TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

March 1, 1985

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

| | | |
|---|---|---|
| In the Matter of | ) | Docket Nos. 50-327 |
| Tennessee Valley Authority | ) | 50-328 |

Enclosed is our response to your October 1, 1984 letter to H. G. Parris regarding additional information on the Sequoyah Nuclear Plant safety parameter display system (SPDS). The delay in submittal of this response was discussed with Carl Stahle of your staff. Previous information regarding the SPDS was provided to you by a January 4, 1984 letter from L. M. Mills.

If you have any questions concerning this matter, please get in touch with Jerry Wills at FTS 858-2683.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

R. H. Shell

R. H. Shell
Nuclear Engineer

Sworn to and subscribed before me
this 1st day of March 1985

L. Cheryl Clark
Notary Public
My Commission Expires 6/24/86

Enclosure
cc: U.S. Nuclear Regulatory Commission (Enclosure)
Region II
Attn: Dr. J. Nelson Grace, Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323



A001
1/1

ENCLOSURE

TVA RESPONSE TO NRC LETTER DATED OCTOBER 1, 1984
FROM E. ADENSAM TO H. G. PARRIS

REQUEST FOR INFORMATION ON THE SEQUOYAH NUCLEAR PLANT
SAFETY PARAMETER DISPLAY SYSTEM (SPDS)

The following attachments provide information in the areas identified by NRC:

Attachment 1 - SPDS Isolation Devices

Attachment 2 - SPDS Description

Attachment 3 - SPDS Verification and Validation Program

Attachment 4 - Unreviewed Safety Questions

Attachment 5 - Implementation Schedules

ATTACHMENT 1

SEQUOYAH NUCLEAR PLANT

SPDS ISOLATION DEVICES

The Safety Parameter Display System (SPDS) computer included points run from the instruments and inputs wired from the input of the plant process computer to the SPDS computer. Since isolation of inputs to the plant process computer was part of the design considerations prior to the installation and startup of that system and have not been affected by the SPDS installation, the information on isolation devices is supplied for the 28 devices installed solely for the SPDS computer.

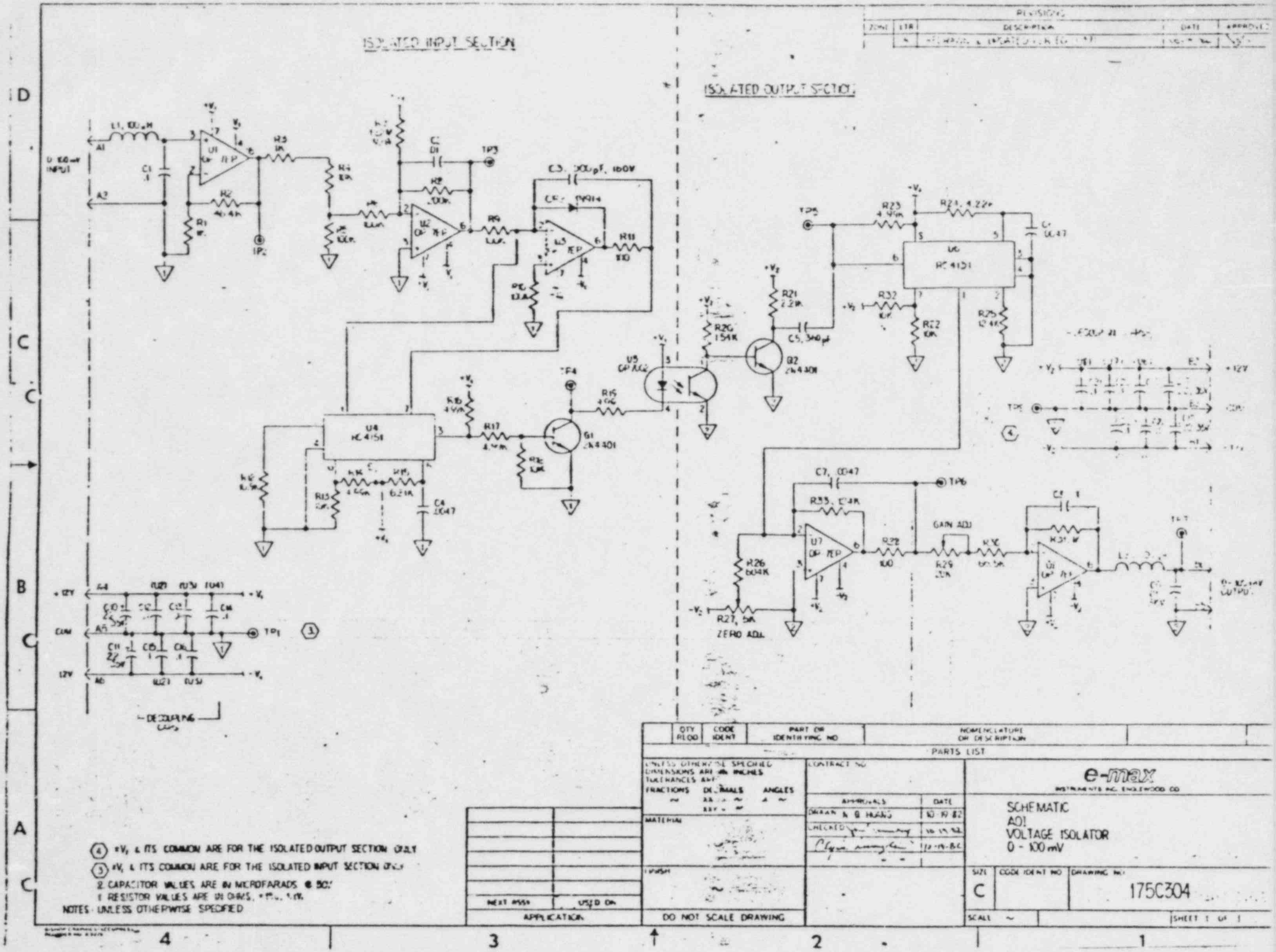
The following information on the isolation devices is given in the same order as paragraphs a through f in reference 1.

Paragraph a. Testing performed to demonstrate that the device is acceptable for its application.

The electrical isolator associated with this particular request is a 0 to 100 MV range (input to output), E-Max Instruments, Inc., model No. 175C304. The application calls for a device capable of providing electrical isolation of a low-level 0-100 MV load. The device must perform this isolation at all times--before, during, and after the design basis event; it does not need to maintain signal continuity during or after these events. Verification that this device is acceptable and qualified for the installed application is demonstrated by tests in the area of seismic, electrical, environmental, and EMI parameters.

An internal schematic diagram for the model 175C304 isolator, E-Max drawing 175C304, and the test procedure are attached for reference. This drawing shows the electrical input is completely isolated electrically from the output and that coupling to maintain continuity of the information signal is accomplished by means of optical isolation. The optical isolation provides a 1/4-inch physical clearance between the input and output electrical circuitry.

E-Max Test procedure covering electrical tests of the 175D304 device is attached to show integration of factory test fixture and module being tested.


ISOLATED INPUT SECTION
ISOLATED OUTPUT SECTION
0-100mV INPUT
0-100mV OUTPUT
C3, 300pF, 100V
GAIN ADJ
ZERO ADJ
DECOUPLING CAPS
NOTES: UNLESS OTHERWISE SPECIFIED
1 RESISTOR VALUES ARE IN OHMS
2 CAPACITOR VALUES ARE IN MICROFARADS
3 -V, & ITS COMMON ARE FOR THE ISOLATED INPUT SECTION ONLY
4 +V, & ITS COMMON ARE FOR THE ISOLATED OUTPUT SECTION ONLY
PARTS LIST
DO NOT SCALE DRAWING
APPLICATION
NEXT ASSY
USED ON
DRAWN K B HUANG 10-19-82
e-max
SCHEMATIC
A01
VOLTAGE ISOLATOR
0 - 100 mV
SIZE C
175C304
SHEET 1 OF 1

-max
struments, Incorporated
Inverness Drive East (1-H)
glewood, Colo. 80112
3) 773-6640 TLX 45657

APPROVED
This approval does not relieve the Contractor from any part of his responsibility for the correctness of design, details and dimensions.
TENNESSEE VALLEY AUTHORITY
Date SEP 21 1982
F. W. CHANDLER

# TEST PROCEDURE

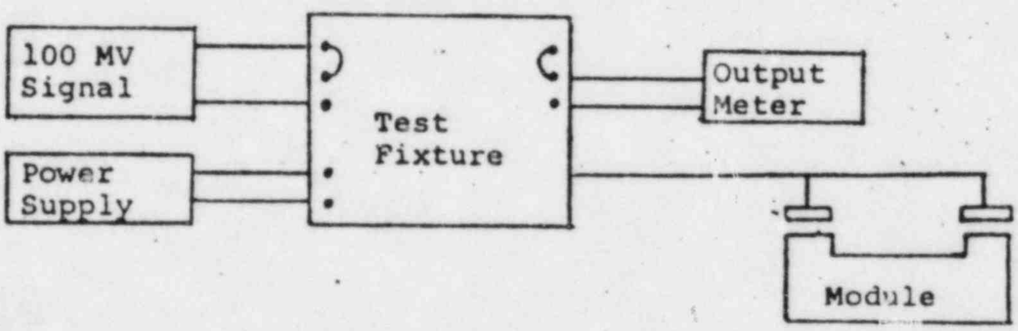
## ANALOG OPTICAL ISOLATOR, VOLTAGE
## P/N 175D304

A. Test Equipment Required:

1 ea. E-MAX Test Fixture
1 ea. Scope - Tektronix T932A or equivalent
1 ea. Counter - HP5232A or equivalent
1 ea. Signal Generator - Wavetek 180 or evuivalent
1 ea. DVM - Keithly 177 or evuivalent
1 ea. Hypot Tester 0-3 kV AC
1 ea. 100 mV DC Source

B. Procedure

1. Set up the test fixture as shown:




a. Set signal generator to output a 10 Hz square wave, 10 Volts peak-to-peak from 0V to 10V.

b. Set Voltage/Current switch to voltage.

c. Source select to external

d. Range select to maximum.

e. Common mode switch to common mode position.

2. Apply power to the module to be tested.

3. Measure the ± 12 Volt supplies for the input and output sections. They should be 12V ± .5V.

4. Adjust R2 to minimize the signal seen on the scope at TP2 using TP1 as scope ground.

5. Set the test fixture switches as below:

   a. Turn cc[illegible]on mode switch to normal.

   b. Turn source select to +V.

   c. Turn range select to ØV.

6. Observe TP7 with DVM. Set TP7 to zero Volts ± .1V MVDC using R25. Use TP8 as ground.

7. Observe the output on the oscilloscope. The noise should be less than .5MV P-P.

8. Set the range select switch to 100MV and measure the input at test points A and C. Set the input level to +100MV using input level adjust pot.

9. Measure the output at TP7 and adjust the voltage to be the same as the input ± .10 MV using R21.

10. Switch source select to external, set signal generator to sine wave and measure input at points A and C. Adjust level to 100MV peak.

11. Observe the output on the oscillograph. Observable distortion or excessive noise are reasons to fail the unit.

12. Recheck zero and gain adjustments and redo steps 6 through 11 if necessary.

C. Hypot Test

1. Connect together A1 through A 6 and B1 through B6.

2. Hypot between A1-6 and B1-6 at 2500V AC for one minute.

D. Aging

1. Install the module in a cabinet and run under load a minimum of 168 hours at 140°F. The unit should have a 100MV input and the output loaded with a 1 meg. resistor.

2. Retest for zero and full scale gain as in steps 6 through 11 of the procedure. Zero should be within ± .2MV, gain within ± .2MV. If adjustments are necessary for the unit to be within specifications, the unit has failed and must begin all tests over again.

E. Acceptance

1. The module shall pass all the above tests prior to acceptance. Should it fail at any time, it must begin all tests at the beginning.

2. All failures shall be logged by serial number in the log. An MIR form shall be used to reject all non-conforming materials.

Paragraphs b and c. Data to verify maximum credible faults.

The concerns addressed in the reference, paragraphs b and c, involve possible electrical faults on the output terminals of the device. The maximum credible fault that the device could see would be 120 volt ac supply power in the SPDS and isolator module cabinets.

Since our design provided for all signal leads to be routed through conduit with only signal leads and to be terminated on dedicated terminal blocks in the cabinets, a fault involving both a power source hot and common lead being applied directly to the output signal and return lead is virtually impossible. Therefore, no requirement or test for this event was specified in our qualification requirements. Our requirements were for electrical isolation between input-output circuitry, and test results verified there is a minimum of 2,500 V RMS isolation between the input and output terminals. This test further demonstrated that a short or open circuit on the output signal terminals could not affect the input side since each side of the isolator is supplied operating power from separate sources. This precludes a fault on the output source affecting the input source.

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

Acceptance criteria dictated that the devices provide electrical isolation for an electrical signal having a range of 0-100 MV dc. The accuracy of the signal must be maintained within 0.5% full scale from input to output during normal operating conditions. Electrical isolation between input and output circuitry was to be demonstrated by applying 2,500 V RMS 60 Hz for one minute. The criteria required that the device not degrade or affect any 1E device associated with the input signal source during normal operation or during any design basis event referenced in paragraphs e and f. There is no requirement for the device to maintain signal continuity and accuracy during or after a design basis event. If the device did not maintain signal accuracy requirements and electrical capability during the test for normal operating conditions, it would be determined that the device had failed. Had the input side of the isolator been affected by any normal or abnormal event in such a way as to degrade the input source devices, the test would have been determined a failure.

Paragraph e. Environmental and seismic qualifications.

The equipment is located in a mild environment and certification by the supplier documents qualification of the devices for the following environmental conditons.

The abnormal conditons could exist for up to 8 hours per excursion and will occur less than 1% of the plant life.

Environmental Conditions:
Normal-Temperature: Maximum 75, minimum 75, average 75°(F)
-Pressure: Atm (+)
-Relative Humidity: Maximum 60, minimum 40, average 50 (%)
-Radiation: $5x10^2$(RADS), TID 40 year
-Vibration: Seismic Category I (Active)

Abnormal-Temperature: Maximum 104°F, minimum 60°F
-Pressure: Atm (+)
-Relative Humidity: Maximum 60, minimum 10 (%)
-Radiation: N/A
-Vibration: Seismic Category (Active)

Accident-Temperature
-Pressure:
-Relative Humidity: N/A
-Radiation:
-Caustic Spray:

Verification that the Sequoyah E-Max electrical isolator assembly complies with seismic qualification, which was the basis for plant licensing, is demonstrated by these seismic qualification tests. One test was performed on the type of isolator installed at Sequoyah and the other test was performed on cabinet assemblies for TVA's Bellefonte Nuclear Plant. The test reports are applicable to the Sequoyah installation since the cabinets are generic in nature. Test response spectra generated during the seismic test of the isolator and the cabinet assembly show the response spectra of the isolator to envelope that of the cabinet assembly. The response spectra of the cabinet envelopes that of the required floor response spectra of the installation. Therefore, the two seismic qualification test reports referenced herein demonstrate seismic qualification of the isolator assembly as installed at Sequoyah.

Seismic qualification for the isolator module is documented in Engineering Dynamics Seismic Qualification Report for E-Max Analog Voltage Isolator P/N 175C304 dated October 27, 1982. Seismic qualification for the cabinet assembly is documented in Wyle Laboratories' Report No. 58430 for E-Max isolator cabinets P/N 17502020-200 and P/N 17502020-300 dated October 9, 1979. Both tests were conducted in accordance with IEEE Std 344-1975 entitled "Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations."

Testing of the module consisted of mounting the article on the shaker table at the test facility and subjecting the article to a resonance search and random excitation tests along three mutually perpendicular axes. The article was functionally energized during the tests.

The resonance search tests consisted of subjecting the test article to sinusoidal swept frequency excitation in the frequency range from 1 to 50 Hz. Below 5 Hz, the acceleration input level was limited by the table displacement and ranged from 0.1 g at 1 Hz to 2 g at 5 Hz. From 5 to 50 Hz, the table was maintained at a constant magnitude of 2 g. The relative magnitudes of the table input motion and test article excitation were recorded as the frequency of excitation swept from 1 to 50 to 1 Hz in each of three perpendicular axes.

The random excitation tests consisted of subjecting the test article to random table motion which is amplitude controlled in one-third octave increments from 1 to 40 Hz. The input spectrum was shaped such that the response spectra for OBE and SSE tests enveloped the required response spectra as specified in the Seismic Qualification Test Plan.

Random excitation tests consisted of five OBE tests and two SSE tests in each of three mutually perpendicular, principle axes.

The test article was functionally monitored prior to, during, and after completion of the tests. No interruption or change in the output voltage occurred as a result of resonance search or random excitation tests. The test article was visually inspected during testing and at the completion of tests, and no nonconformances were observed.

Testing of the isolator cabinets consisted of mounting the specimen on the shaker table and subjecting the specimen to a resonance search and random excitation tests along three mutually perpendicular axes.

A steady state sinusoidal resonance search was performed in each of the three mutually perpendicular axes. The resonance search was performed in the frequency range of 1 to 35 and back to 1 Hz with an input of 0.2 g. A frequency sweep rate of one octave per minute was used. One control and 10 response accelerometers were used to determine the resonance frequencies of the test specimens. The output of each accelerometer was recorded on a direct readout recorder.

The test specimens were subjected to a seismic random motion which was amplitude-controlled in one-third octave increments from 1.25 to 35 Hz. A 30-second recording of random signals was used as the input source. The input signal was tuned with a bank of parallel one-third octave filters with individual output attenuators to meet the required response spectra.

Independent signal sources were used for the horizontal and vertical axes so that input motion phasing was random.

Visual inspection of the test specimen upon completion of each test revealed no structural damage had occurred.

Paragraph f. Provide a description of the measures taken to protect the safety systems from electrical interference.

Acceptable practices of routing cable and grounding of circuits have been utilized in the design to minimize effects of radiated or coupled signals on the input leads to the device.

Electromagnetic compatibility testing of E-Max power supply and isolator cabinets were performed on equipment supplied for TVA's Bellefonte Nuclear Plant. The reports are applicable to the Sequoyah installation since the equipment is generic in nature and has been certified as such by the manufacturer.

The test results are documented in Teledyne Ryan Aeronautical Environmental Laboratory test report No. EL-80-01 dated January 30, 1980. The isolator cabinets were tested in accordance with requirements specified in TVA contract 79KJ2-822988 with E-Max Instruments, Inc. Two cabinet assemblies of different size were tested.

The large and medium isolator cabinets were set up on a ground plane which was 3 ft. by 8 ft. by .043 inch sheet of copper. Signal ground and equipment ground were isolated within each cabinet and tied together at earth ground. Testing was performed on Class 1E and non-Class 1E power. The isolators, as applicable, were loaded as follows:

| | |
|---|---|
| DC isolator | 250V dc at 100 mA |
| DC isolator | 120V dc at 10 mA |
| DC isolator | 48V dc at 20 mA |
| AC isolator | 120V ac at 200 mA |
| Analog Current Isolator | .15 mA Input |
| Analog Voltage Isolator | .5V Input |

Each cabinet was tested for electromagnetic compatibility as follows:

- Conducted EMI Transient Susceptibility
- Conducted RF EMI Susceptibility
- Radiated Transient EMI Field Susceptibility
- Radiated RF EMI Field Susceptibility
- Conducted Emissions
- Surge Withstand Capability Test

Test data verifies that the devices passed all specified requirements.

ATTACHMENT 2

SEQUOYAH NUCLEAR PLANT

SAFETY PARAMETER DISPLAY SYSTEM

The Safety Parameter Display System (SPDS) consists of the block type critical safety function status trees from the upgraded Westinghouse Owners Group (WOG) Emergency Response Guidelines (ERGs). Documentation for these status trees "Emergency Response Guidelines Revision 1" were transmitted to Hugh L. Thompson, Jr., Director, Division of Human Factors Safety, by the Westinghouse Owners Group on May 4, 1984.

Each tree uses several blocks containing questions with a yes or no output which leads to a status. When a status tree branch is not satisfied, it directs the operator to an appropriate function restoration guideline.

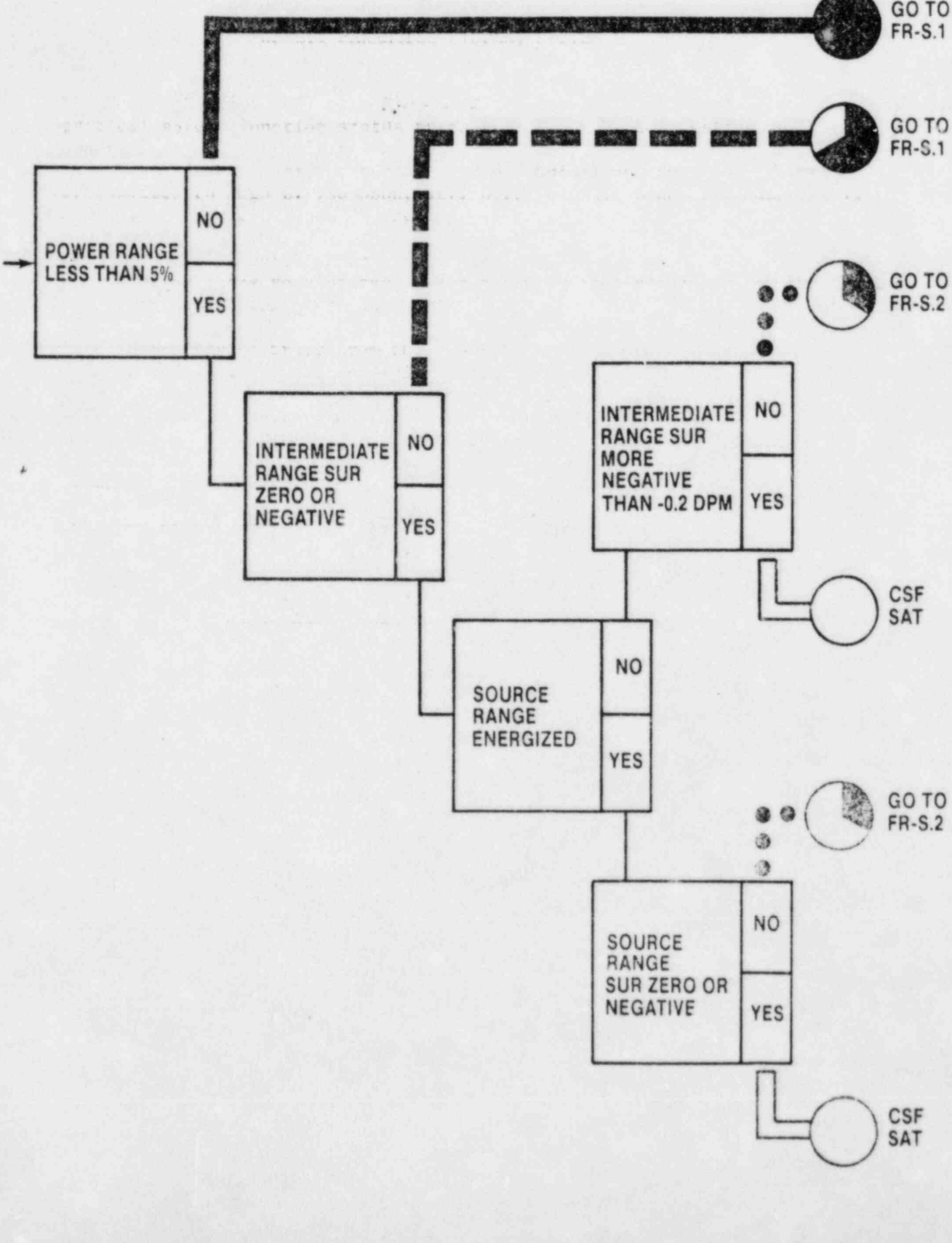
Six generic status trees from the WOG ERGs are attached. These trees will be converted to plant-specific trees for Sequoyah. The different branches are color coded to show the operator how serious any challenge is to a critical safety function. The ordering of the trees also defines priorities. The colors in order of priority are: red (solid line), magenta (dashed line), yellow (short dashed line), and green (double line).

When any status tree is displayed, colors are shown in a designated area, giving the status of the other five trees.

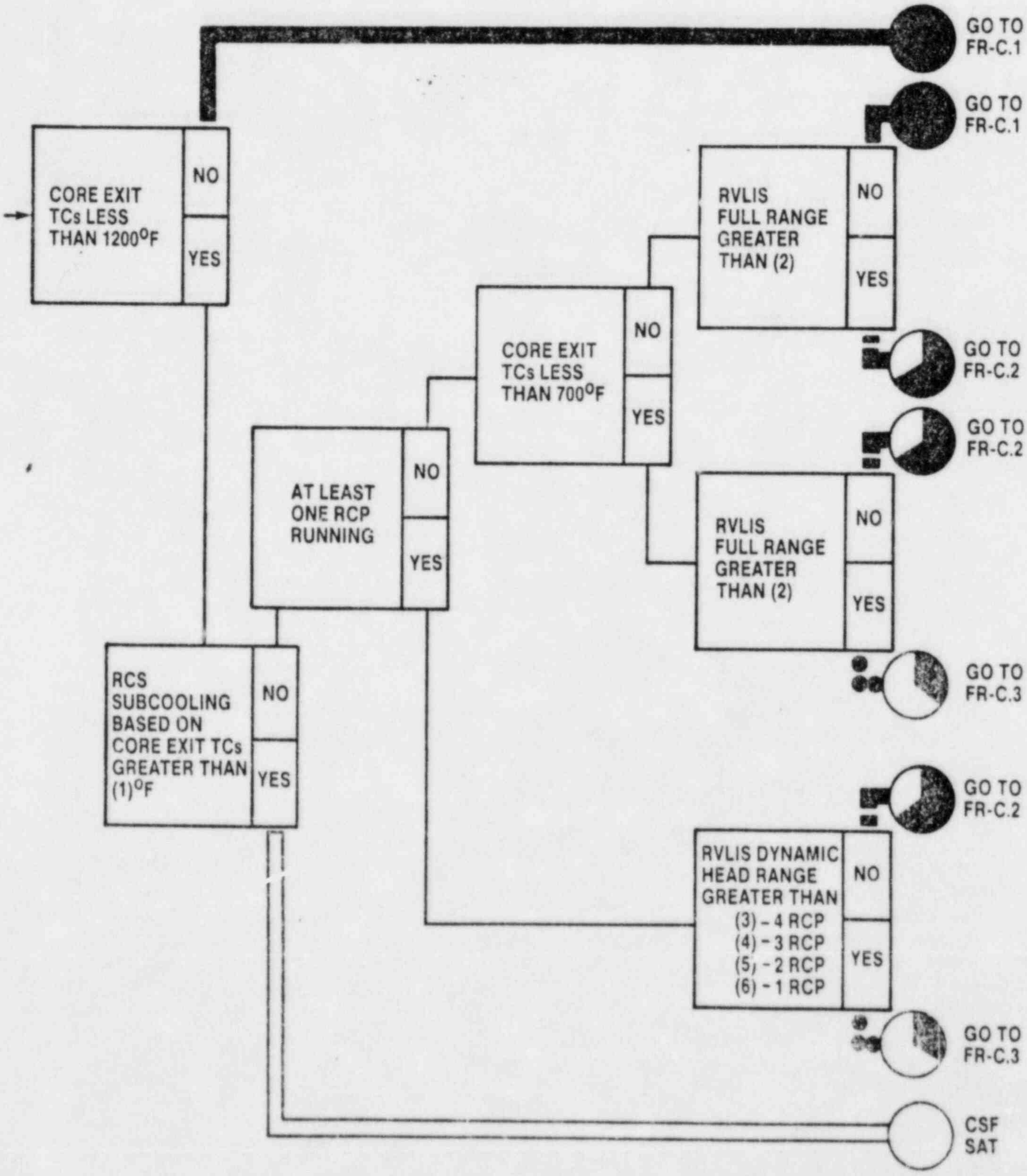
The critical safety function status trees have been developed using human factors principles. When the SPDS system is operational, the control room design review team will make a human factors review on the status tree displays.

In addition to the critical safety function status trees, a radiation monitoring display is included. This display provides readings for important radiation monitor points (including shield building, auxiliary building, steam generator blowdown, and condenser vacuum exhaust) to supplement the containment critical safety function status trees. The critical safety function status trees along with this additional radiation monitoring display fulfill the five SPDS functions (reactivity control, reactor core cooling and heat removal from primary system, reactor coolant system integrity, radioactivity control, and containment) as identified in Supplement 1 to NUREG-0737.

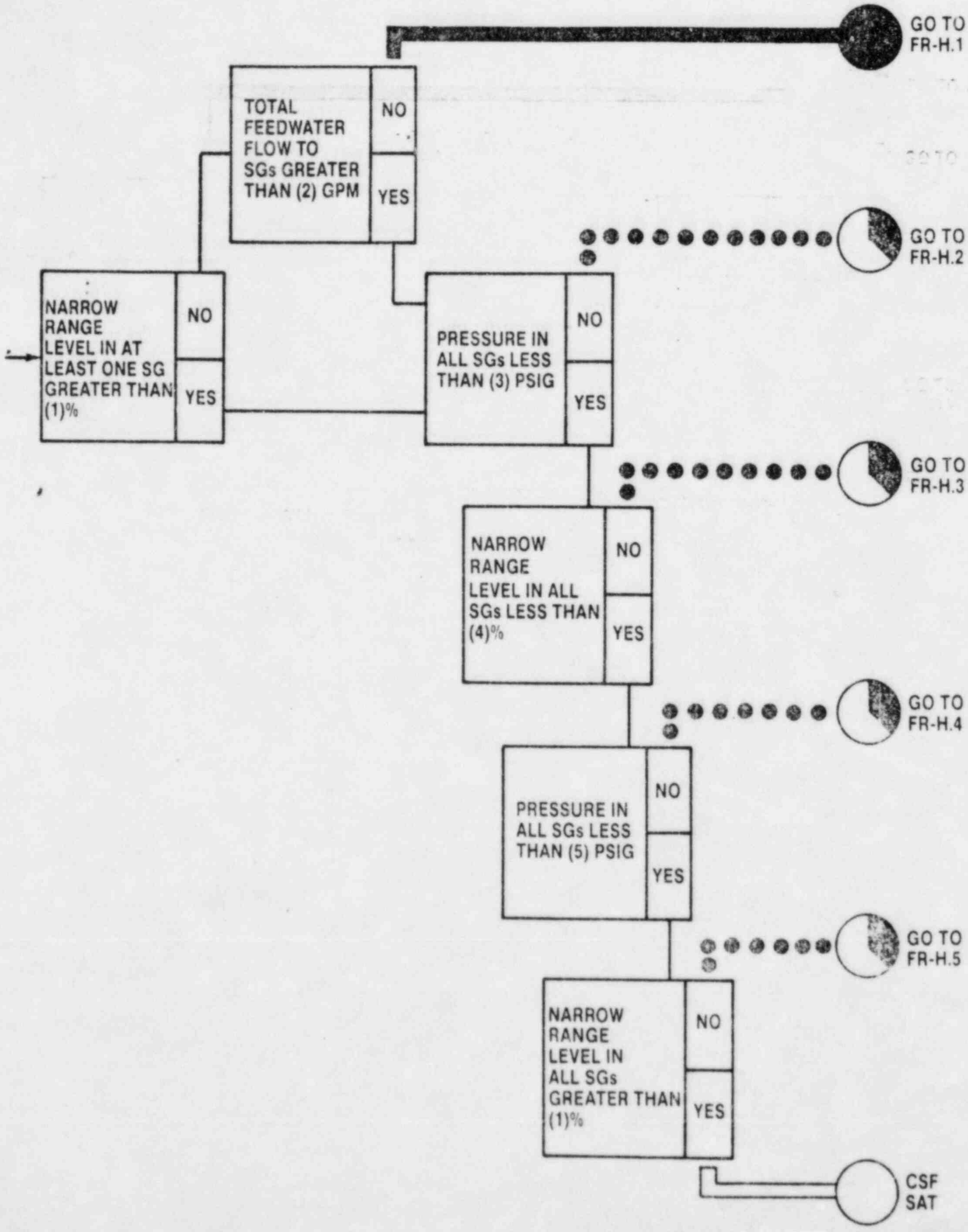
| Number: | Title: | Rev. Issue/Date: |
|---|---|---|
| F-0.1 | SUBCRITICALITY | HP/LP, REV. 1<br>1 Sept., 1983 |



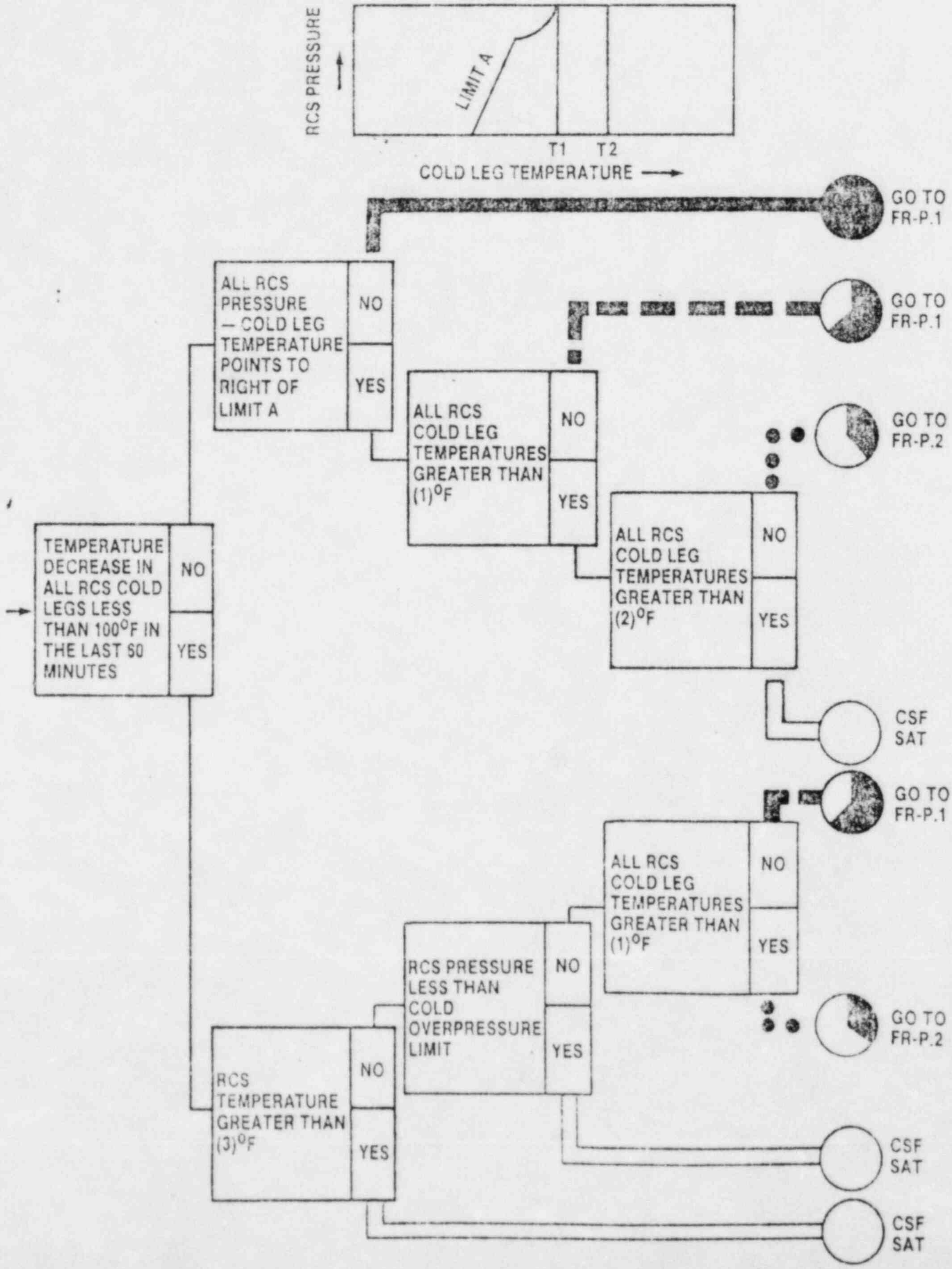
| Number: | Title: | Rev. Issue/Date: |
|---|---|---|
| F-0.2 | CORE COOLING | HP/LP, REV. 1<br>1 Sept., 1983 |



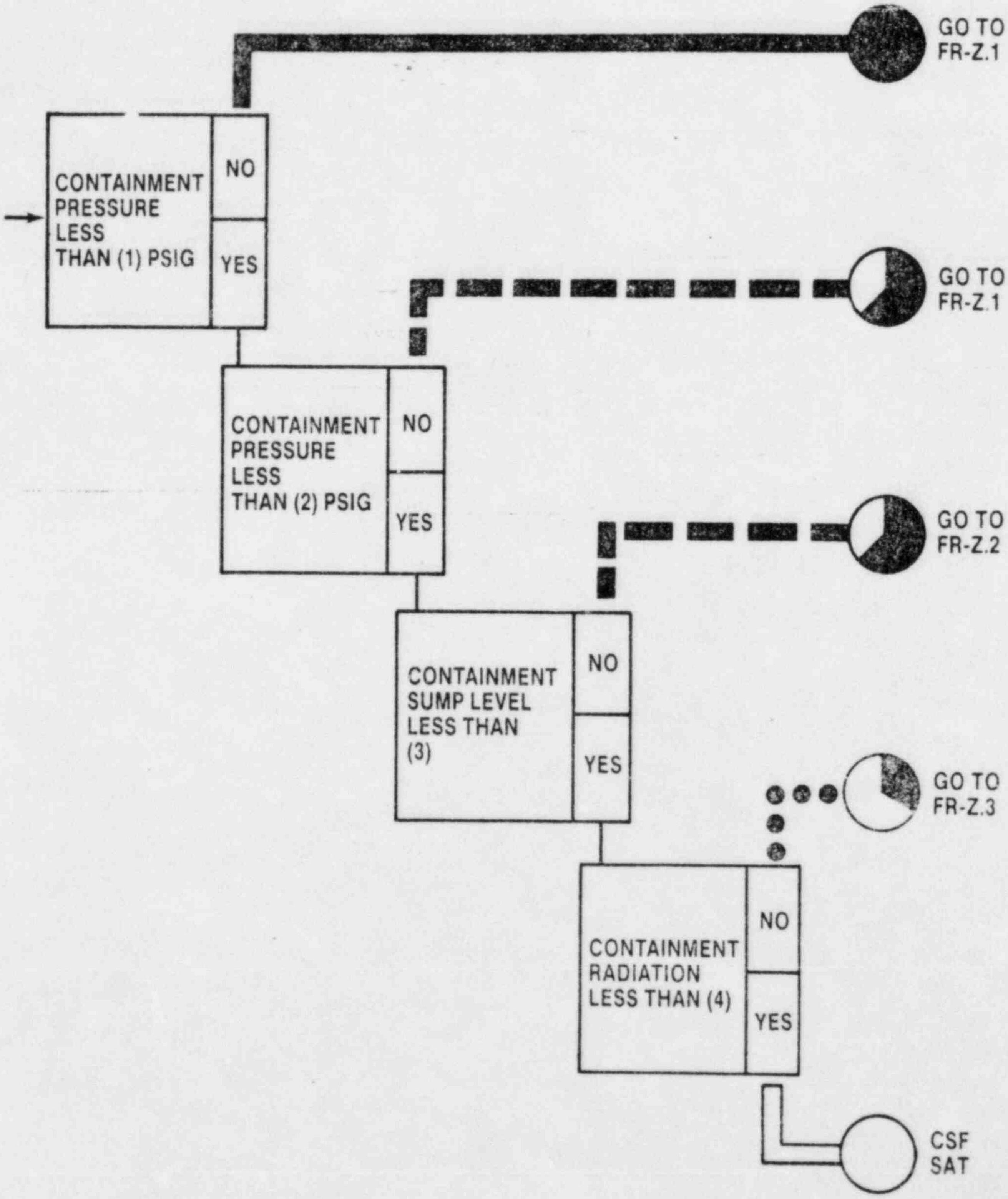
| Number: | Title: | Rev. Issue/Date: |
|---|---|---|
| F-0.3 | HEAT SINK | HP/LP, REV. 1<br>1 Sept., 1983 |



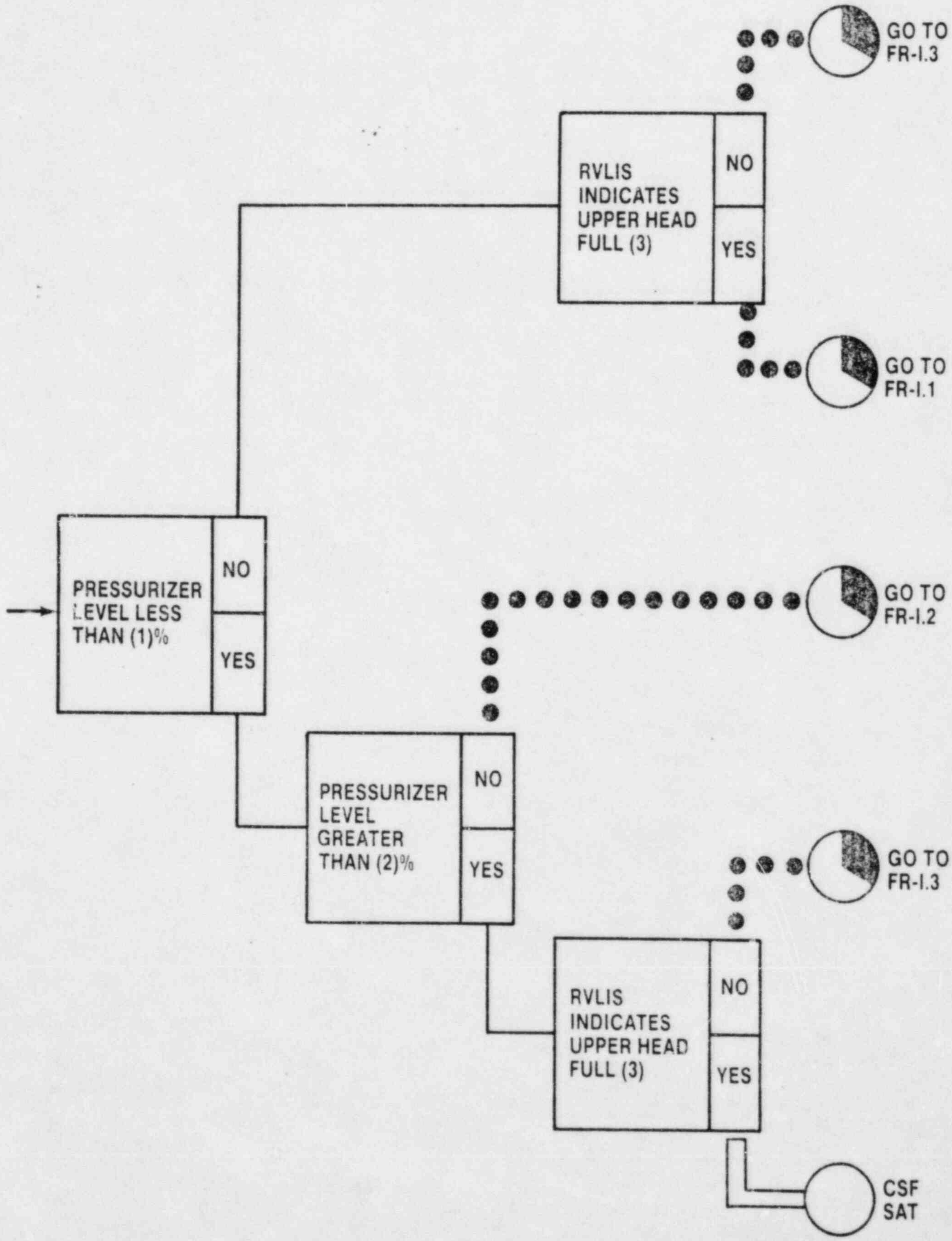
| Number: | Title: | Rev. Issue/Date: |
|---|---|---|
| F-0.4 | INTEGRITY | HP/LP, REV. 1<br>1 Sept., 1983 |



| Number: | Title: | Rev. Issue/Date: |
|---|---|---|
| F-0.5 | CONTAINMENT | HP/LP, REV. 1<br>1 Sept., 1983 |



| Number: | Title: | Rev. Issue/Date: |
|---|---|---|
| F-0.6 | INVENTORY | HP/LP, REV. 1<br>1 Sept., 1983 |



## FOOTNOTES

### F-0.2 CORE COOLING

(1) Enter sum of temperature and pressure measurement system errors, including allowances for normal channel accuracies and post accident transmitter errors, translated into temperature using saturation tables.

(2) Enter plant specific value which is 3-1/2 feet above the bottom of active fuel in core with zero void fraction, plus uncertainties.

(3) Enter plant specific value corresponding to an average system void fraction of 50 percent with 4 RCPs running, plus uncertainties.

(4) Enter plant specific value corresponding to an average system void fraction of 50 percent with 3 RCPs running, plus uncertainties.

(5) Enter plant specific value corresponding to an average system void fraction of 50 percent with 2 RCPs running, plus uncertainties.

(6) Enter plant specific value corresponding to an average system void fraction of 50 percent with 1 RCP running, plus uncertainties.

### F-0.3 HEAT SINK

(1) Enter plant specific value showing SG level just in the narrow range, including allowances for normal channel accuracy, post-accident transmitter errors, and reference leg process errors, not to exceed 50%.

(2) Enter the minimum safeguards AFW flow requirement for heat removal, plus allowances for normal channel accuracy (typically one MD AFW pump capacity at SG design pressure).

(3) Enter plant specific pressure for highest steamline safety valve setpoint.

(4) Enter plant specific value for SG high-high level feedwater isolation setpoint.

(5) Enter plant specific pressure for lowest steamline safety valve setpoint.

FOOTNOTES (Continued)

F-0.4 INTEGRITY

(1) Enter plant specific value corresponding to temperature $T_1$. Refer to background document for status tree F-0.4.

(2) Enter plant specific value corresponding to temperature $T_2$. Refer to background document for status tree F-0.4.

(3) Enter plant specific temperature setpoint below which cold overpressure protection system is in service.

F-0.5 CONTAINMENT

(1) Enter plant specific containment design pressure.

(2) Enter plant specific containment high-2 pressure setpoint.

(3) Enter plant specific containment water level just below design flood level minus allowances for normal channel accuracy.

(4) Enter plant specific value corresponding to radiation level alarm setpoint for post accident containment radiation monitor.

F-0.6 INVENTORY

(1) Enter plant specific pressurizer high level reactor trip setpoint.

(2) Enter plant specific pressurizer low level letdown isolation setpoint.

(3) Enter plant specific instrument channel and setpoint which indicates upper head is full.

ATTACHMENT 3

SEQUOYAH NUCLEAR PLANT

SPDS VERIFICATION AND VALIDATION PROGRAM

The letter from L. M. Mills to E. Adensam, dated January 4, 1984, gave details on the TVA V&V Program. Additional requested information is as follows.

With the block-type status tree displays, computer points are displayed below a block, where applicable. The point and the yes/no outputs will be shown as bad or suspect when internal software checks show the data to be questionable. There are four quality classifications:

a. Good data.

b. Sensor data inconsistent with the majority of redundant sensor values.

c. Data evaluated as bad because it is outside the process sensor or data acquisition system span, or because hardware checks indicate a malfunctioning input device.

d. Data which is operator entered.

Further validation of data is accomplished by field verification tests which are performed after system installation. This verifies that the system will properly display the input signals and that the inputs are connected correctly.

ATTACHMENT 4

SPDS SEQUOYAH NUCLEAR PLANT

UNREVIEWED SAFETY QUESTIONS

A 10 CFR 50.59 evaluation has been performed, and TVA does not consider the SPDS an unreviewed safety question.

On Technical Specification Improvement, NUREG 1024, NRC referenced statements by the Atomic Safety and Licensing Appeals Board (ALAB-531 in the matter of Portland General Electric, ET AL Trojan Nuclear Plant). In part, the Appeal Board stated:

> Technical Specifications are to be reserved for those matters as to which the imposition of rigid conditions or limitations upon reactor operation is deemed necessary to obviate the possibility of an event giving rise to an immediate threat to the public health and safety.

Inoperability of the SPDS would not pose an immediate threat to the health and safety of the public. TVA does not plan to submit technical specifications for the SPDS. This decision will enhance regulatory performance in regards to compliance with existing technical specifications.

ATTACHMENT 5

SEQUOYAH NUCLEAR PLANT

SAFETY PARAMETER DISPLAY SYSTEM

IMPLEMENTATION SCHEDULES

TVA has installed the SPDS/Technical Support Center (TSC) computer system hardware before startup following the second refueling outage for each unit. The SPDS, including computer systems software, will be operable with procedures and users manuals verified and validated with operators trained no later than September 1985 for unit 1 and October 1985 for unit 2.