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DENTON,H.R. Office of Nuclear Reactor Regulation, Director
STOLZ,J.F. Operating Reactors Branch 4

SUBJECT: Forwards addl info on safety parameter display sys re isolation devices,human factors program,sys description supporting displays,task analysis & data validation programs,per 840914 request re Suppl 1 to NUREG-0737.

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October 18, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. John F. Stolz, Chief
Licensing Branch No. 4

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287

Dear Mr. Denton:

In a letter dated September 14, 1984, the NRC provided the results of a review of the Oconee Safety Parameter Display System submittal and requested that Duke respond to several items identified during the review. The Duke response for Oconee is contained in the attachment to this letter.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

JSW:slb

Attachment

cc: Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
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101 Marietta Street, NW, Suite 2900
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Mr. J. C. Bryant
NRC Resident Inspector
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A003 1/1

DUKE POWER COMPANY

OCONEE NUCLEAR STATION

RESPONSES TO NRC REQUESTS
FOR ADDITIONAL INFORMATION
ON THE SAFETY PARAMETER DISPLAY SYSTEM
October 18, 1984

The Safety Parameter Display System (SPDS) has been designed and developed for the Oconee Operator Aid Computer (OAC) systems. The existing OAC systems are being upgraded with the installation of new Honeywell 45000 central processing units, dot addressable color-graphic CRT's, and additional input capacity to provide computing capability needed to implement the SPDS as well as other enhancements. The existing computer input systems are being retained. The installation of this equipment is currently in progress on unit 3 (scheduled completion in November 1984) with installations on units 1 and 2 scheduled to be completed in January 1985 and July 1985 respectively.

INSTRUMENTATION AND CONTROL SYSTEMS INFORMATION

Isolation Devices

a. For each type of device used to accomplish electrical isolation, describe the specific testing performed to demonstrate that the device is acceptable for its application(s). This description should include elementary diagrams when necessary to indicate the test configuration and how the maximum credible faults were applied to the devices.

b. Data to verify that the maximum credible faults applied during the test were the maximum voltage/current to which the device could be exposed, and define how the maximum voltage/current was determined.

c. Data to verify that the maximum credible fault was applied to the output of the device in the transverse mode (between signal and return) and other faults were considered (i.e., open and short circuits).

d. Define the pass/fail acceptance criteria for each type of device.

e. Provide a commitment that the isolation devices comply with the environmental qualifications (10CFR 50.49) and with the seismic qualifications which were the basis for plant licensing.

f. Provide a description of the measures taken to protect the safety systems from electrical interference (i.e., Electrostatic Coupling, EMI, Common Mode and Crosstalk) that may be generated by the SPDS.)

Response:

The Oconee SPDS uses operator aid computer inputs which were primarily provided as part of the original plant design and utilize previously NRC - reviewed electrical isolation techniques, as described in Oconee FSAR Section 7.2.3.3. Incorporation of existing OAC inputs into the SPDS, therefore, introduces no additional exposure, challenges, or failure modes to safety system interfaces. The existing OAC computer systems have been in service since the initial startups of the Oconee units and have provided high levels of availability. Similarly, the OAC's input system and its interfaces to the field have been reliable and have never caused any interference to the safety systems. As such Duke Power does not feel it is necessary to provide the volumnous information required to respond to the above questions. The SPDS utilizes existing computer input systems which are connected to plant safety equipment through isolation devices and techniques which meet or exceed the requirements in effect during the design of the plant.

HUMAN FACTORS ENGINEERING INFORMATION

Human Factors Program

(Provide a description of the display system, its human factored design, and the methods used and results from a human factors program to ensure that the displayed information can be readily perceived and comprehended so as not to mislead the operator.)

SPDS System Description

The SPDS provides the control room operators with an overview of the station operation during all normal and emergency operating conditions through the monitoring of six Critical Safety Functions as determined by Duke Power to be appropriate for the Oconee units:

a. Subcriticality
b. Inadequate Core Cooling
c. Heat Sink
d. Reactor Coolant Integrity
e. Containment Integrity
f. Reactor Coolant System Inventory

The SPDS display system to be installed at Oconee is as described in our response to supplement 1 to NUREG-0737. It was developed in house using over ten years experience in implementing colorgraphic plant computer display systems. Additional human factors guidance was obtained from various EPRI, NRC, and INPO documents.

The six critical safety functions will be displayed on the alarm video as shown on attachment one (1) and updated on a five second frequency. The status of each CSF can readily be determined from any location in the control room horseshoe area. The importance of the status for each function is defined by the color of the block for a particular CSF. Following is a description of the importance for each color.

1. Green - The critical safety function is satisfied and no operator action is required.

2. White - The CSF is not fully satisfied and operator action may eventually be needed.

3. Yellow - The CSF is not satisfied and operator action is required.

4. Orange - The CSF is under severe challenge and prompt operator action is necessary.

5. Red - The CSF is in jeopardy and immediate operator action is required.

6. Magenta - Safety function is indeterminate due to an invalid input.

During normal operation the six blocks should be green and non-blinking. If a status should change to any other condition, the change will be alarmed on the alarm video as well as documented on the alarm typer, and the appropriate function block will begin to blink and remain blinking until the condition returns to normal or is acknowledged. If a function block is already in alarm and the status changes to any other alarm condition, the block will change to the new status color, remain or begin blinking, and the change will be alarmed on the alarm video as will as documented on the alarm typer.

Supporting Displays

In addition, supporting displays have been implemented on the OAC (plant computer) to provide the operator, shift technical advisor, and shift supervisor with additional levels of detail to allow them to determine the exact nature and causes of SPDS alarms. These supporting displays include status trees which indicate the status and condition of plant systems with true paths automatically highlighted. Additionally, alpha-numeric display lists and SPDS alarm logic displays are provided to allow the operator, shift technical advisor, and shift supervisor to determine which plant field inputs are in alarm and thereby causing the CSF to be in alarm.

Other operator aid computer CRT displays are available to the operator, STA, and shift supervisor such as saturation monitor, alarm summary table, systems input lists, etc. for their use in monitoring plant systems status.

Human Factors Review Program

The SPDS and supporting displays will be reviewed by members of the Control Room Review Team which had been trained on human factors. This review team also contained a human factors engineering consultant.

A human factors survey of the SPDS and secondary supporting displays as implemented on the actual SPDS hardware (keyboards and CRT displays) will be performed. During the survey the CRT displays and operator keyboard will be used to call-up, observe, and review each separate display. In addition, the displays will be reviewed during a simulated alarm condition.

The survey will evaluate the format and arrangement of the displays and the operator keyboard interface using applicable survey principles from the Control Room Survey Principles Checklist which was derived from NUREG-0700 for use in the Control Room Design Review. These principles covered areas, such as, color usage, character heights, room lighting and glare, presentation of data, labels and coding, operator message presentation, and the arrangement and use of the operator keyboard interface.

Task Analysis

The task analysis activity of the SPDS human factors evaluation will be conducted using actual SPDS display system hardware (CRT displays and operator keyboard). An event scenario will be developed using the plant emergency procedures and the B&W ATOG guidelines. The scenario will provide an ordered framework of a set of possible responses to an initiating event against which the system can be evaluated.

Plant parameter inputs to the SPDS logic will be identified from the event scenario, and values for these parameters to represent plant conditions for selected time intervals during the duration of the scenario, will be developed. These values will then be used as simulated plant parameter inputs during a walk-through of the event scenario.

The walk-through will be performed by a senior reactor operator and an instrumentation and controls engineer. During the walk-through, the operator will perform the task actions required while the engineer serves as observer.

The usability and effectiveness of the displays will be evaluated using a set of pre-selected task analysis principles. These principles will cover such items as logical ordering of displays, terminology and abbreviations, labeling, coding, usability of displayed information, and operator task support. In general, the task analysis activity will evaluate the SPDS and supporting displays to determine if the displays provide a logical, readily usable format to support the following operator tasks:

- Monitor Critical Safety Function Status (CSF)
- Observe CSF status changes
- Determine which CSF is degraded
- Determine severity of degradation
- Identify component/functional area out-of-tolerance
- Determine which confirming displays and restoration procedures to use
- Monitor restoration progress
- Monitor remaining CSF status during restoration

Results

The results from both the task analysis activity and the human factors survey will be documented in the form of recommendations for design changes to the SPDS and secondary supporting displays. These recommendations will be resolved and implemented as necessary to ensure that the SPDS and supporting displays and the operator keyboard interface produce readily usable and easily comprehended information, in an effective format to support operator task requirements.

DATA VALIDATION

(Describe the specific methods used to validate data displayed in the SPDS. Also describe how invalid data is defined to the operator.)

The logic which drives the SPDS display utilizes redundant inputs on critical parameters where available. These inputs are logically combined to provide conservative alarming, such that the tendency will be toward more alarms. However, maintenance programs provide high levels of availability for SPDS inputs. Further, each computer analog input is continuously monitored for over and under range conditions, scan lockout, and out of service status. Digital input power fuses are monitored. The SPDS logic is designed such that any failed input as monitored above is considered by the SPDS and indeterminate status is displayed to the operator.

When an input involving a function becomes invalid (blown fuse, over/under ranged, out of service, etc.) but the CSF status can still be determined from the remaining inputs, an alarm indicating an invalid input for the particular function affected will be displayed and documented.

If the invalid input affects the determination of the status, the above alarm will be output along with a second alarm indicating the particular CSF affected is indeterminate. Also, the affected CSF block will change to magenta indicating an indeterminate condition and remain in this state until the invalid input can be corrected or until the input is locked out to a known valid value or status. If the CSF's status should change to one in which the input does not affect determination, then the CSF block will change to the appropriate color for that status.

Ongoing Data Validation Programs

Sensor signal validation in nuclear power plants has been historically confined to limit checks on individual sensors, averages of redundant sensors, or the detection of outlyers among a group of redundant sensors. Duke Power is currently working closely with other utilities on a Utility Advisory Group formed to provide project direction to EPRI Research Project RP-2292-1, "Validation and Integration of Critical PWR Signals". The purpose of the project is to develop a methodology and a system of computer software for on-line validation of signals for use in nuclear power plants. The project scope is specifically aimed at validation of signals which input to a Safety Parameter Display System.

Using advanced signal validation techniques developed in previous EPRI projects, the specific objectives of this project are to develop, qualify, and field test a set of software modules for the validation and integration of SPDS signals. The signal validation software will provide a validated signal, associated quality tag, and error message for each signal (variable). Where sufficient physically redundant instrumentation is available, simple algorithms to combine the signals to produce the best estimate of the variable will be provided. When physically redundant instrumentation is not available, the signals are validated using analytic redundancy. Analytic redundancy uses available signals and component or system mathematical models to provide an estimate of the variable.

An important goal of the project as a whole is a high degree of utility involvement in the requirements definition, the system design review and test results review to insure that the project results will satisfy the needs of the utilities. Duke Power is hopeful that the project will produce practical signal validation techniques that potentially can be retrofitted into the Oconee Safety Parameter Display Systems.

IMPLEMENTATION PLAN

(Provide a schedule for full implementation of the SPDS including hardware, software, operator training, procedures and users manuals.)

The SPDS OPERATIONAL schedules proposed on page 2-6 of Duke Power's response to Supplement 1 to NUREG-0737, revision 1, submitted by H. B. Tucker's letter to H. R. Denton dated August 23, 1983, is still valid with milestones completed on or near schedule. The software has been completed, hardware for all three units have been received at Duke's corporate offices, hardware for unit 3 is currently being installed at the station. Some delay has been experienced in the installation of hardware at Oconee, however, unless unplanned problems occur during the computer hardware and software checkout phases, the SPDS will be implemented on schedule as proposed. Operator training and SPDS and supporting displays system descriptions have been completed.

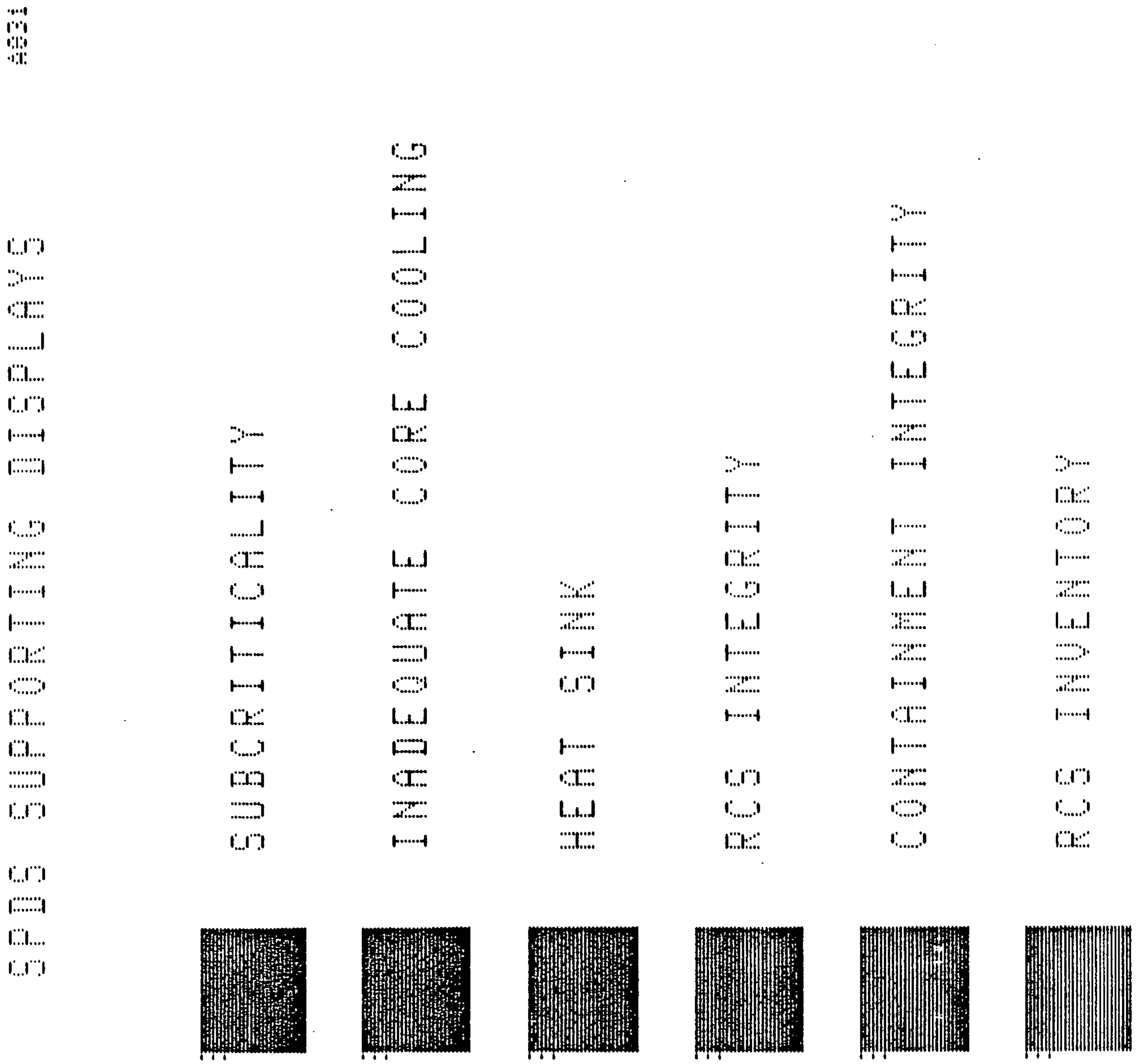
11:32:15 OCONEE STATION UNIT 3 09/19/84

ALRM	CPD050	SPDS ICC INVLD INP	TRUE	1
ALRM	CPD046	SPDS ICC WHITE	TRUE	1
ALRM	CPD042	SPDS RCS INTEG INVLD INP	TRUE	1
ALRM	CPD034	SPDS RCS INVEN INVLD INP	TRUE	1
ALRM	CPD032	SPDS RCS INVEN INDETER	TRUE	1
ALRM	CPD026	SPDS CONT INTEG INVD INP	TRUE	1
ALRM	CPD024	SPDS CONT INTEG INDETER	TRUE	1
ALRM	CPD018	SPDS HEAT SINK INVLD INP	TRUE	1
ALRM	CPD010	SPDS SUBCRIT INVLD INP	TRUE	1
ALRM	CPD008	SPDS SUBCRIT INDETER	TRUE	1

SUBCRIT ICC HEAT SINK RCS INTEG CONTAIN RCS INVEN

ATTACHMENT 1

FIGURE 2.1


A031
SPDS SUPPORTING DISPLAYS
SUBCRITICALITY
INADEQUATE CORE COOLING
HEAT SINK
RCS INTEGRITY
CONTAINMENT INTEGRITY
RCS INVENTORY

SUBCRITICALITY

A201

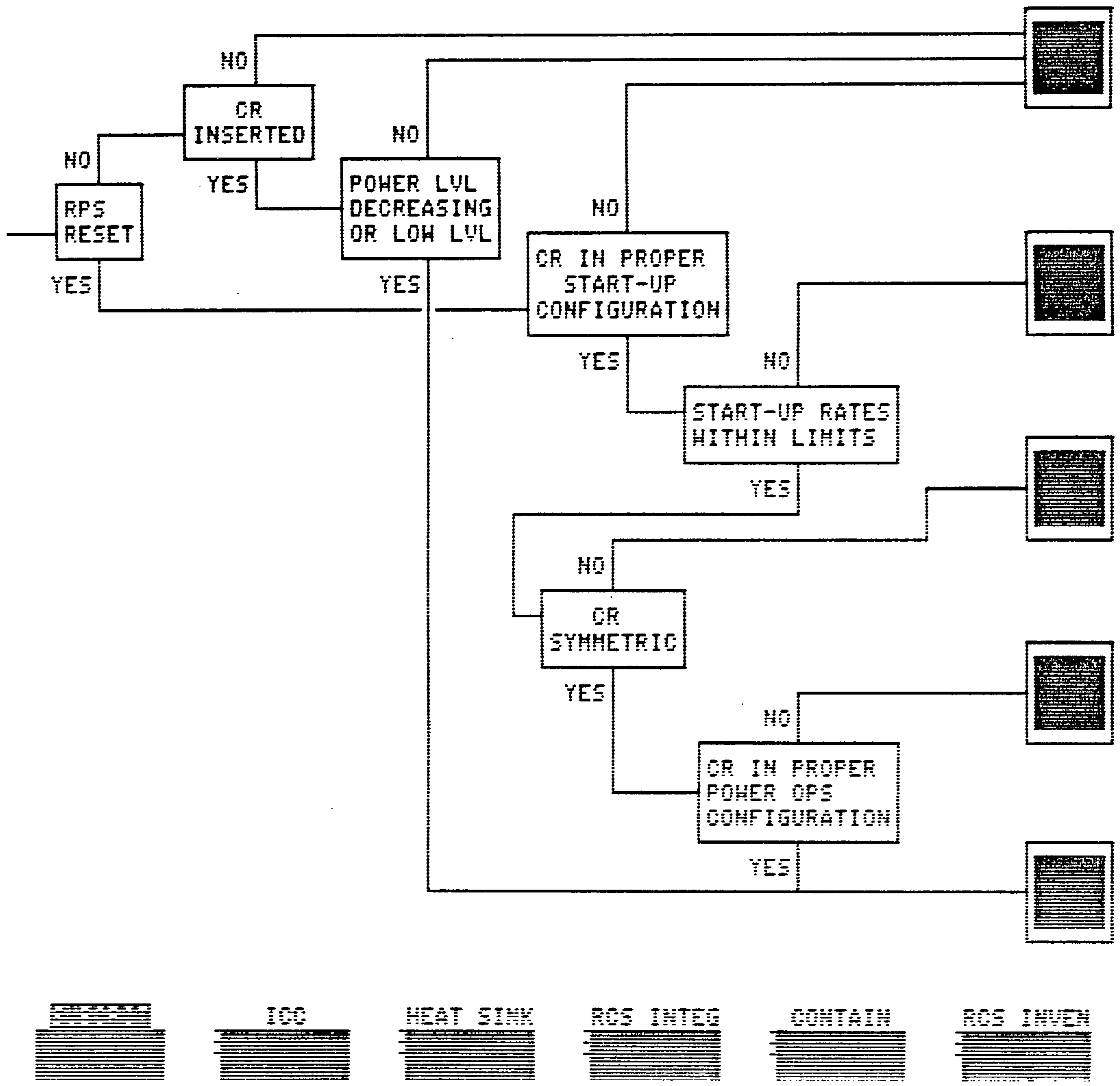


FIGURE 3.1

.30

INADEQUATE CORE COOLING

A286

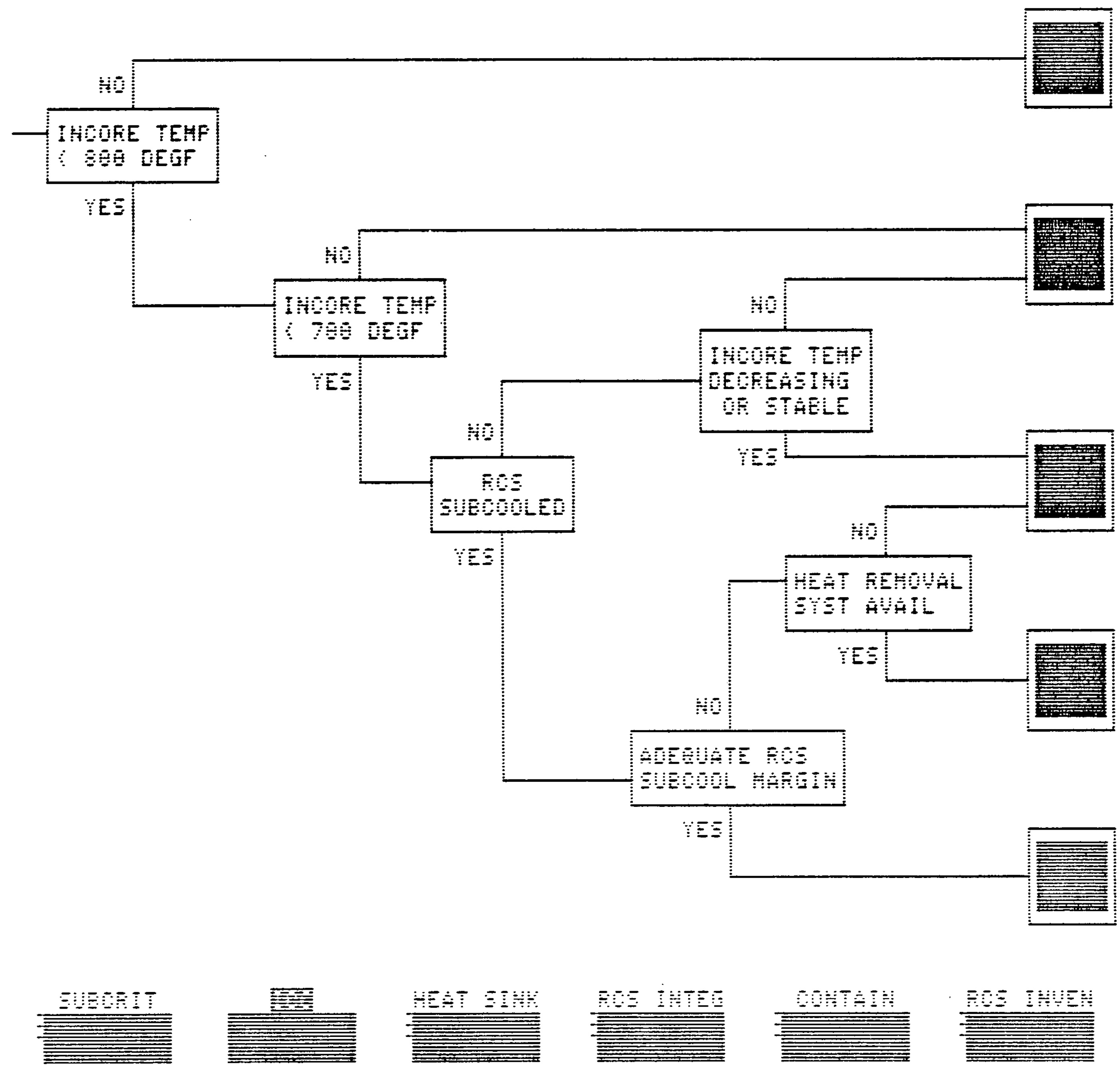


FIGURE 3.2

HEAT SINK

A211

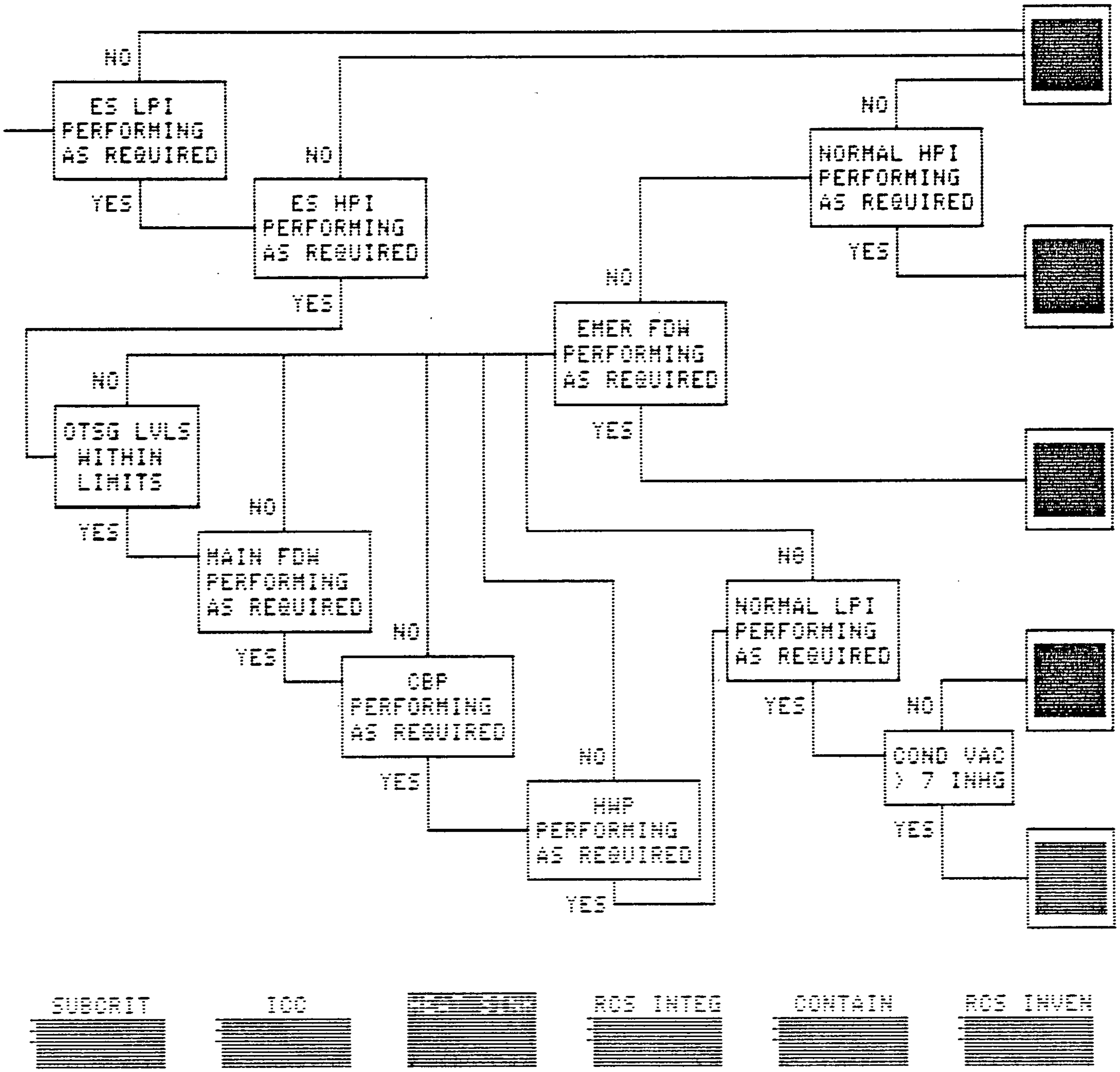
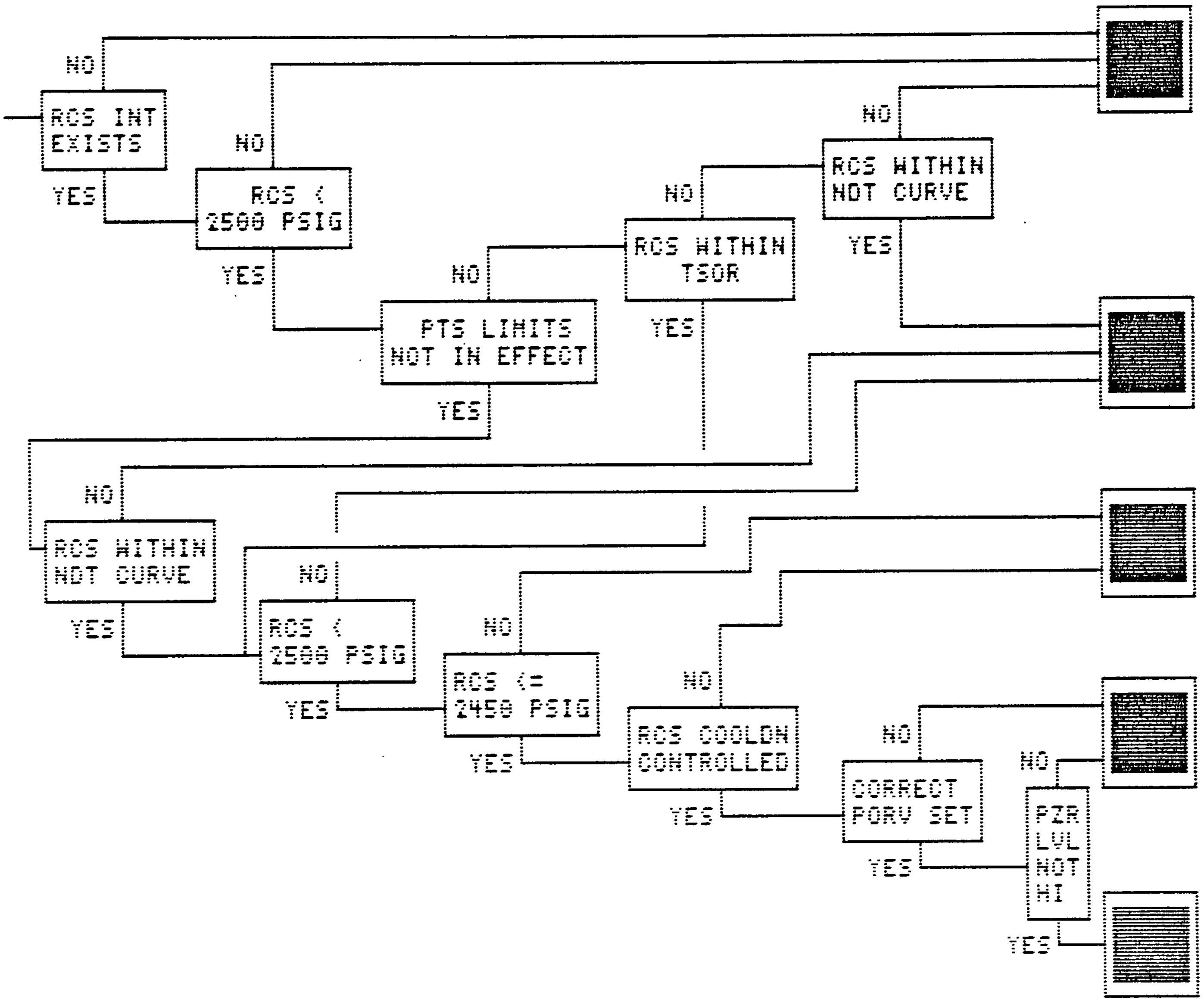


FIGURE 3.3

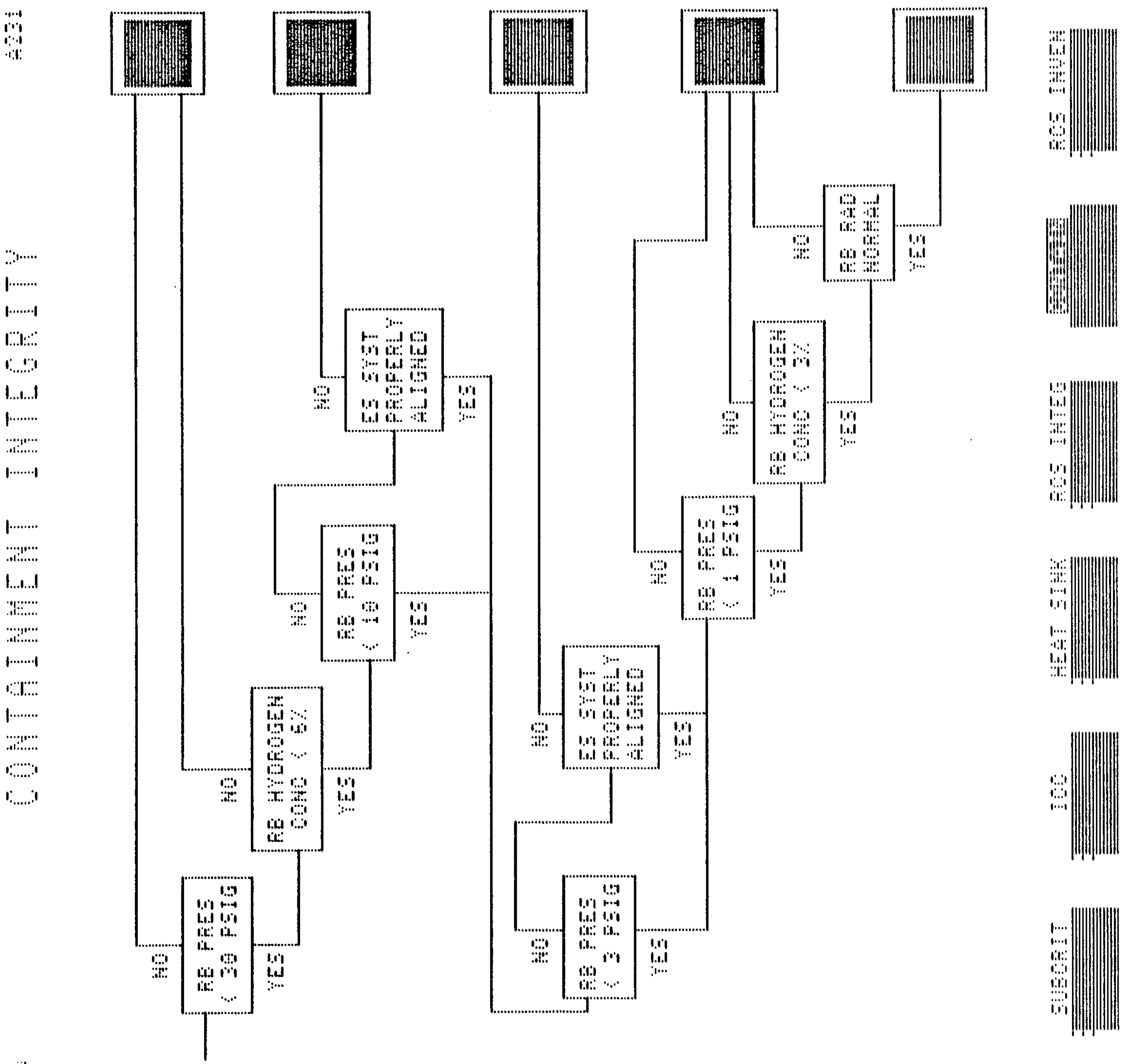
RCS INTEGRITY

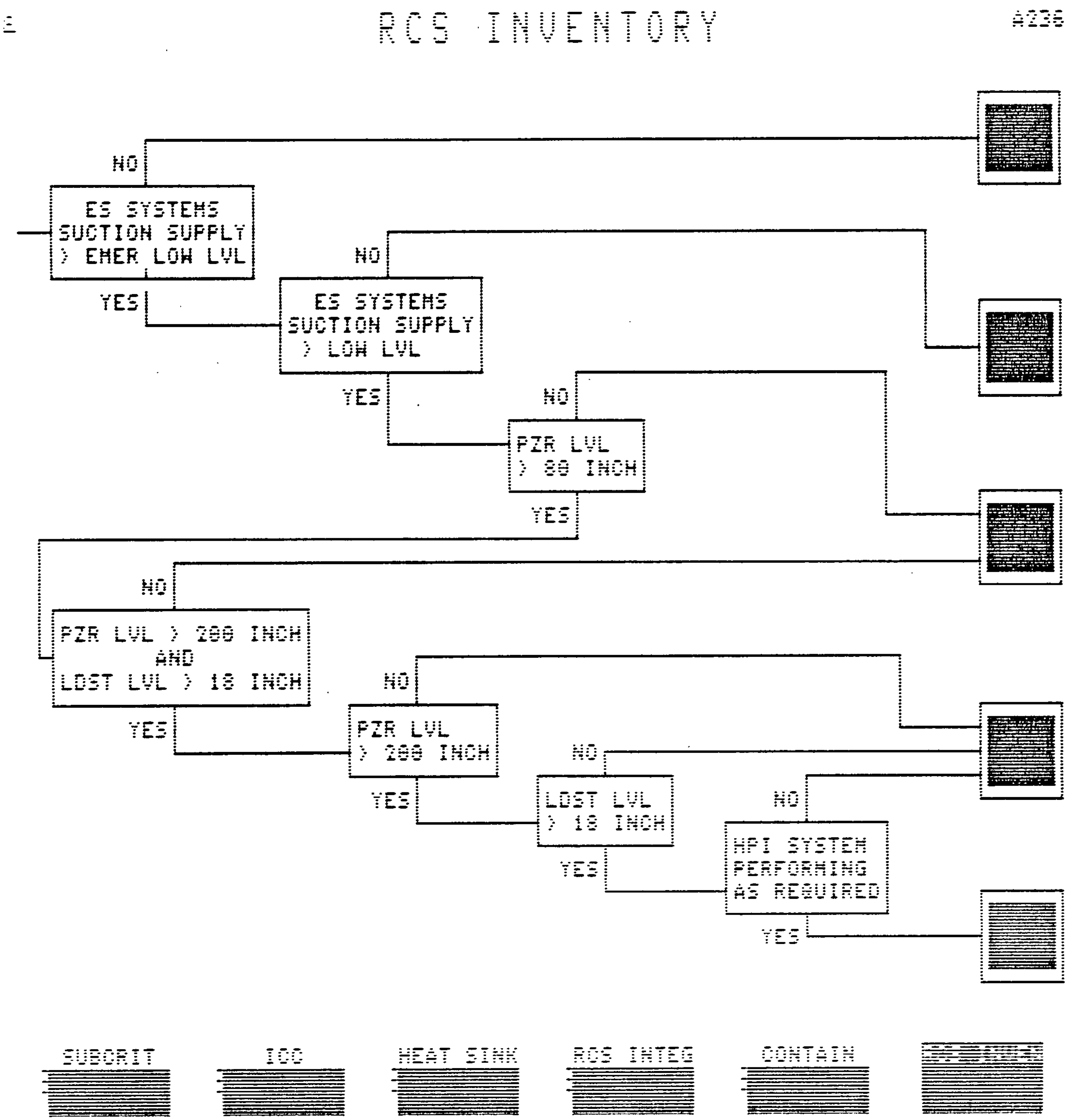


SUBCRIT | ICC | HEAT SINK | CONTAIN | RCS INVEN

FIGURE 3.4

FIGURE 3.5


CONTAINMENT INTEGRITY
RB PRES < 30 PSIG
RB HYDROGEN CONC < 6%
RB PRES < 10 PSIG
ES SYST PROPERLY ALIGNED
RB PRES < 3 PSIG
ES SYST PROPERLY ALIGNED
RB PRES < 4 PSIG
RB HYDROGEN CONC < 3%
RB RAD NORMAL
NO
YES
SUBCRIT
ICC
HEAT SINK
RCS INTEG
RCS INVEN



RCS INVENTORY
A236
ES SYSTEMS SUCTION SUPPLY > EMER LOW LVL
NO
YES
ES SYSTEMS SUCTION SUPPLY > LOW LVL
NO
YES
PZR LVL > 80 INCH
NO
YES
PZR LVL > 200 INCH AND LOST LVL > 18 INCH
NO
YES
PZR LVL > 200 INCH
NO
YES
LOST LVL > 18 INCH
NO
YES
HPI SYSTEM PERFORMING AS REQUIRED
NO
YES
SUBCRIT
ICC
HEAT SINK
RCS INTEG
CONTAIN

FIGURE 3.6