PSE&G

Public Service Electric and Gas Company P.O. Box 236 Hancocks Bridge, New Jersey 08038

Nuclear Department

September 17, 1984

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Licensing
Washington, D. C. 20555

Attention: Mr. Steven A. Varga, Chief
Operating Reactors Branch, No. 1

Dear Mr. Varga:

INADEQUATE CORE COOLING
TMI ITEM II.F.2
SALEM GENERATING STATION
UNITS 1 AND 2
DOCKET NOS. 50-272 AND 50-311

In a telephone conversation with Mr. T. Huang of your office on August 28, 1984, we committed to provide additional information so that NRC can complete their review for implementation approval of the installed Reactor Vessel Level Instrumentation System (RVLIS). The open items identified in your letter dated November 17, 1983, are addressed in the attached status summary. Additional information as requested by Mr. T. Huang is also provided.

Sincerely,

E. A. Liden
Manager - Nuclear
Licensing and Regulation

MB:mg
Attachment

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The Energy People

C Mr. Donald C. Fischer
Licensing Project Manager

Mr. James Linville
Senior Resident Inspector

ATTACHMENT 1

STATUS SUMMARY OF ITEMS DESCRIBED IN NRC LETTER DATED NOVEMBER 17, 1983.

ENCLOSURE 1

1. Calibration procedures used for RVLIS were provided in PSE&G letters dated April 4 and May 24, 1984.

2. A schedule for implementation of the Emergency Operating Procedures (EOP) incorporating RVLIS was provided in PSE&G letter dated May 24, 1984. The walk-through on the EOP Critical Function Status Trees (CFST) that include RVLIS was performed during June 1984. Comment/corrections generated from the walk-through were incorporated. Final operator training will take place during September and October of 1984. Final rewrite to incorporate comments from training and approval will take place between November 1984 and March 1985.

3. A preliminary copy of the proposed Technical Specification for RVLIS was submitted to the NRC with our June 19, 1984 letter. The proposed technical specification is being revised to incorporate the NRC comments received over the telephone and a draft copy will be submitted to you by October 15, 1984. The technical specification will be submitted to the NRC for license change as soon as the RVLIS procedures are signed off and are ready to be implemented.

4. As indicated in our April 4, 1984 letter, no temperature compensation is provided for independently run vertical sections of impulse lines for RVLIS; as all the risers without compensation are within the same ambient environment. This information was verbally transmitted to us by Westinghouse.

   We are still awaiting written documentation from Westinghouse.

5. Commitment to upgrade the Core Exit Thermocouple (CET) system was provided in PSE&G letter dated June 19, 1984.

6. With regards to the CET system backup displays, items (a) through (g) were addressed by the commitment provided in PSE&G letter dated June 19, 1984. Regarding item (h) qualified backup displays for CETs will be integrated into the emergency operating procedures after installation is completed.

7. Commitment to provide qualified redundant back displays for CETs was included in PSE&G letter dated June 19, 1984.

8. An integrated display system has been developed to aid the control room operator in determining the existence of adequate core cooling. Primary inadequate core cooling information is indicated by CET, the Saturation Margin Monitor (SMM), and the RVLIS. Additional devices available for operator use are parameters such as Reactor Coolant System Pressure and Temperature, Steam Generator Level, and Auxiliary Feedwater Flow. The following is a description of the existing display system:

   a. Display Systems Located in the Control Room

      a.1 The RVLIS provides a water inventory status to the control room operator. Display for the RVLIS is provided on recorder panel 1RP1 and the console bezel in the Control Room. For train A, Monitor LD-3375IB and Recorder LA-3376RB are located on 1RP1. For train B, Monitor LD-3367IB is located on the Control Room Console. Also for train B, wiring has been provided to the recorder panel 1RP1 should recorder selection be required for train B.

      Also in the Control Room, the Auxiliary Annunciator provides two alarms. One point is for the Reactor Level Train A Failure Alarm, and another point is for the Reactor Level Train B Failure Alarm.

      The RVLIS display for train B is located on the Control Room Console at the location designated as 1CC1 position 2 - 10. It is integrated with the controls for the reactor coolant pumps and for the pressurizer overpressure protection system.

      The RVLIS monitor and recorder for train A are located on 1(2) RP1 near column CC-13.2 above the minimum line of sight approximately three feet from the floor.

      The RVLIS is a Class 1E system with redundancy meeting seismic and environmental criteria of IEEE 344 and IEEE 323.

      Information displayed to the operator for the RVLIS is intended to be unambiguous and reliable to minimize the potential for operator error or misinterpretation. The redundant control board displays provide the following information:

- An indication of reactor vessel level (full range) for each instrumented set displaying vessel level in percent from 0 to 100 percent after compensation for the effects of the reactor coolant and capillary line temperature and density, when reactor coolant pumps are not operating. The display is scaled 0 to 120 percent.

- An indication of reactor d/p (Dynamic Head) from each instrumented set displaying d/p in percent from 0 to 100 percent, after compensation for the effects of the reactor coolant and capillary line temperature and density effects, when reactor coolant pumps are operating at T no-load conditions. At full power, the display reading will exceed 100 percent indication. The display is scaled 0 to 120 percent.

- An indication of upper range vessel level on each of the two instrumented sets displaying vessel level in percent from 60 to approximately 106 percent after compensation for any reactor coolant and capillary line density effects, when reactor coolant pumps are not operating. The display is scaled 60 percent to 120 percent.

Information is transmitted to remove digital display units from each train via a serial data link.

Redundant displays are provided for the two trains. Level information based on all three d/p measurements is presented. Correction for reference leg densities is automatic. Any error conditions such as out-of-range sensors or hydraulic isolators are automatically displayed on the affected measurements.

There are three display sheets for reactor vessel level: the first is a summary sheet, the second is a trending of the three vessel level indications over a 20 minute period and the 3rd is a sensor status sheet which indicates which sensors are out of range or offscale.

Each train includes digital to analog converters to provide three analog signals per train for a single three-pen strip chart recorder.

- Display Functions for the Control Room. The prime display unit for the vessel level monitor is the 8-line, 32-character-per-line alphanumeric display which is located in the Control Room remote from the main processing unit.

- Vessel Level Monitor Summary Display. Figures a-1, a-2, a-3, and a-4 give example displays. General arrangement is shown on figure a-1. The vessel level summary display is shown on figure a-2.

- Trend Display. The trend display for the vessel level monitor must use the format shown in figure a-3.

- Sensor Status Display. The sensor status display for the vessel level monitor is shown in figure a-4.

- Out-of-Range Inputs. The control board display will indicate an out-of-range or limit of motion condition when the inputs reach the following setpoints:

  Hydraulic isolator (limit of Motion) $\pm$ 0.4in^3

  Impulse line (out of range) $450° \leq T \leq 32°F$

  RCS T_{Hot} (out of range) $700° \leq T_H \leq 50°F$

  RCS Pressure (out of range) 3000 psig $\leq P_{WR} \leq$ 0 psig

a.2 The CET system provides an indication of radial distribution of temperature rise across representative regions of the core. The primary operator display is a CRT located on the control console in the vicinity of the train B RVLIS monitor.

A core map for each quarter of the core is available to the operator on demand on the computer output CRT. The core map gives the temperature at each CET location in that quarter of the core.

The core map will give the location of the hottest in-core thermocouple. The hottest in-core thermocouple reading is the basis for the subcooling calculation and procedures.

There is direct read-out and hard copy capability for all thermocouple temperatures. The range extends from 30°F to 2200°F.

Trend capability for the thermocouples is available on demand on the trend typewriter located on the operator's console.

Alarm capability is provided consistent with operator procedure requirements: when reactor power is less than 0.25% alarm at 1200°F; when reactor power is greater than 0.25% alarm at 630°F.

The primary display channel and associated hardware are not Class 1E. The primary display channel uses a computer with an estimated reliability of 98 to 99%. The overall primary display channel reliability is 90 to 95%.

a.3 The SMM indicates the superheat conditions in the core coolant. It indicates the approach to inadequate core cooling by showing saturation conditions. The primary display located on the main control console and an analog pen recorder located on the operators console are utilized for core subcooling information.

Continuous information concerning (Tsat-Tact) and (Pact-Psat) is displayed on the analog pen recorder. The following information is available on the analog pen recorder on demand: (Tsat-Tact), (Pact-Psat), Psat, Reactor Coolant Pressure, and the temperature including location of the hottest incore thermocouple. This information is also available on demand from the primary display (CRT) or the trend typewriter.

Alarms for saturation margin monitoring are provided as follows:

(Tsat-Tact) -- Less than 50°F subcooling
(Pact-Psat) -- Less than 200 psi
Temperature -- Any thermocouple greater than 630°F

If these alarms occur, they will be displayed even if the subcooling calculation program has not been requested by the operator.

The analog range of display is 1 to 120°F differential for (Tsat-Tact) and 0 to 1000 psi differential for (Pact-Psat).

The subcooling calculations are performed on an 8 to 10 second basis. The saturation margin monitoring system is not Class 1E.

a.4 Additional Class 1E indication is available for operator use as follows:

Wide Range Reactor Coolant Pressure - During the inadequate core cooling event, indication is available showing general reactor coolant pressure trends (Control Console).

Auxiliary Feedwater Flow - During the inadequate core cooling event, indication is available showing flow of makeup water to the steam generators (Control Console).

Wide Range Temperature - Recorders mounted on recorder panel 1 (2) RP4 are available for determining trends of recovery actions (Recorder Panel 1 (2) RP4).

Steam Generator Level - During an inadequate core cooling event, indication is available for determining the availability of a heat sink for the Reactor Coolant System (Control Console).

Control Room Instrumentation can help the operator to determine heat sink availability, to detect the onset of inadequate core cooling through the saturation margin monitoring and CETs, and to detect the effectiveness of mitigation actions following the onset of an inadequate core cooling event. The RVLIS permits a continuous indication of all phases of the approach to inadequate core cooling as a result of a small break loss of coolant accident.

b. Display Systems Located in the Auxiliary Equipment Room Adjacent to the Control Room

b.1 The RVLIS microprocessor is located in the Auxiliary Equipment Room. The one-line 40-character alphanumeric display on the front panel of the main processing unit is used to display individual sensor inputs, calibration constraints, and compensated outputs. The sensor is selected with a two-digit thumbwheel switch. The following information is given for each sensor:

- Sensor identification
- Input signal level
- Input signal converted to engineering units
- Status of sensor input

Any inputs can be disabled by the operator. This action is under the control of a keyswitch on the front panel of the main computational unit and causes the processor to disregard the analog unit for that variable.

b.2 The interim backup display indicating CET temperatures is located in the Auxiliary Equipment Room. The existing backup display and CET systems are not qualified but are scheduled to be upgraded during outages planned for 1986.

In the existing system, all thermocouples may be read, but only one at a time. The range is 370°to 400°F or 670° to 700°F and not the required 200 to 2300°F. The readout meter on the flux mapping panel does not allow the operator to read 16 thermocouples within a time interval of less than 6 minutes.

c. CET System Upgrade

A CET system upgrade is planned for the 1986 outages. Presently, PSE&G is looking at a Combustion Engineering (CE) system which is a safety grade processing and display system and is qualified to Class 1E standards. The proposed system will also upgrade the CET backup display. The CET Processor will be located in the Auxiliary Equipment Room.

The following is a description of the CE proposed system:

The CET Processor provides three main functions:

Sensor input processing

Calculation and display of representative Core Exit temperature (if optional CET Algorithm is used)

Class 1-E isolated data link transmission to customer's computer

c.1 Sensor Input Processing

The design and qualification of the CET Processor are to Class 1E standards. The CET Processor consists of two redundant channels to avoid interruption of display due to a single failure and to meet the 1E requirement of NUREG-0737, and Reg. Guide 1.97.

The sensor input processing consists of:

- Checking that the sensor inputs are within range.
- Converting sensor inputs into engineering units.
- Calculating parameters from the sensor inputs.
- Calculating alarms when a parameter exceeds the setpoint.
- Compensation of the CET signals.

The proposed CET Processor includes the sensor processing and integrated display of individual CET temperatures and can display a representative CET temperature. The CET Processor can accommodate 33 type K-chrome/alumel thermocouples and up to 3 RTD inputs for the reference junction temperatures. The processing temperature range is from 200 to 2300°F.

c.2 Display of Core Exit Temperature

The CET Processor provides two digital (4-digit, 7 segment) output displays (one per channel) which present the core exit temperature parameters to the operator. The CET Processor displays the following:

1. Individual CET temperatures
2. ALARM indication
3. Diagnostic error indication
4. Representative CET temperature

c.3 Algorithm

The CETs are used to monitor the temperature of reactor coolant as it leaves the fuel assemblies. Using statistical analysis, the processor forms a model evaluating the distribution of the CET temperatures. The processor then designates temperatures that are out range (if any) and temperatures outside of a calculated bank (if any) as suspicious and does not use these temperatures for further calculations (until they later return within normal range).

The processor calculates a temperature which represents 95% of the distribution of valid CET temperatures with a 95% confidence level. This is the representative CET temperature.

Outputs such as individual CET temperatures, highest and next highest quadrant temperatures, and the representative CET temperature may be used to study core temperature conditions. These inputs are provided over the data link interface for display to the plant operators and can be manually selected for display on the digital panel meter.

c.4 Data Transmission

The CET Processor has output capabilities to transmit all display information to a customer computer. A noise-resistant, isolated data link is employed to provide the desired information exchange.

ENCLOSURE 2 (RVLIS ONLY)

1. A design description of RVLIS was submitted to the NRC in an April 4, 1984 letter enclosing the RVLIS Manual (latest revision). Also, in a response to the NRC dated April 22, 1983, plant specific installations and deviations were described. No new deviations exist concerning these documents.

   Westinghouse stated that installation of Kit No. 2 is necessary for PSE&G to have a fully operational system. This installation is complete for Unit No. 1. Unit No. 2 installation of Kit No. 2 is scheduled for the 3rd refueling outage in February 1985.

   Kit No. 3 incorporates several changes dealing with qualification and general product improvement and is not required for system operation, system startup, and check out. Kit No. 3 is scheduled to be installed in Units 1 and 2 during the next refueling outages.

2. The revised emergency operating procedures were developed following the Revision 1 of the Westinghouse emergency response guidelines (ERG). No significant deviation other than minor plant specific information to clarify operator action is included.

3. PSE&G letter dated April 4, 1984, identified the modifications found necessary on RVLIS after calibration and testing. Refer to Item 1 above for status of installation of these modifications.

4. PSE&G letters dated April 4 and May 24, 1984 provided the test and calibration results.

5. Plant operating procedures were developed following Westinghouse technical manual. These procedures are currently being reviewed. For emergency operating procedures (see Item 2 under Enclosure 1).

6. Implementation letter report - see Attachment 2.

7. For procedure walk-through (see Item 2 under Enclosure 1).

8. Subsequent to emergency operating procedure (with RVLIS) walk-through the system will be turned on for a period of time for operator familiarization purposes.

   RVLIS is not yet incorporated in training simulator. However existence of RVLIS on simulator was "simulated" by providing the operator with vessel level values based on the scenario and effect from the Westinghouse Owners Group guideline.

Attachment 2

IMPLEMENTATION LETTER REPORT

1. The RVLIS is installed in both Units No. 1 and 2. The functional testing and calibration for both units have been finalized. Test and calibration results have been submitted to the NRC previously for information and review (See April 4, 1984 letter).

2. During RVLIS functional testing and calibration, three deviations from the original RVLIS design were identified. These three deviation (denoted as Kits No. 1, 2 and 3) will be corrected as denoted below. The details associated with the three following design modifications will be maintained at the Salem site facilities.

   A. Kit No. 1: Installed on both Units. Includes minor circuit modifications to enhance the compatibility and operability of the system.

   B. Kit No. 2: Installed on Unit 1. Scheduled to be installed during 3rd refueling outage on Unit 2 (February 1985). This incorporates human factor and environmental/seismic qualification changes, 0 to 120% analog output scale change, steam density compensation algorithm, 3 position key switch to the microprocessor drawer, removal of containment monitor features from the existing system.

   C. Kit No. 3: Scheduled to be installed during 2nd refueling outage in February 1985 for Unit 2 and 6th refueling during 1986 for Unit 1. Kit No. 3 will include the following changes:

      - The addition of a hold-down clamp for the remote display power supply.

      - New software program for the remote display.

      - Addition of filter capacitors to the daughterboards.

      - Addition of a remote display unistrut nut.

      - PS2 thermistor change.

      - Modification of the A4 board jumper block.

      As stated previously, Westinghouse states that installation of Kit No. 2 makes RVLIS fully operational.

IMPLEMENTATION LETTER REPORT (Continued)

3. For description of deviations, refer to Item 2 (Implementation Letter Report) above.

4. For technical specification modification, see Item 3 of Enclosure 1. The proposed technical specification will be submitted to the NRC for license change following PSE&G internal review and sign-off.

5. A RVLIS is installed and could be declared operational subsequent to normal/emergency operating procedure approval and implementation, we request NRC to approve the plant specific installation.

6. As described in Item 2 under Enclosure 2, EOPs are developed following the Revision 1 of Westinghouse Emergency Response Guidelines.

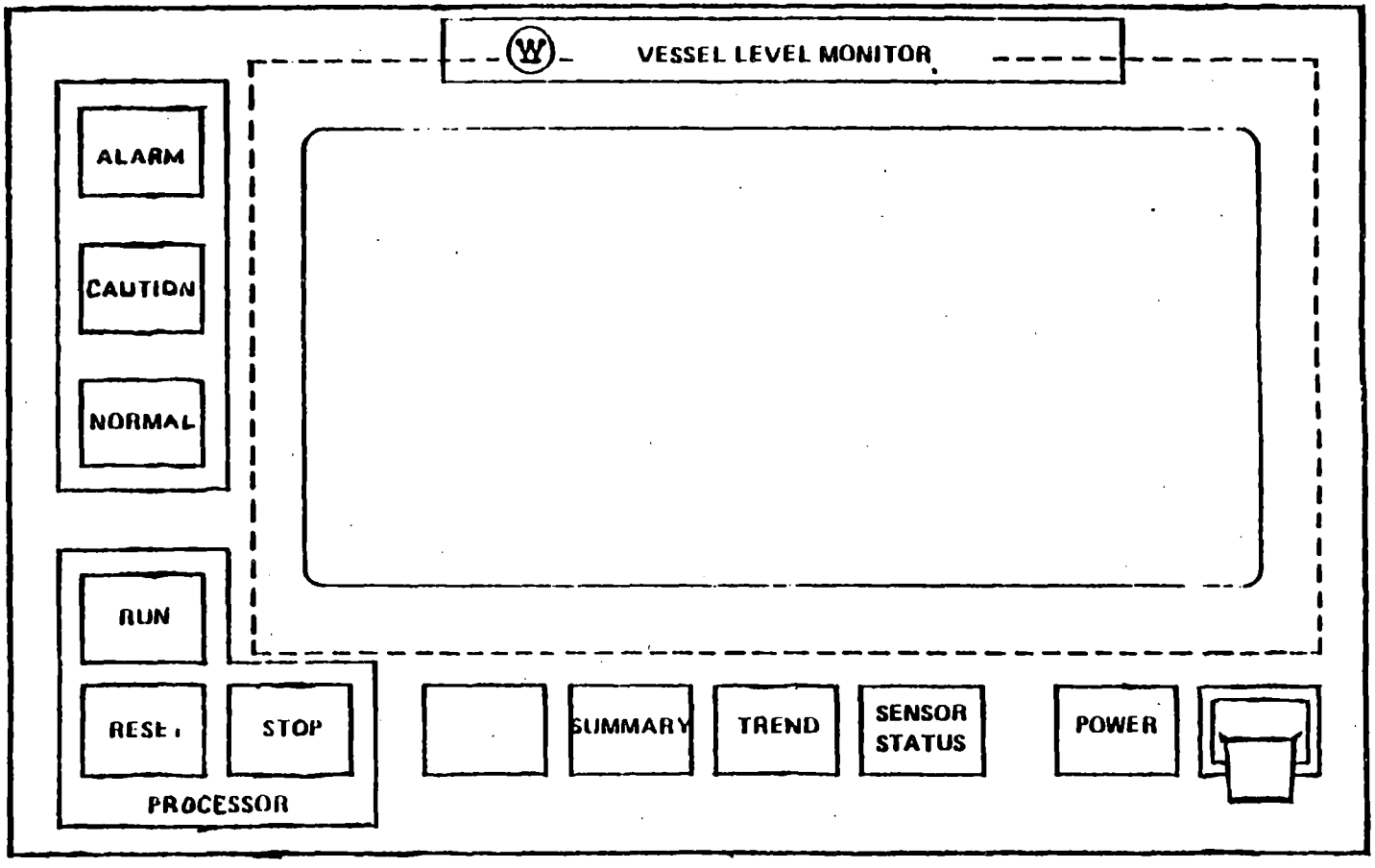

Figure A-1 Remote Display Module (Control Board)

REACTOR VESSEL LEVEL SUMMARY

	ACTUAL	NORMAL	STATUS
UPPER RANGE	73%	100%	
FULL RANGE	47% *	0%	
DYNAMIC HEAD	> 120 % * #	100%	OFF SCA

PUMPS RUNNING: No. 1 No. 2 No. 3 No. 4

* ISOLATOR ALARMS: LI3

DISABLED: T3 TH1

Figure 9-2 Vessel Level Summary Display

REACTOR VESSEL LEVEL TREND

TIME MIN	UPPER RANGE	FULL RANGE	DYNAMIC HEAD
0	73%	47%	110%
5	78%	49%	98%
10	79%	52%	97%
15	82%	56%	98%
20	97%	99%	99%

Figure A-3 Vessel Level Trend Display

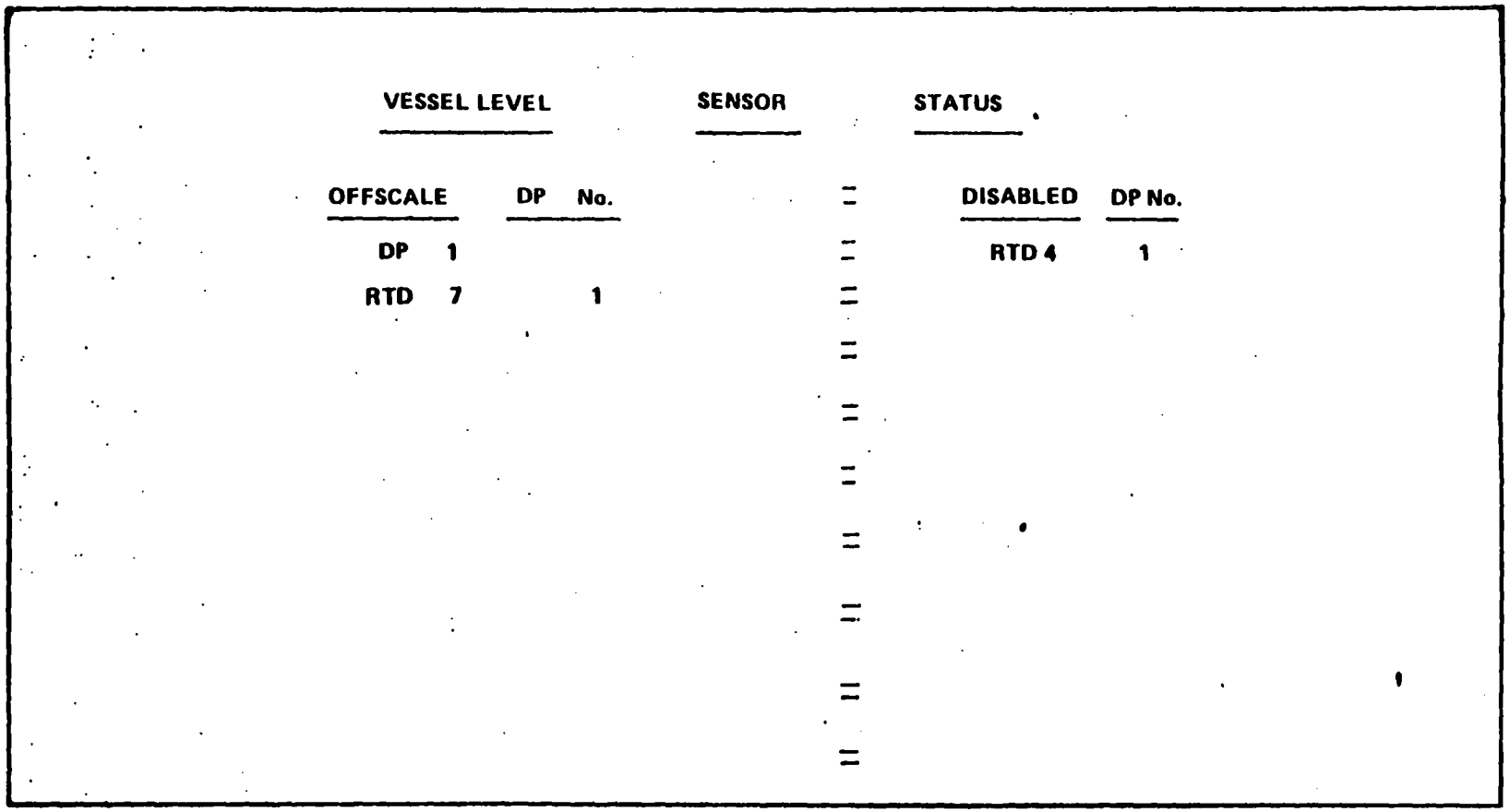

Figure A-4 Typical Vessel Level Sensor Status Display