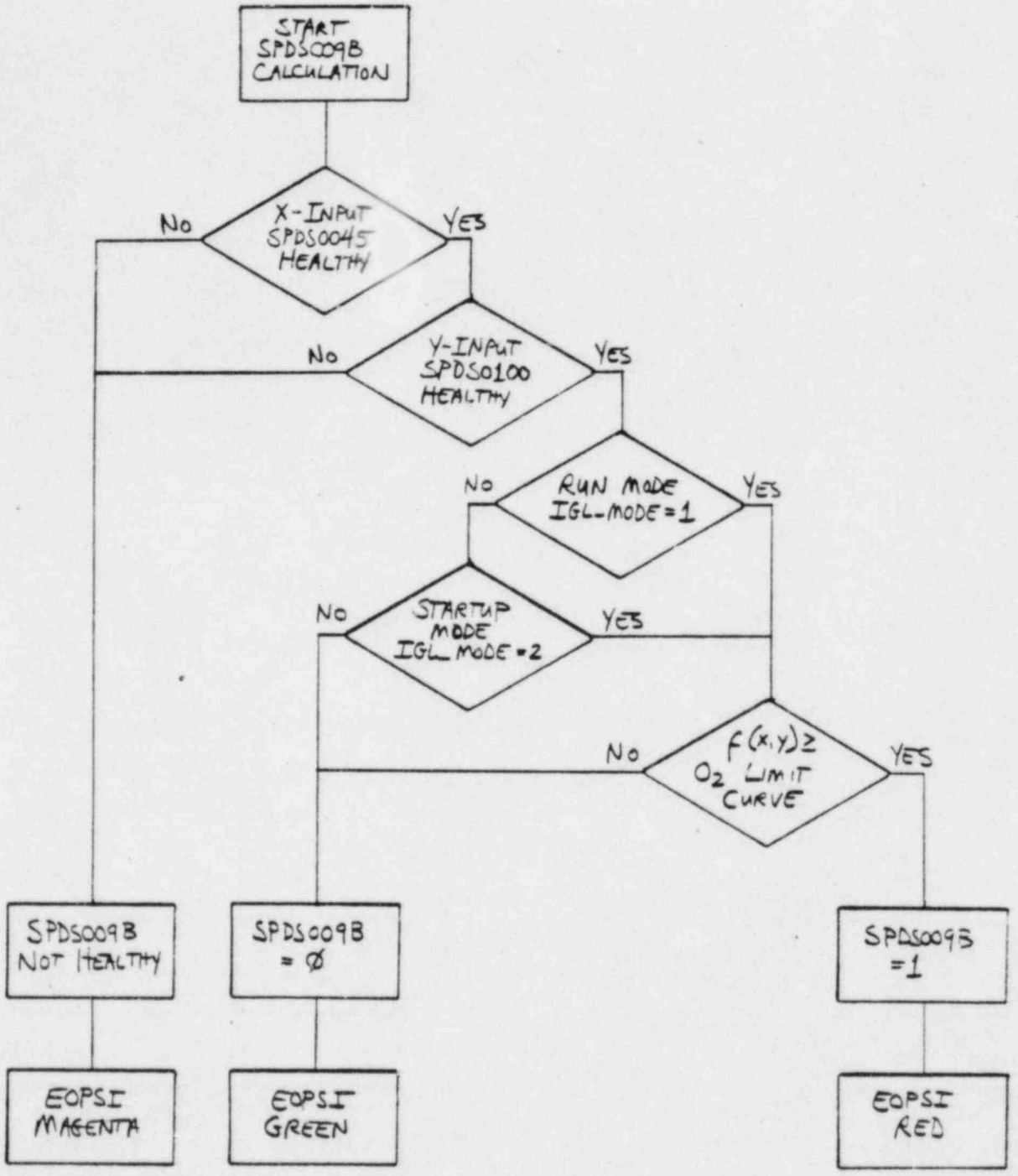


Figure 9-14. Processing Logic for Point SPDS009B and Operation of the Drywell Oxygen Concentration Limit EOPSI.

## 9.7 EOP DISPLAY L3.7, SUPPRESSION CHAMBER HYDROGEN AND OXYGEN STATUS

The purpose of this display is to show current torus status with respect to hydrogen and oxygen concentration. The hydrogen limit applies during all modes of plant operation, and the oxygen limit applies during RUN and STARTUP plant modes, when the containment is inerted. At the present time, there is no instrument to monitor torus hydrogen, therefore, the torus hydrogen plot is inoperable. Coordinates of the hydrogen and oxygen limit curves are listed in Table 9-6. The detailed arrangements of this display is shown in Figure 9-15.

A. Input Variables Required

1. SPDS0045, average mid-range drywell pressure
2. SPDS0069, calculated torus oxygen
3. XXXX, torus hydrogen (not currently available on PMIS)

B. Graph Characteristics

This display contains two x-y plots, one for torus hydrogen limits and one for torus oxygen limits. The hydrogen graph is plotted above the oxygen graph with the x-axis of both graphs aligned. It should be noted that they hydrogen and oxygen limits currently are defined as constants and therefore are independent of suppression chamber pressure. Suppression chamber hydrogen and oxygen status are displayed as x-y plots in anticipation of future flammability limits which may be defined as functions of suppression chamber pressure.

1. X-Axis (both graphs)

   a. Title: Suppression Chamber Pressure
   b. Variable: SPDS0045 (Note that this is actually the average of the mid-range drywell pressure instruments F084 and F085. These instruments should accurately reflect torus pressure).
   c. Range: 0 to 80

d. Units: psia
e. NV indicator: SPDS09NV

2. Y-Axis (hydrogen graph)

a. Title: Torus Hydrogen Concentration
b. Variable: XXXX (not currently available on PMIS)
c. Range: 0 to 10
d. Units: percent
e. NV indicator: None

3. Y-Axis (oxygen graph)

a. Title: Torus Oxygen Concentration
b. Variable: SPDS0069
c. Range: 0 to 25
d. Units: percent
e. NV indicator: None

C. Calculations for External (Real) Data Points SPDS0069 and SPDS010B

1. External (Real) Point SPDS0069
The calculations for point SPDS0069 are described in Section 9.6, and the processing logic for this point is shown in Figure 9-12.

2. External (Real) Point SPDS010B
In this Level 3 display, the difference between f(x,y) and the oxygen limit curve controls the status of external point SPDS010B. When the plant is in the RUN or STARTUP mode and f(x,y) < limit 1, acceptable oxygen conditions exist and SPDS010B = 0. Limit 1 does not apply during SHUTDOWN and REFUEL modes, thus SPDS010B = 0 during these plant modes. When the plant is in the RUN or STARTUP mode and f(x,y) $\geq$ limit 1, an alarm condition exists and SPDS010B = 1. The processing logic for this data point is shown in Figure 9-16.

D. Operation of the Suppression Chamber Oxygen EOPSI

External (real) point SPDS010B is used to drive the suppression chamber oxygen status indicator in the L2.4 containment displays (see Section 8). Operation of this EOPSI is defined in Figure 9-16.

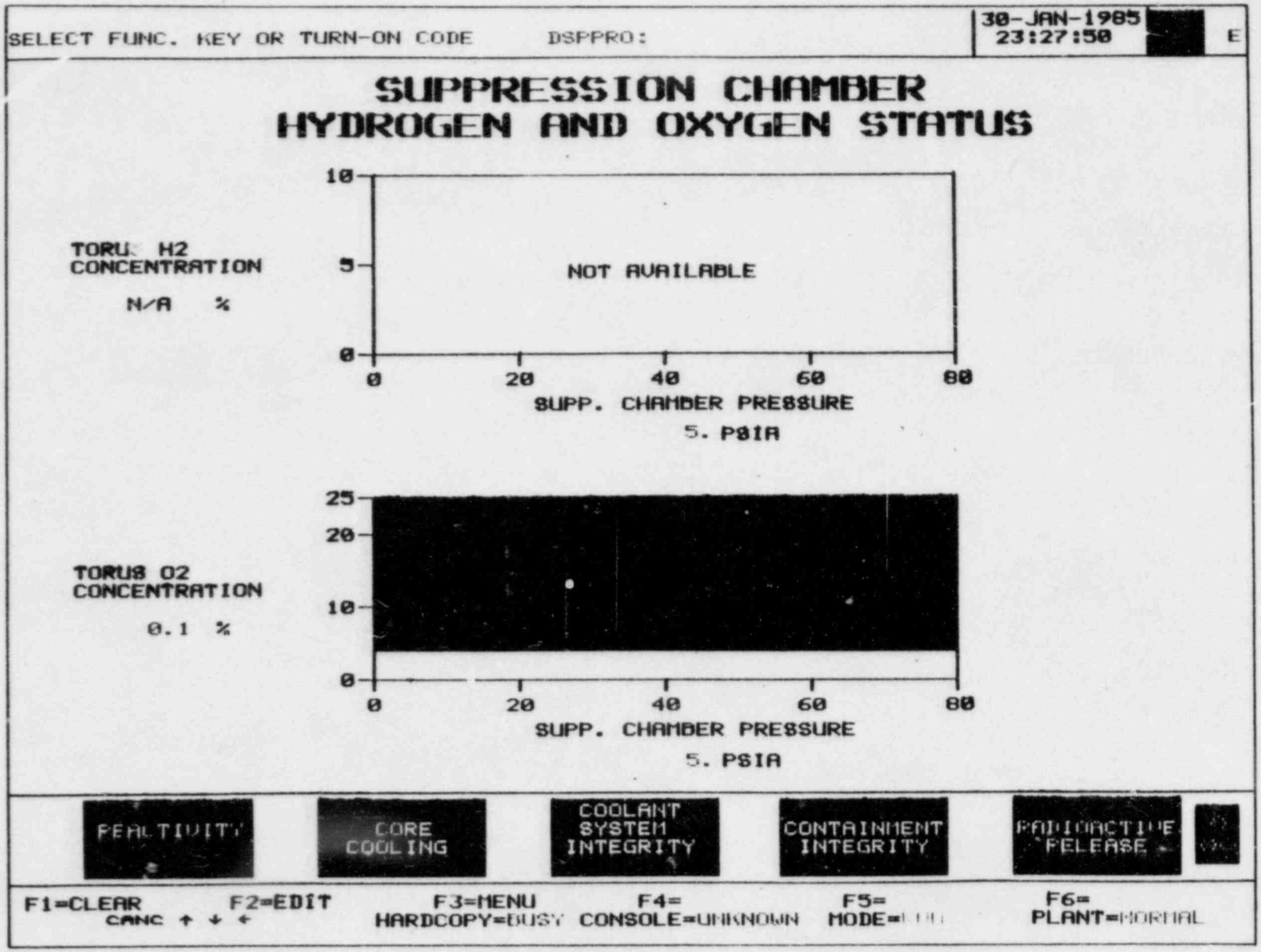


Figure 9-15. Display L3.7, Suppression Chamber Hydrogen and Oxygen Status.

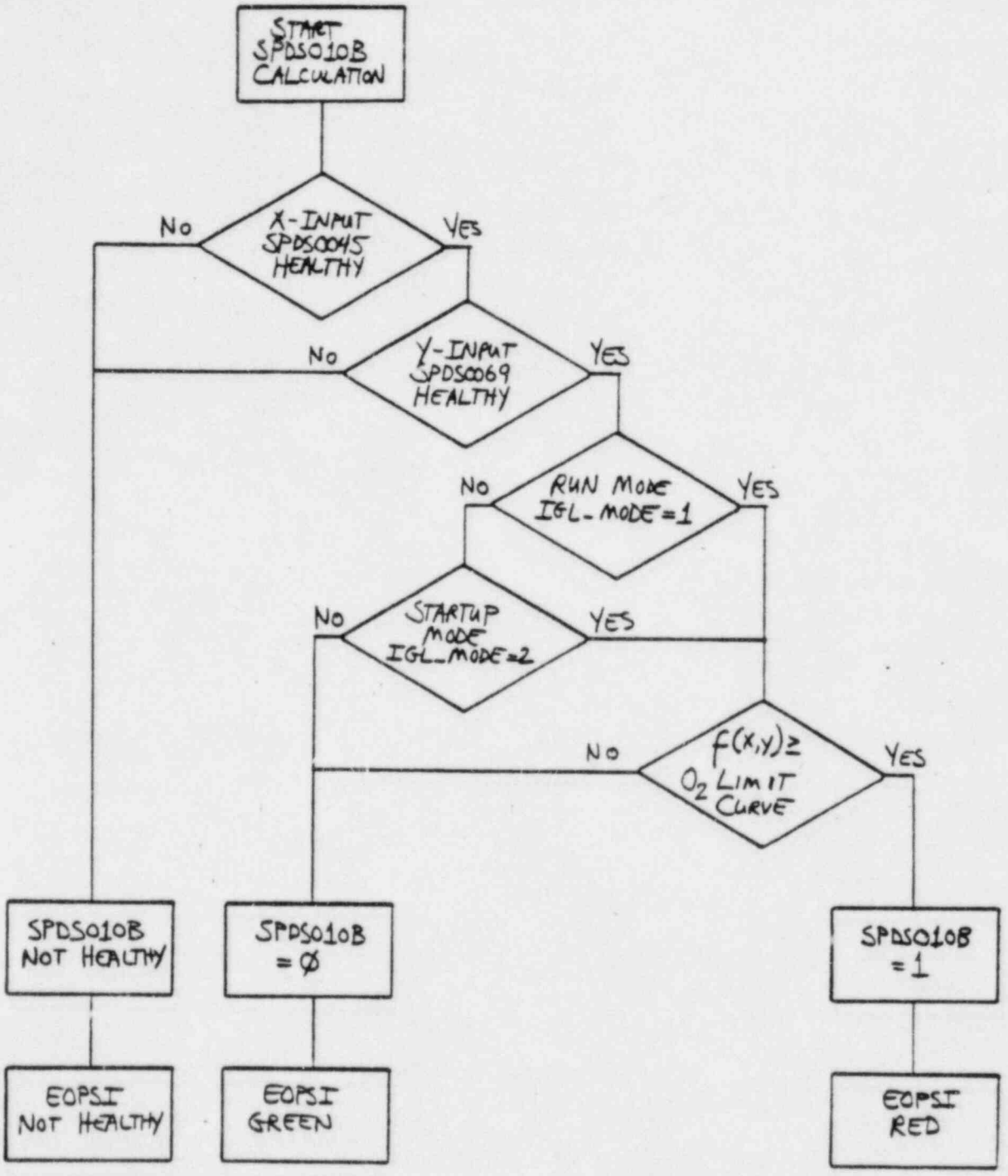


Figure 9-16. Processing Logic for Point SPDS010B and Operation of the Suppression Chamber Oxygen Concentration Limit EOPSI.

9.8 EOP DISPLAY L3.8 RHR PUMP NPSH LIMITS

The purpose of this display is to show the present status of operating RHR pumps with respect to multi-parameter net positive suction head (NPSH) limits. The detailed arrangement of this display is shown in Figure 9-17.

A. Input Variables Required

1. N004, RHR loop A flow
2. N005, RHR loop B flow
3. N861, RHR pump 1A status
4. N862, RHR pump 1B status
5. N863, RHR pump 1C status
6. N864, RHR pump 1D status
7. SPDS0045, average mid-range drywell pressure
8. SPDS0063, overall average suppression pool water temperature

B. Graph Characteristics

This display contains two, side-by-side x-y plots, one for each RHR loop.

1. X-Axis (graph 1)

   a. Title: RHR loop A flow
   b. Variable: N004
   c. Range: 0 to 20,000
   d. Units: gpm
   e. NV indicator: None

2. X-Axis (graph 2)

   a. Title: RHR loop B flow
   b. Variable: N005
   c. Range: 0 to 20,000
   d. Units: gpm
   e. NV indicator: None

3. Y-Axis (both graphs)

   a. Title: Avg. Supp Pool Temp
   b. Variable: SPDS0063
   c. Range: 0 to 250
   d. Units: degrees fahrenheit
   e. NV indicator: None

4. RHR NPSH Limit Curve Coordinates

   Coordinates of multiple NPSH limit curves are listed in Table 9-7. Each limit curve defines the applicable NPSH limits for single pump per loop operation at a specific torus pressure (i.e., 0, 5 or 10 psig). These limit curves do not apply when two RHR pumps per loop are operating. Limit curves for two pump per loop oeration have not been established. The NPSH limit for the current torus pressure condition is calculated by linear interpolation between the static limit curves included in the display. If torus pressure exceeds 10 psig, the limit curve for 10 psig is still used (i.e., limits are not extrapolated).

C. Additional Display Characteristics

Four RHR pump status indicators are included in this display. The operator should refer to these status indicators to verify the operational status of the RHR pumps if an NPSH alarm occurs. The alarm may not be valid if two RHR pumps are operating in a single RHR loop. The operation of these Equipment Status Indicators is described in Section 6. In addition, the current value of drywell pressure (SPDS0045) is included in this display. This is an average value with engineering units of "psia". The NV indicator is SPDS09NV.

D. Calculations for External (Real) Data Point SPDS011B

The processing logic for this point is shown in Figure 9-18. Point SPDS011B has a value of 0 when acceptable NPSH conditions exist in RHR loops A and B and core spray loops A and B. Point SPDS011B = 1 under any of the following conditions:

- An RHR NPSH limit is exceeded in RHR loop A or B
- A core spray NPSH limit is exceeded in CS loop A or B.

The RHR pump NPSH limits are shown in display L3.8 and the core spray pump NPSH limits are shown in display L3.9. In total, there are four x-y plots, and hence four values of f(x,y) that are considered when determining the state of SPDS011B. When all f(x,y) are less than their respective NPSH limit, SPDS011B = 0. When any f(x,y) is above its respective NPSH limit, SPDS011B = 1.

E. Operation of the NPSH Limit EOPSI

External (real) point SPDS011B is used to drive the NPSH Limit Indicator in the L2.2 reactor core cooling displays (see Section 8). Operation of this EOPSI is defined in Figure 9-18. The NPSH limit EOPSI considers the current status of four different NPSH limit plots (i.e., RHR loops A and B and core spray loops A and B). The EOPSI is GREEN when all NPSH limits are satisfied, and is RED when any NPSH limit is exceeded. The validation process for this EOPSI causes it to be displayed in MAGENTA when: (a) one or both input variables to any NPSH plot is not healthy, or (b) average drywell pressure (SPDS0045) is not healthy, or (c) PMIS redundant point check is failed by average drywell pressure (SPDS0045) or average suppression pool temperature (SPDS0063). Operation of this EOPSI does not consider the possible operation of two RHR pumps per loop.

Table 9-7. Coordinates of the RHR NPSH Limit Curves (Single RHR Pump per Loop Operation Only).

| X-Axis | Y-Axis | | |
|---|---|---|---|
| RHR Flow (gpm) | Suppression Pool Temperature (°F) | | |
| | Limit 1* | Limit 2* | Limit 3* |
| 0 | 193.0 | 213.0 | 228.0 |
| 3950 | 193.0 | 213.0 | 228.0 |
| 4810 | 192.0 | 212.0 | 226.0 |
| 5775 | 190.5 | 211.0 | 225.0 |
| 6740 | 188.0 | 210.0 | 224.5 |
| 7700 | 186.0 | 208.0 | 224.0 |

* Limit 1 applies at a containment pressure of 0 psig, Limit 2 applies at 5 psig and Limit 3 applies at 10 psig.

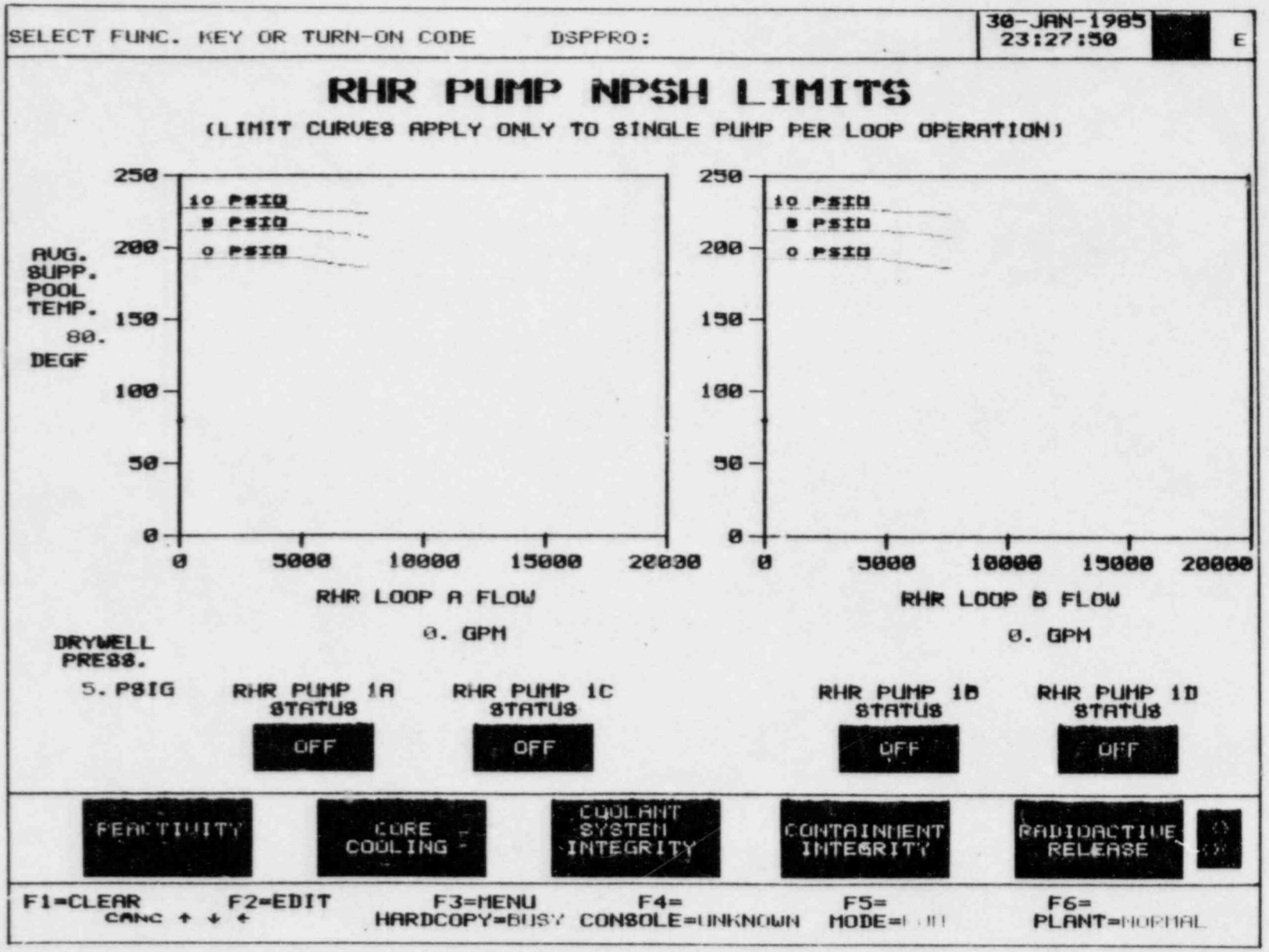


Figure 9-17. Display L3.8, RHR Pump NPSH Limits.

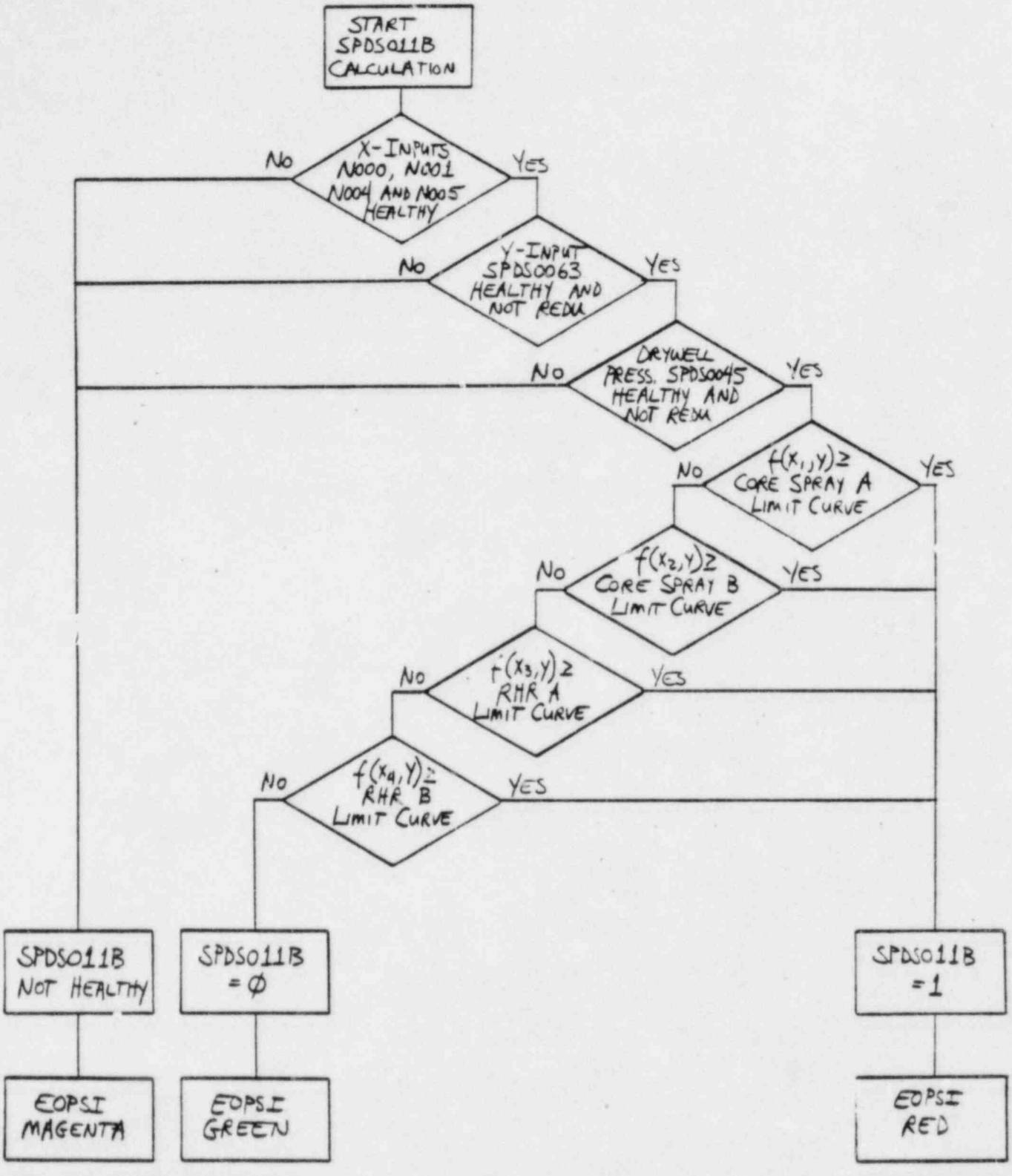


Figure 9-18. Processing Logic for Point SPDS011B and Operation of the NPSH Limit EOPSI.

9.9 EOP DISPLAY L3.9, CORE SPRAY PUMP NPSH LIMITS

The purpose of this display is to show the present status of operating Core Spray pumps with respect to multi-parameter NPSH limits. The detailed arrangement of this display is shown in Figure 9-19.

A. Input Variables Required

1. N000, Core spray 1A flow
2. N001, Core spray 1B flow
3. SPDS0045, average mid-range drywell pressure
4. SPDS0063, overall average suppression pool water temperature

B. Graph Characteristics

This display contains two, side-by-side x-y plots, one for each core spray loop

1. X-Axis (graph 1)

   a. Title: Core Spray Pump 1A flow
   b. Variable: N000
   c. Range: 0 to 6000
   d. Units: gpm
   e. NV indicator: None

2. X-Axis (graph 2)

   a. Title: Core Spray Pump 1B flow
   b. Variable: N001
   c. Range: 0 to 6000
   d. Units: gpm
   e. NV indicator: None

3. Y-axis (both graphs)

   a. Title: Supp Pool Temp
   b. Variable: SPDS0063
   c. Range: 0 to 250
   d. Units: degrees fahrenheit
   e. NV indicator: None

4. Core Spray NPSH Limit Curve Coordinates
   Coordinates of multiple NPSH limit curves are listed in Table 9-8. Each limit curve defines the applicable NPSH limits for a specific torus pressure (i.e., 0, 5 or 10 psig). The NPSH limit for the current torus pressure condition is calculated by linear interpolation between the static limit curves included in the display. If torus pressure exceeds 10 psig, the limit curve for 10 psig is still used (i.e., limits are not extrapolated).

C. Additional Display Characteristics
   This display includes two core spray pump status indicators. Operation of these equipment status indicators is described in Section 6. In addition, the current value of drywell pressure (SPDS0045) is included in this display. This is an average value with engineering units of "psia". The NV indicator is SPDS09NV.

D. Calculations for External (Real) Data Point SPDS011B
   In each core spray x-y plot, the proximity of f(x,y) to the respective NPSH limit is a factor to be considered in determining the status of external point SPDS011B. For details, see Section 9.8.

E. Operation of the NPSH Limit EOPSI
   See Section 9.8.

Table 9-8. Coordinates of the Core Spray NPSH Limit Curves.

| X-Axis | Y-Axis | | |
|---|---|---|---|
| Core Spray Flow (gpm) | Suppression Pool Temperature (°F) | | |
| | Limit 1* | Limit 2* | Limit 3* |
| 0 | 201 | 219 | 233 |
| 1500 | 201 | 219 | 233 |
| 2950 | 199 | 217 | 231 |
| 4720 | 188 | 210 | 225 |
| 4850 | 184 | 207 | 224 |

* Limit 1 applies at a containment pressure of 0 psig, Limit 2 applies at 5 psig, and Limit 3 applies at 10 psig.

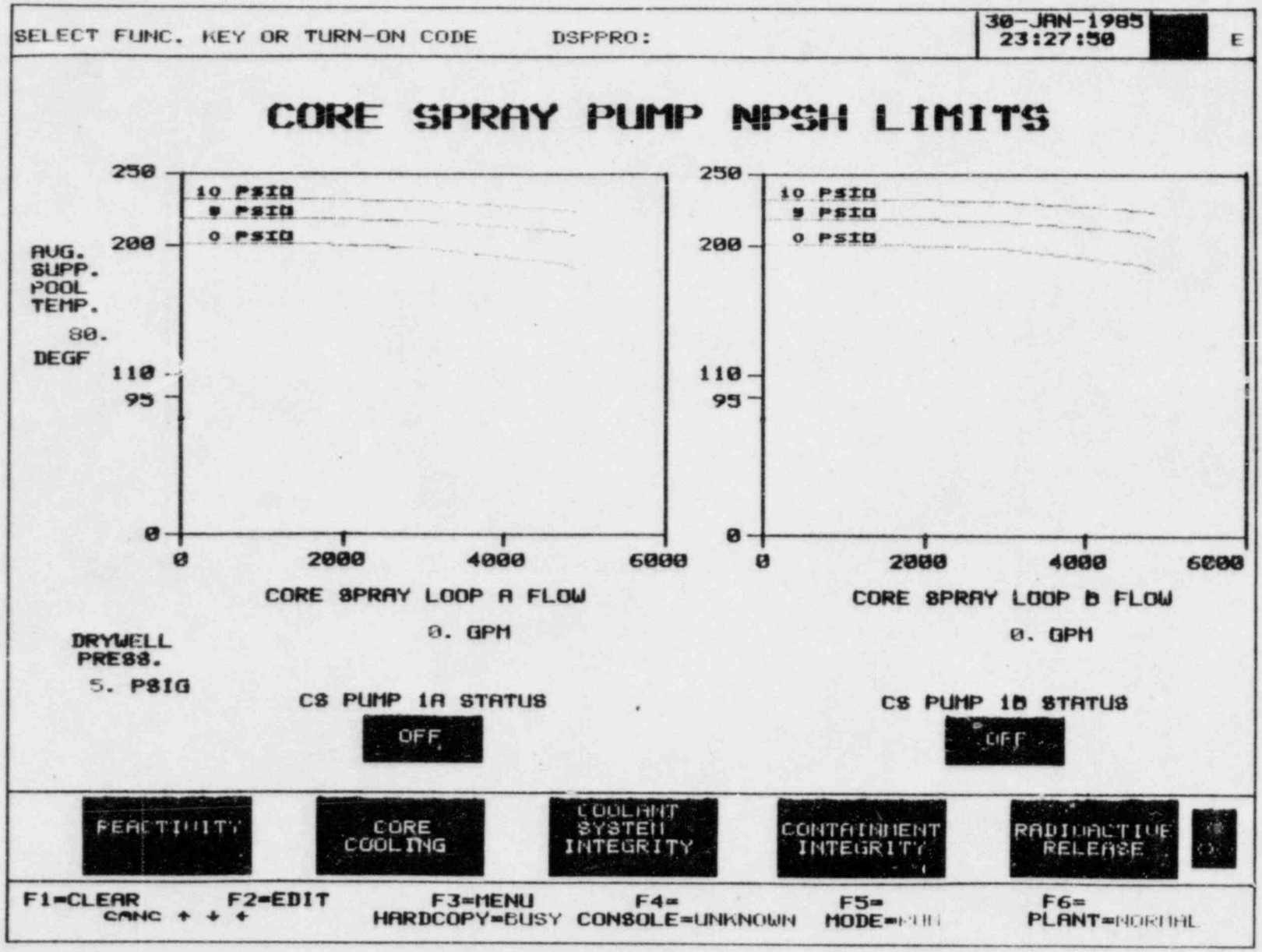


Figure 9-19. Display L3.9, Core Spray Pump NPSH Limits.

## 9.10 EOP DISPLAY L3.11, RPV SATURATION TEMPERATURE LIMIT

The purpose of this display is to show present plant status with respect to a multi-parameter limit that the operator must remain below in order to prevent boil-off or flashing in the cold reference leg RPV level instruments. The operator can no longer rely on the cold reference leg RPV level instruments if plant conditions are above the saturation temperature limit. Coordinated of the limit curve are listed in Table 9-9. The detailed arrangement of this display is shown in Figure 9-20.

A. Input Variables Required

1. SPDS0030, average RPV pressure
2. SPDS0051, maximum drywell temperature

B. Graph Characteristics

1. X-Axis

   a. Title: RPV Pressure
   b. Variable: SPDS0030
   c. Range: 0 to 1500
   d. Units: psig
   e. NV indicator: SPDS07NV

2. Y-Axis

   a. Title: Maximum Drywell Temperature
   b. Variable: SPDS0051
   c. Range: 0 to 600 (Note that this range exceeds the 0 to 400°F dynamic range available from variable SPDS0051)
   d. Units: degrees fahrenheit
   e. NV indicator: SPDS06NV

C. Calculations for External (Real) Data Point SPDS028B

The processing logic for this point is shown in Figure 9-21. The difference between f(x,y) and this limit curve controls the status of external point SPDS028B. When f(x,y) < limit, RPV water level should not be adversely affected by drywell temperature and SPDS028B = 0. When f(x,y) $\geq$ limit, flashing in the reactor water level instrument cold reference legs may occur, thereby adversely affecting the validity of RPV water level indication. In this case, SPDS028B = 1.

D. Operation of the RPV Saturation Temperature Limit EOPSI

External point SPDS028B is used to drive the RPV saturation temperature status indicator in all displays which present RPV water level information (the L1.0 overview display, the L2.2 core cooling displays, and the L3.15 RPV Pressure/Level Status Matrix). The RPV saturation temperature limit status indicator provides supplementary validation of the RPV water level information. Operation of this EOPSI is defined in Figure 9-21.

With regard to the operation of this EOPSI, note that RPV saturation temperature at normal operating conditions is approximately 545°F. The CNS containment temperature monitoring instruments used by the SPDS have a capability of monitoring temperature up to 400°F, which corresponds to saturation temperature for an RPV pressure of 232 psig. If drywell temperature exceeds 400°F, the proximity to the RPV saturation temperature limit cannot be determined using data available to the SPDS. In this case the RPV saturation temperature limit EOPSI will be displayed in MAGENTA. A limit line is included in this x-y plot to clearly define the 400°F engineering high range of the containment temperature monitoring instruments used by the SPDS.

Table 9-9. Coordinates of the RPV Saturation Temperature Limit Curve.

| X-Axis | Y-Axis |
|---|---|
| RPV Pressure (psig) | Drywell Temperature (°F) |
| 0 | 212 |
| 15.13 | 250 |
| 34.50 | 280 |
| 52.31 | 300 |
| 88.35 | 330 |
| 119.91 | 350 |
| 181.03 | 380 |
| 232.56 | 400 |
| 328.97 | 430 |
| 407.85 | 540 |
| 452.2 | 460 |
| 500.0 | 470 |
| 551.4 | 480 |
| 606.8 | 490 |
| 666.2 | 500 |
| 729.8 | 510 |
| 797.8 | 520 |
| 870.5 | 530 |
| 948.1 | 540 |
| 1030.7 | 550 |
| 1080.0 | 556 |
| 1118.7 | 560 |
| 1500 | 597.6 |

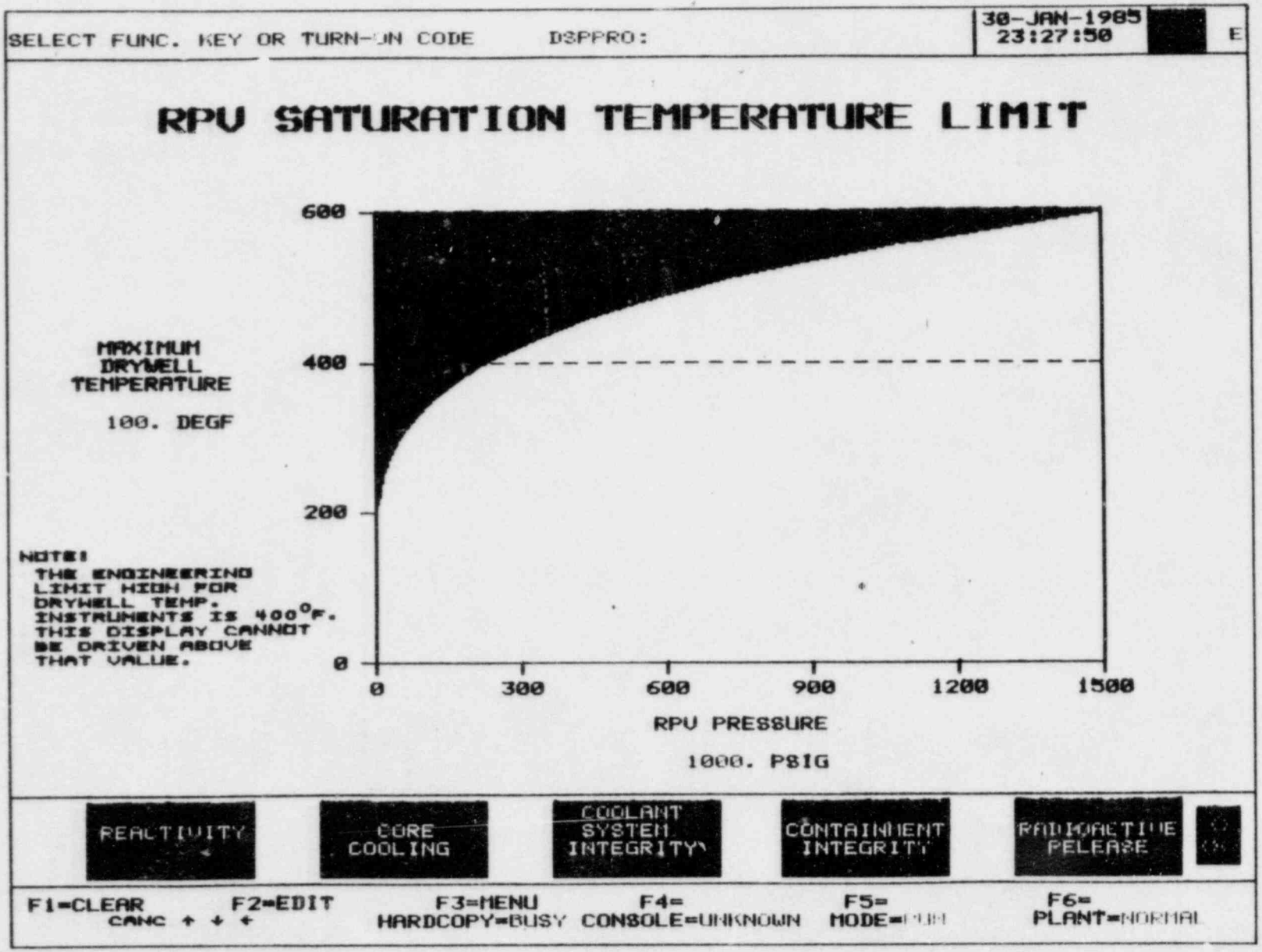


Figure 9-20. Display L3.11, RPV Saturation Temperature Limit.

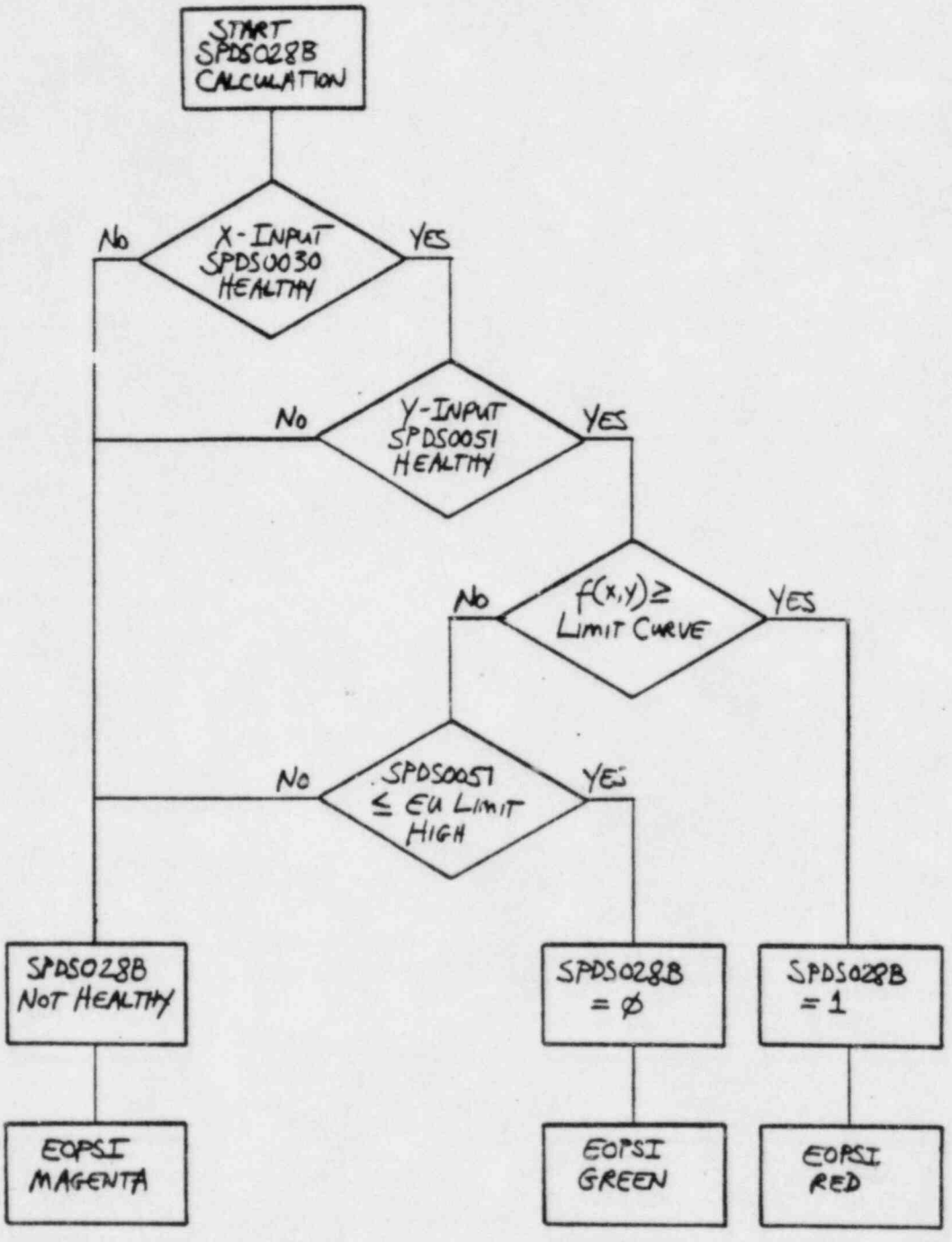


Figure 9-21. Processing Logic for Point SPDS028B and Operation of the RPV Saturation Temperature Limit EOPSI.

9.11 EOP DISPLAY L3.12, MAXIMUM CORE UNCOVERY TIME LIMIT

The purpose of this static display is to provide the operator with rapid access to a multi-parameter limit that defines the time following shutdown from full power for a completely uncovered reactor core to heatup from equilibrium at 545°F to a peak clad temperature of 2200°F with no spray or steam cooling. Coordinates of the limit curve are listed in Table 9-10. The detailed arrangement of this display is shown in Figure 9-22.

A. Input Variables Required

None. This is a static graph for reference only.

B. Graph Characteristics

1. X-Axis

a. Title: Time after Reactor Shutdown
b. Variable: None
c. Range: 1 to 6000
d. Units: minutes

2. Y-Axis

a. Title: Maximum Core Uncovery Time Limit (min.)
b. Variable: None
c. Range: 0 to 40
d. Units: minutes

Table 9-10. Coordinates of the Maximum Acceptable Core Uncovery Time Limit Curve.

| X-Axis | Y-Axis |
|---|---|
| Time After Reactor Shutdown (min) | Maximum Acceptable Core Uncovery Time (min) |
| 1 | 3.50 |
| 5 | 4.82 |
| 10 | 5.55 |
| 15 | 6.10 |
| 20 | 6.58 |
| 30 | 7.42 |
| 40 | 8.13 |
| 50 | 8.75 |
| 60 | 9.30 |
| 80 | 10.22 |
| 100 | 10.97 |
| 600 | 16.90 |
| 1000 | 19.33 |
| 3000 | 27.20 |
| 6000 | 35.27 |

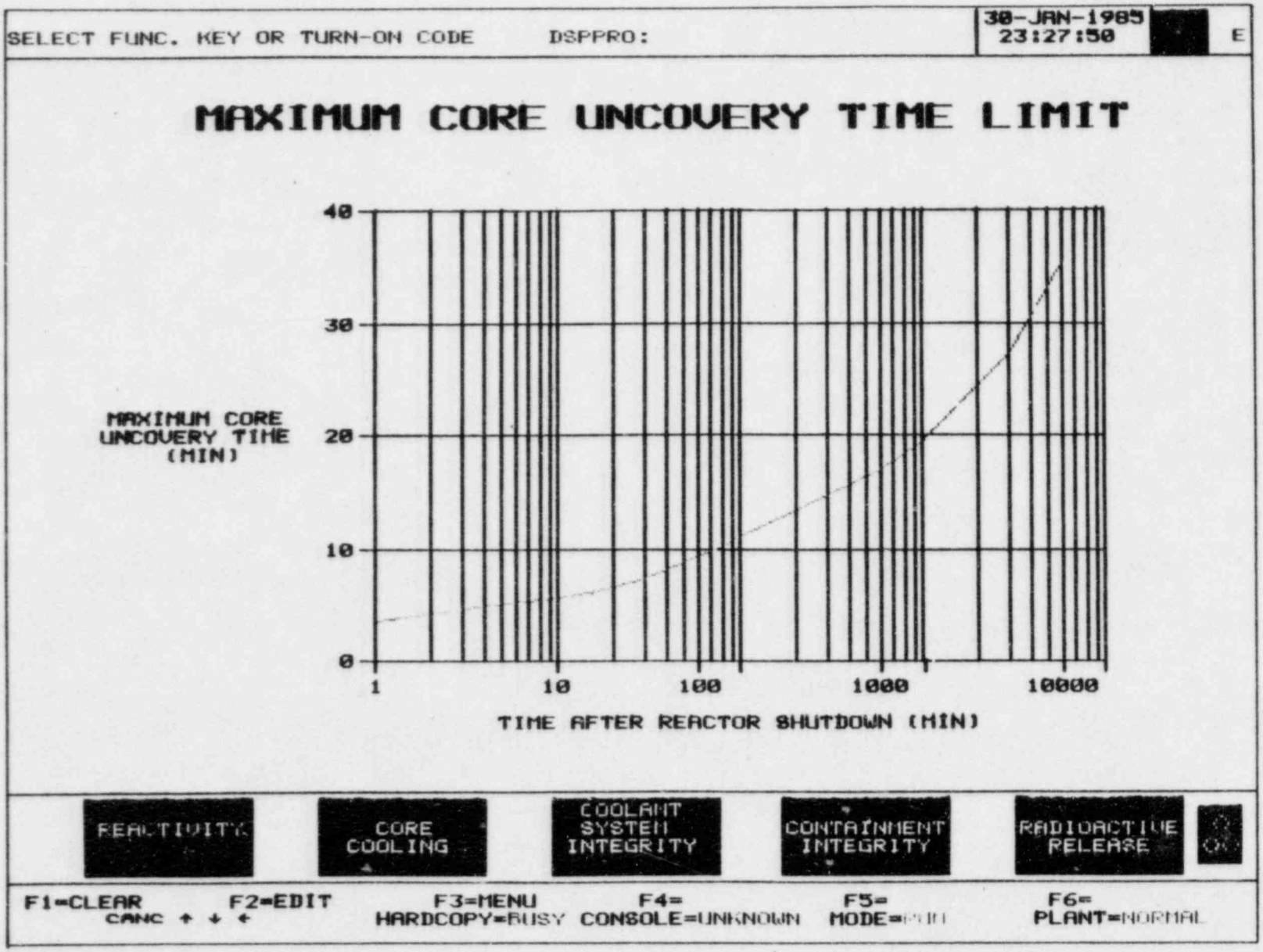


Figure 9-22. Display L3.12, Maximum Core Uncovery Time Limit.

## 9.12 EOP DISPLAY L3.15, RPV PRESSURE/LEVEL STATUS MATRIX

The purpose of this display is to show present plant status with respect to multiple plant variables and to show the complement of low-head and high-head pumps that are operating to supply makeup to the reactor vessel. This combination of information is to support the operator in a relatively complex decision-making process related to implementation of Emergency Operating Procedures (see SPDS Safety Analysis* for further details). The detailed arrangement of this display is shown in Figure 9-23.

A. Input Variables Required

1. SPDS0024, Average wide range RPV level rate-of-change
2. SPDS0030, Average RPV pressure
3. SPDS021B, Constant 100 psig
4. SPDS022B, Constant 425 psig

B. Matrix Characteristics

1. X-Axis of Matrix

   a. Title: RPV Pressure Region

   b. Variable: RPV pressure region is subdivided into three mutually exclusive states: high, intermediate and low. Data points SPDS021B and SPDS022B are constants which establish the values of RPV pressure which divide these three pressure regions (i.e., currently set at 100 psig and 425 psig, respectively). A high pressure condition exists when RPV pressure (SPDS0030) is $\geq$ SPDS022B. An intermediate pressure condition exists when SPDS021B < SPDS0030 < SPDS022B. A low pressure condition exists when SPDS0030 $\leq$ SPDS021B.

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Safety Parameter Display System Safety Analysis, 503-8500000-76

c. Range: Not applicable

d. Units: psig

2. Y-Axis of Matrix

a. Title: RPV Level

b. Variable: RPV level has two mutually exclusive states: steady/increasing, and decreasing. RPV water level is steady or increasing when the rate-of-change (SPDS0024) is $\geq$ 0. Water level is decreasing when rate-of-change is < 0.

c. Range: Not applicable

d. Units: Not applicable

C. Operation of the Status Matrix

Five external points, SPDS023B to SPDS027B, are defined to control the operation of the following five boxes which constitute the RPV pressure/level status matrix:

- RPV pressure high/RPV level increasing
- RPV pressure intermediate/RPV level increasing
- RPV pressure low/RPV level increasing
- RPV pressure high or intermediate/RPV level decreasing
- RPV pressure low/RPV level decreasing

At any given time, only one of the five external points can be in a "TRUE" state (i.e., have a current value of "1").

The color coding of the status matrix has been chosen to be:

- CYAN for the one box of the matrix that represents the current state of RPV pressure and RPV level rate-of-change. All other boxes of the matrix are blanked.

- All boxes of the matrix are MAGENTA if one or both input points (SPDS0024 and/or SPDS0030) are not healthy.

The RPV pressure/level status matrix does not unambiguously define the severity of the present plant condition. Therefore, color coding of the matrix to indicate warning or alarm conditions is not implemented.

The processing logic for operating the status matrix is shown in Figure 9-24.

D. Calculation of External (Real) Data Points SPDS023B to SPDS028B

The processing logic for each external (real) point is shown in Figure 9-24, and is described in detail below.

1. External (Real) Point SPDS023B
   The "RPV pressure high/RPV level increasing' box of the status matrix is controlled by external point SPDS023B. If SPDS0030 $\geq$ SPDS022B and SPDS0024 $\geq$ 0, then SPDS023B = 1 and the joint condition of high pressure and steady or increasing level exists. For any other condition, SPDS023B = 0.

2. External (Real) Point SPDS024B
   The "RPV pressure intermediate/RPV level increasing" box of the status matrix is controlled by external point SPDS024B. If SPDS021B < SPDS0030 < SPDS022B and SPDS0024 $\geq$ 0, then SPDS024B = 1 and the joint condition of intermediate pressure and steady or increasing level exists. For any other condition SPDS024B = 0.

3. External (Real) Point SPDS025B
   The "RPV pressure low/RPV level increasing" box of the status matrix is controlled by external point SPDS025B. If SPDS0030 $\leq$ SPDS021B, and SPDS0024 $\geq$ 0, then SPDS025B = 1 and the joint

condition of low pressure and steady or increasing level exists. For any other condition SPDS025B = 0.

4. External (Real) Point SPDS026B

The "RPV pressure high or intermediate/RPV level decreasing" box of the status matrix is controlled by external point SPDS026B. If SPDS0030 > SPDS021B and SPDS0024 > 0, then SPDS026B = 1 and the joint condition of high or intermediate pressure and decreasing level exists. For any other condition SPDS026B = 0.

5. External (Real) Point SPDS027B

The "RPV pressure low/RPV level decreasing" box of the status matrix is controlled by external point SPDS027B. If SPDS0030 $\leq$ SPDS021B and SPDS0024 < 0, then SPDS027B = 1 and the joint condition of low pressure and decreasing level exists. For any other condition SPDS027B = 0.

E. Additional Display Characteristics

In addition to the status matrix described above, this display contains the following information:

1. Digital Current values

- SPDS0023, average wide range RPV level. Engineering units are "inches". The NV indicator is SPDS04NV.
- SPDS0024, average wide range RPV level rate-of-change. Engineering units are "inches/minute". There is no NVI.
- SPDS0030, average RPV pressure. Engineering units are "psig". The NV indicator is SPDS07NV.
- SPDS0031, average RPV pressure rate-of-change. Engineering units are "psi/minute". There is no NVI.

2. Equipment and EOP Limit Status Indicators (see Section 6)
   - RHR pump 1A (N861)
   - RHR pump 1B (N862)
   - RHR pump 1C (N863)
   - RHR pump 1D (N864)
   - CS pump 1A (M578)
   - CS pump 1B (M580)
   - HPCI pump (SPDS0085)
   - RCIC pump (SPDS0086)
   - RPV saturation temperature limit (SPDS028B)

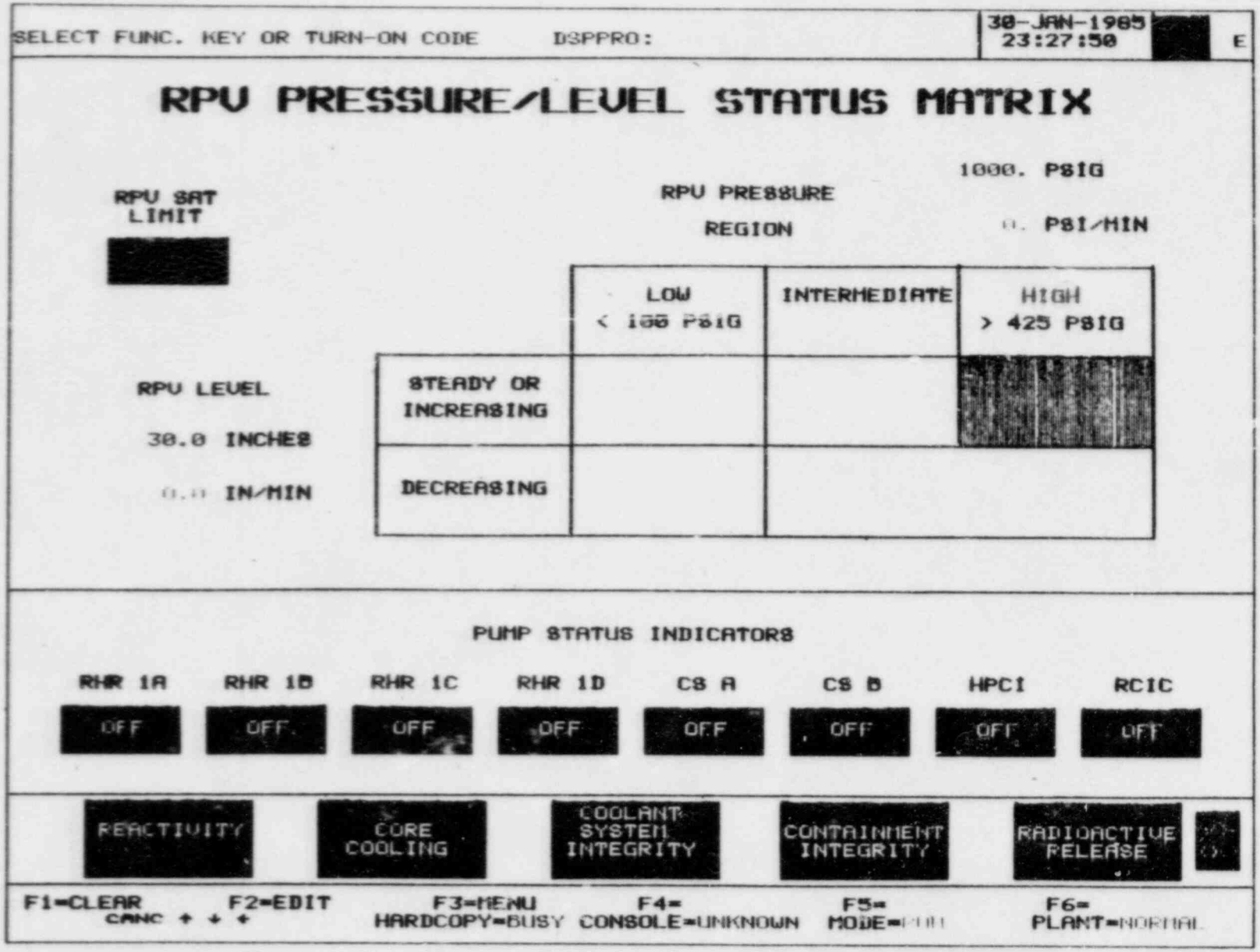


Figure 9-23. Display L3.15, RPV Pressure/Level Status Matrix.

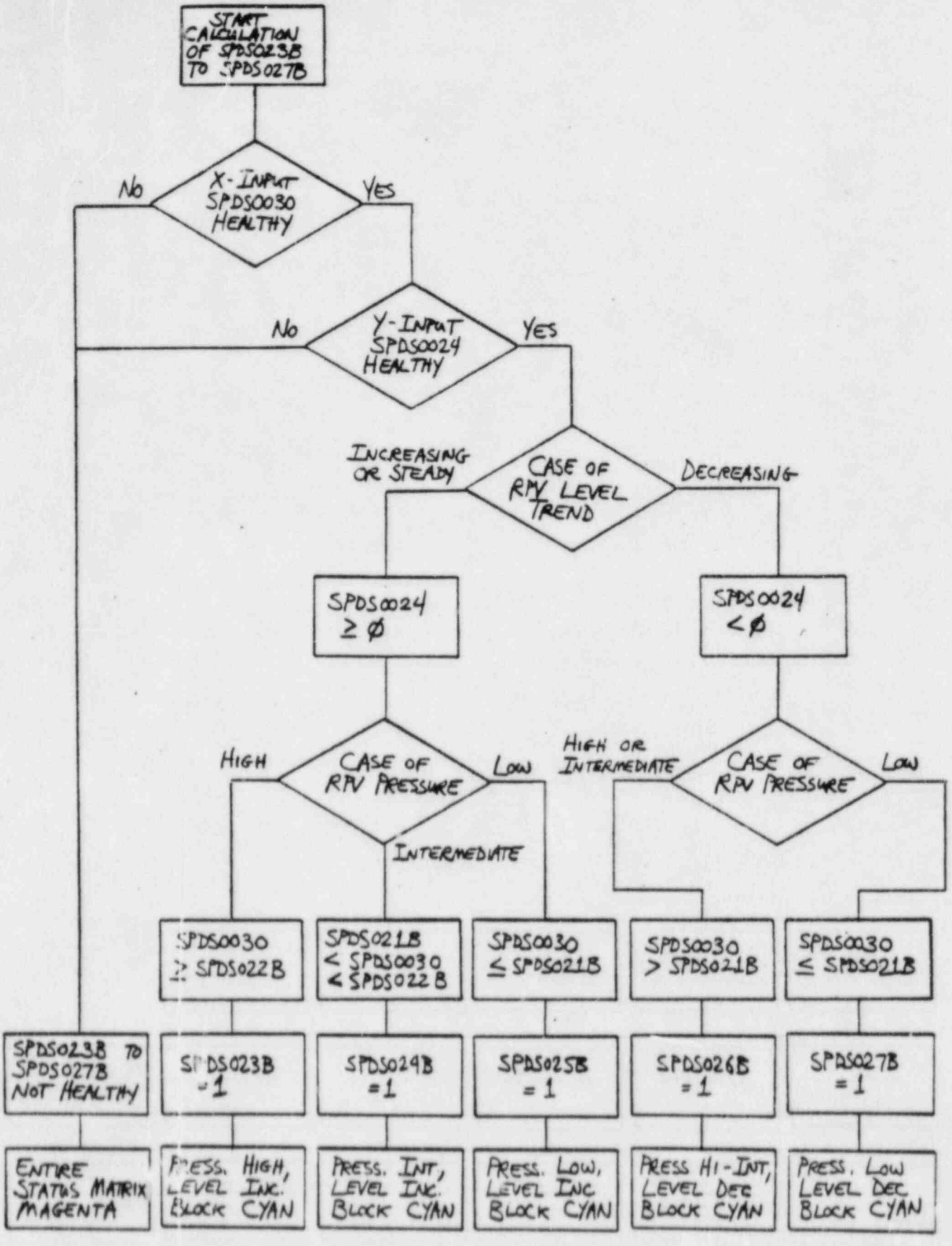


Figure 9-24. Processing Logic for Points SPDS023B to SPDS027B and Operation of the RPV Pressure/Level Status Matrix.

# 10. SUMMARY

The preceding sections provide detailed information on the format, content, and operation of the SPDS displays developed for the Cooper Nuclear Station. A summary of the information available in each SPDS display is presented in Table 10-1.

# Table 10-1. Summary of Plant Information Contained in CNS SPDS Displays.

| Display ID | Type | Plant Variables Displayed As Bars, Trends, or X-Y Plots[1] | Additional Plant Variables[2] | Safety Function Indicators[3] | Equipment Status Indicators[3] | EOP Limit Status Indicators[3] |
|---|---|---|---|---|---|---|
| L1.0 | Bar | APRM<br>RPV pressure<br>RPV level (NR)<br>Drywell pressure (NR) | None | Reactivity Control<br>Core Cooling<br>Coolant System Integrity<br>Containment Integrity<br>Radioactive Release | Reactor scram<br>All-rods-in | RPV saturation temp lim |
| L2.1.1 | Bar | APRM<br>SRM | None | Same as above | All APRM DNSC trip<br>Any APRM upscale<br>Any APRM inoperative<br>Any APRM bypassed<br>SRM position<br>Any SRM upscale<br>Any SRM inoperative<br>Any SRM bypassed<br>Reactor scram status<br>All-rods-in | None |
| L2.1.2 | Trend | Same as L2.1.1 | None | Same as above | Same as L2.1.1 | None |
| L2.2.1 | Bar + Mimic | RPV level (NR,3 channels)<br>(WR,2 channels)<br>(FZ,2 channels)[4]<br>(mimic) | RPV pressure | Same as above | SRV status<br>MSIV status | NPSH lim<br>RPV saturation temp lim |
| L2.2.2 | Trend | RPV level (WR avg)<br>(FZ avg) | Same as L2.2.1 | Same as above | Same as L2.2.1 | Same as L2.2.1 |

## Table 10-1. Summary of Plant Information Contained in CNS SPDS Displays (continued).

| Display ID | Type | Plant Variables Displayed As Bars, Trends, or X-Y Plots[1] | Additional Plant Variables[2] | Safety Function Indicators[3] | Equipment Status Indicators[3] | EOP Limit Status Indicators[3] |
|---|---|---|---|---|---|---|
| L2.3.1 | Bar | RPV pressure<br>Drywell pressure (MR)<br>Containment radiation | None | Reactivity Control<br>Core Cooling<br>Coolant System Integrity<br>Containment Integrity<br>Radioactive Release | Isolation demand (groups 1 to 7)<br>SRV status<br>MSIV status<br>Drywell sump pump | None |
| L2.3.2 | Trend | Same as L2.3.1 | None | Same as above | Same as L2.3.1 | None |
| L2.4.1 | Bar | Drywell pressure (MR)<br>Drywell temperature (max)<br>Supp pool temperature (avg)<br>Supp pool water level (WR) | None | Same as above | Isolation demand (groups 1 to 7) | Heat cap temp lim<br>Heat cap level lim<br>Supp pool load lim<br>Cont press lim<br>Drywell spray lim<br>Drywell $H_2$ lim<br>Drywell $O_2$ lim |
| L2.4.2 | Trend | Drywell pressure (MR)<br>Drywell temperature (max)<br>Supp pool temperature (avg) | None | Same as above | Same as L2.4.1 | Same as L2.4.1 |
| L2.4.3 | Mimic | Supp pool temperature bars (8 sector average readings) | Supp pool temp (avg)<br>Supp pool temp ROC<br>RPV pressure<br>RPV pressure ROC | Same as above | SRV "A" to SRV "H" valve position<br>SV "A" to SV "C" valve position<br>HPCI pump<br>RCIC pump | Heat cap temp lim<br>Heat cap level lim<br>Supp pool load lim<br>Supp Chbr $H_2$ lim[4]<br>Supp Chbr $O_2$ lim |

Table 10-1. Summary of Plant Information Contained in CNS SPDS Displays (continued).

| Display ID | Type | Plant Variables Displayed As Bars, Trends, or X-Y Plots[1] | Additional Plant Variables[2] | Safety Function Indicators[3] | Equipment Status Indicators[3] | EOP Limit Status Indicators[3] |
|---|---|---|---|---|---|---|
| L2.5.1 | Bar | ERP effluents<br>AOG & RW effluents<br>Rx bldg effluents<br>Turb bldg effluents<br>SJAE effluents | None | Reactivity Control<br>Core Cooling<br>Coolant System Integrity<br>Containment Integrity<br>Radioactive Release | None | None |
| L2.5.2 | Trend | ERP effluents<br>AOG & RW effluents<br>Rx bldg effluents | None | Same as above | None | None |
| L2.5.3 | Trend | Turb bldg effluents<br>SJAE effluents | None | Same as above | None | None |
| L3.1 | X-Y | RPV pressure<br>Supp pool temperature (avg) | None | Same as above | None | None |
| L3.2 | X-Y | Delta T heat capacity<br>Supp pool water level (WR) | None | Same as above | None | None |
| L3.3 | X-Y | RPV pressure<br>Supp pool water level (WR) | None | Same as above | None | None |
| L3.4 | X-Y | Containment water level (WR)<br>Drywell pressure (MR) | None | Same as above | None | None |

Table 10-1. Summary of Plant Information Contained in CNS SPDS Displays (continued).

| Display ID | Type | Plant Variables Displayed As Bars, Trends, or X-Y Plots[1] | Additional Plant Variables[2] | Safety Function Indicators[3] | Equipment Status Indicators[3] | EOP Limit Status Indicators[3] |
|---|---|---|---|---|---|---|
| L3.5 | X-Y | Drywell pressure (MR)<br>Supp pool temp (avg) | None | Reactivity Control<br>Core Cooling<br>Coolant System Integrity<br>Containment Integrity<br>Radioactive Release | None | None |
| L3.6 | X-Y | Drywell pressure (MR)<br>Drywell hydrogen conc.<br>Drywell oxygen conc. (max) | None | Same as above | None | None |
| L3.7 | X-Y | Drywell pressure (MR)<br>Torus hydrogen conc.[4]<br>Torus oxygen (conc.) | None | Same as above | None | None |
| L3.8 | X-Y | RHR loop A flow<br>RHR loop B flow<br>Supp pool temp (avg) | Drywell pressure (MR) | Same as above | RHR pump 1A<br>RHR pump 1B<br>RHR pump 1C<br>RHR pump 1D | None |
| L3.9 | X-Y | Core spray A flow<br>Core spray B flow<br>Supp pool temp (avg) | Drywell pressure (MR) | Same as above | CS pump 1A<br>CS pump 1B | None |
| L3.11 | X-Y | RPV pressure<br>Drywell temperature (max) | None | Same as above | None | None |

Table 10-1. Summary of Plant Information Contained in CNS SPDS Displays (continued).

| Display ID | Type | Plant Variables Displayed As Bars, Trends, or X-Y Plots[1] | Additional Plant Variables[2] | Safety Function Indicators | Equipment Status Indicators[3] | EOP Status Indicators[3] |
|---|---|---|---|---|---|---|
| L3.12 | X-Y (Static) | None | None | Reactivity Control<br>Core Cooling<br>Coolant System Integrity<br>Containment Integrity<br>Radioactive Release | None | None |
| L3.15 | Matrix | None | RPV level (WR)<br>RPV level ROC<br>RPV pressure<br>RPV pressure ROC | Same as above | RHR pump 1A<br>RHR pump 1B<br>RHR pump 1C<br>RHR pump 1D<br>CS pump 1A<br>CS pump 1B<br>HPCI pump<br>RCIC pump | RPV pressure high/RPV level increasing<br>RPV pressure int/RPV level increasing<br>RPV pressure low/RPV level increasing<br>RPV pressure hi-int/RPV level decreasing<br>RPV pressure low/RPV level decreasing<br>RPV saturation temp |

Notes: (1) NR = narrow range, WR = wide range, FZ = fuel zone range, MR = mid-range;

(2) Only current values appear in the display;

(3) Status indicators are described in Sections 5 and 6;

(4) This feature is not operational because data to drive this feature is not available on PMIS.