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RECIP.NAME RECIPIENT AFFILIATION
MILLER,J.R. Operating Reactors Branch 3

SUBJECT: Forwards addl info re safety parameter display sys implementation plan submitted in response to Generic Ltr 82-33 & 840914 request.Info covers isolation devices,human factors program & data validation.

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FLORIDA POWER & LIGHT COMPANY

November 2, 1984
L-84-285

Office of Nuclear Reactor Regulation
Attention: Mr. James R. Miller, Chief
Operating Reactors Branch #3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Miller:

Re: St. Lucie Units 1 and 2
Docket Nos. 50-335 and 50-389
SPDS Implementation Plan and
Parameter Selection Report
Request for Additional Information

In our letters L-84-48 and L-84-49, FPL provided a Safety Parameter Display System (SPDS) Implementation Plan and Parameter Selection Report to NRC in accordance with Generic Letter No. 82-33 for St. Lucie Units 1 and 2 respectively.

In an NRC letter dated September 14, 1984, the staff requested additional information on the St. Lucie Plant SPDS. The attachment to this letter provides the additional information requested.

Should you have any questions regarding this submittal, please contact us.

Very truly yours,

for J.W. Williams, Jr.
Group Vice President
Nuclear Energy

JWW/RJS/DCB/mp

cc: Mr. James P. O'Reilly, Region II
Harold F. Reis, Esquire

A003

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RESPONSE TO THE NRC QUESTIONS

ISOLATION DEVICES

General

Two types of isolation devices are used for safety signal isolation for the Safety Parameter Display System (SPDS). These are:

Analog Isolators

TEC model 980 series A through G (Attachment I describes the various input/output ranges of these isolators) and TEC Model 156 A through K. These are magnetically coupled isolators. There are 4 isolators mounted on one card for Series 980.

Digital Isolators

TEC model 981 A through D. (Attachment I describes the input/ output ranges of these isolators) and TEC Model 159 A through G. These are optically coupled isolators. There are 4 isolators mounted on one card.

Both the Model 980 and 981 isolators are placed in TEC model 2200 isolation system cabinets. These cabinets have ±15Vdc power supplies. IE field cables are connected to the IE side of the isolation cards. The isolators non - IE output is connected to a connector box and to the mulitplexors located adjacent to the isolation cabinet. Model 156 and 159 isolators are placed in TEC field mounted IE qualified boxes. The output of these isolators are brought to multiplexors via cable and pass-through cards in the cabinets.

The following paragraphs provide answers to the specific questions a) through f) as requested in the NRC correspondence to Florida Power & Light Co. (letter from Mr. James R. Miller, Chief Operating Reactors Branch #3 to Mr. J.W. Williams, Jr. Vice President, FPL dated Sept. 14, 1984):

a) The testing to demonstrate that the device was acceptable to accomplish electrical isolation was performed using 2000 V dc. This voltage was applied across the non-IE outputs during the seismic test. The IE input side of the isolators (Figure I) was monitored to see that no breakdown occurred. Figure 2 shows the test configuration and the manner in which the maximum credible faults were applied. The model 981 digital isolators were functionally tested for high and low output during the second SSE. The output of the recorders during the 2000 V dc test is shown in Fig. 3. The chart shows that there was no effect on the isolator.

   Digital isolators were also tested using the Fig. 2 arrangement by applying 2000 V dc. Once again there was no effect on the input or class IE side of the isolator noted.

b) The maximum credible fault is the maximum voltage/current that an isolator's non IE side would be exposed to. At St. Lucie Plant the

non-IE side of the field mounted isolators are connected to the TEC Model 2200 Cabinet terminations via qualified cables. The length of these cables are approximately 200 ft. The cable is run through the instrumentation trays. The maximum voltage on any cable run through this tray does not exceed 125Vdc ± 15%. TEC model 2200 cabinets are placed adjacent to the multiplexors and are electrically connected with each other by multiple pin connectors. The connector cables approximately 15 ft. long are run under the cabinets. Therefore, the maximum credible voltage that can be applied to 125Vdc. Figure 2 provides the data that 2000 V dc was applied to the non-IE side. This is far above the 125Vdc required. Since 2000 V dc was applied, the current flowing through the isolators is much greater than that at 125Vdc.

c) Figure 1 "Diagram of On-Line Monitoring of Isolators page 16 from TEC test report 30152-TR-02 and Figure 2 "Isolation Capabilities test of 2200 Isolation System" from TEC procedure number 30152-DVTP-01 show that the signals were applied to the TEC isolator devices in the transverse mode and open circuit mode. It is also apparent from the block diagram of the analog and digital isolators (Figures 4, 5, 6 & 7) that any short on the output side would not pass through the opto isolator in the digital 981 and 159 isolators or the demodulator section of the analog 980 isolators and 156.

d) The pass/fail acceptance criteria is described in TEC report No. 30152-TR-02 Revision 1 (Attachment 2). A Honeywell absolute pressure transmitter was placed in operation as the analog input to the analog isolator and the IE inputs were recorded by a solid state strip chart recorder. During the seismic event, 2000 V dc was applied continuously to the non-IE output of the isolators. No transients were recorded on the IE input line nor was there any damage to the input or recording electronics.

e) The TEC model 2200 isolation cabinets are located in the computer room of the St. Lucie Plant in a mild environment. 10 CFR 50.49 does not apply to devices located in a mild environment. However, the cabinets were seismically tested and designed to insure operability in its intended environment.

f) The TEC model 2200 isolation system uses differential inputs, high impedence amplifier inputs, steel cabinet shielding and shielded output cable to eliminate common mode, electrostatic coupling, EMI and cross talk problems.

HUMAN FACTORS PROGRAM

DISPLAY SYSTEM DESCRIPTION

The SPDS provides a centralized, flexible, computer-based data analysis and display system to assist control room personnel in evaluating the safety status of the plant and detecting possible abnormal operating conditions. This assistance is accomplished by providing graphical displays containing a minimum set of parameters representative of the plant safety status for three modes of plant operation (NORMAL, HEATUP/COOLDOWN, and COLD SHUTDOWN). (This set of parameters has previously been submitted to the NRC by Florida Power & Light Company in a letter from Mr. J.W. Williams to Mr. D.G. Eisenhut dated March 1, 1984.) The information is presented to the Control room operator on a medium resolution, multi-color cathode ray-tube (CRT) dedicated to the SPDS.

Attachment 3 provides the specific display formats for the three modes of operation. The displays consist of bar graphs, trending graphs, message areas, targets, and digital values for the various parameters monitored. In addition, on two of the three high level displays an Accident Identification Display System (AIDS) is provided.

AIDS is not considered a part of the SPDS and no credit is taken for any of the parameters monitored and displayed exclusively on AIDS. However, since AIDS bars will be available to the operators on the primary CRT, the following provisions will be made to ensure that AIDS will not compromise the intended function and use of the SPDS.

The software providing parameter status information via AIDS bar indicators and associated displays will be subject to the same validation testing requirements as the SPDS software. AIDS will be subject to the same human factors design criteria as the SPDS. Operator training will be conducted to insure that they understand the AIDS philosophy for use with the SPDS. The availability of AIDS will not impair or compromise the use of the SPDS.

The displays are selected from a dedicated function key pad conveniently located near the control board. A 19" CRT is located on the control board where it is easily visible to the Control Room Reactor operator and Senior Reactor Operator.

The SPDS CRT provides three top level displays. These displays are for the following modes of operation:

1. Normal Operation Display - Selected during plant conditions at or above normal operating pressure and temperature.

2. Heatup/Cooldown Display - Selected when the RCS is intentionally cooled below normal operating values or is being heated up prior to startup.

3. Cold Shutdown Display - Selected to monitor Cold Shutdown plant conditions.

These displays are configured so that the displayed information is readily perceived and comprehended and do not mislead the operator. This was confirmed during a simulator evaluation of the SPDS. A simulator evaluation of the SPDS showed the SPDS to be easily interpretable by team of operators not directly involved with the design.

HUMAN FACTORS DESIGN

A multiple disciplinary team of operators, instrumentation and control engineers, and human factor engineers from twelve (12) utilities and Quadrex designed the displays for the SPDS. The design of these displays are based upon the guidelines of NUREG 0696. These displays were mocked up on a simulator and evaluated by a team of operators from various utilities at the Indian Point Plant. An evaluation report prepared on the display at the simulator indicated that the overall SPDS design was well received by the end users (operators).

The display formats are designed with low information densities and include information required to support the task activity of the user. Further, the color scheme is designed to reduce the visual dominance of the static background information. Extensive use of demarcation lines is employed to separate classes of data or parameters.

Simple display formats are provided to reinforce user recognition of plant status. Vertical bar level indications are easy to associate with parameter values or magnitudes of a parameter, as most control boards contain vertical meters. A red (off-normal)/green (normal) color is used to fill the vertical bars on top-level display.

As numerous alarms already exist in the control room, the use of alarms on the SPDS display system is kept to a minimum.

Arrangement consistency is an important factor in display design and is a feature of the SPDS displays. Certain areas of data (date, time, display titles, message, etc.) always appear in the same area in related formats. This is done to assist user identification of data appearing on multiple displays. The data or information groups are located on the display by importance. Generally, the groups are arranged in a top-to-bottom and left-to-right ranking, with the most important data at the top or on the left of the display. Additionally, the message areas remain on primary CRT displays, to prompt the user that status change has occurred.

The quality of information being displayed to the user is also presented. Should a caution exist concerning the validity of data, the numerical value is displayed in yellow rather than red (off-normal) or white. If all sensors providing data for a parameter fail, or are taken out of scan, the digital value for the parameter is replaced by a yellow "FAIL".

Extensive use of graphic symbology or presentations is used on the SPDS displays. By using a 640 by 512 pixel colorgraphic CRT, symbol set, color and line clarity are achieved. With the high resolution display and sharpness provided, high levels of object/background and object/object discrimination can be obtained. Pattern and coding techniques are extensively used to portray status in a graphic form for rapid user recognition. Bar charts are selected as the means of presenting primary status indications for a wide range of values in a form easily comprehended by the user.

Minimum use of color combined with a simplified format for the CRT display is a key design feature to aid both normal and off normal pattern recognition. Color coding is used only to enhance changes in status, and to aid differentiation and association. Color is used in a consistent and restrained manner (green is always used to portray normal or acceptable conditions). Only seven colors plus a black background are used. The use of color is backed up by a redundant code. Status or information is obtainable should a color gun fail or an operator suffer from a visual color imbalance, by providing an alternate means (location, digital values, etc.) of gaining the same data.

The use of color employed a structured approach. To present status information the following conventions are used:

- Red - off-normal, immediate action, loss of function
- Orange - prompt action, potential loss of function
- Yellow - failure or caution (sensor related), loss of redundancy, action may be needed
- Green - normal

DATA VALIDATION AND HOW INVALID DATA IS DEFINED

The displayed value of each SPDS parameter is determined by processing one or more plant signals. Valid/invalid indications are provided for SPDS parameters and are determined through systematic consideration of the type and number of signals available for each parameter. A displayed variable which consists of a single analog input signal is generally determined to be valid or invalid based only on a validation table comparison check of the high and low limits. If the data is out of range, the parameter is failed, and the digital value on the display is replaced by "fail' in yellow.

For two sensor inputs for a given parameter, both sensor input data are checked against the validation table limits. Three different situations can occur:

1. One sensor is rejected in range checking. The data for the remaining one sensor is taken as the parameter data. Since only one sensor data is left, it is defined to be in an "Alert" condition and the parameter data is displayed in yellow.

2. Both sensors are rejected in range checking. The parameter will be displayed as a failed parameter, i.e., displayed "FAIL' in yellow.

3. No sensor has been rejected. The average or high/low as previously defined in the table of the two sensor's data will be displayed as the parameter data. There is another test for the "Alert" condition for this situation. If the two sensor data are spread too wide (i.e. more than 10%), it is considered an "Alert" condition.

For a number of sensor inputs greater than 2, the sensor inputs are checked against validation table range limits. If the unrejected sensors are less than 3, the data will be checked as described earlier for one or two sensor inputs. If more than 2 sensors are left unrejected, the data will be verified using Chauvenet's criteria. If any of the data is rejected, the data will be tested in the way described for one, two, and three sensor inputs depending on the number of unrejected inputs. The test will be terminated if no data is rejected against Chauvenet's criteria.
Table I provides a summary of the data validation process.

Table I

NUMBER OF SENSOR INPUTS	RESULT	CONDITION
1	Sensor out of range.	FAIL
	Sensor in range.	O.K.
2	One sensor out of range	ALERT
	Two sensors out of range	FAIL
	No sensor out of range and percent difference 10%.	ALERT
	No sensor out of range and percent difference 10%.	O.K.
3	One sensor left after rejection test.	ALERT
	Two sensors left after rejection test and percent difference 10%.	ALERT
	Two sensors left after rejection test and percent difference 10%.	O.K.
	More than two sensors left after rejection test.	O.K.

ATTACHMENT I
ANALOG ISOLATORS

Specifications

I. INPUT SIGNAL RANGE — OUTPUT SIGNAL RANGE

Model	Input Signal Range	Output Signal Range
980A	±10mV	±10 V
980B	±20mV	±10 V
980C	±100mV	±10 V
980D	±1 V	±10 V
980E	±10 V	±10 V
980F	±2 V	±10 V
980G	±5 V	±10 V

DIGITAL ISOLATORS

Specifications

1. INPUT SIGNAL RANGE

Model	Type	Output Low	Output High	Current
981A	Voltage Input	0-9 V ac rms	75-150 V ac	1.5 mA max.
981B	Voltage Input	0-15 V dc	75-200 V dc	1.5 mA max.
981C	Voltage Input	0-1.0 V dc	2.5-50 V dc	2.5 mA max.
981D*	Contact Sense	500 K	0-10 K	1.5 mA max.

* For contact sense, the sense voltage (15 V dc) is internally supplied by the module.

2 OUTPUT SIGNAL RANGE

Output = "1": 15 V ± 5% in series with 430 (±5%)

Output = "0": 0.4 max. @ 16 mA max. sink current

ANALOG ISOLATORS

INPUT SIGNAL RANGE		OUTPUT SIGNAL RANGE
Model		
156A	1-5 V	4-20 ma
156B	0-5 V	"
156C	0-10 V	"
156D	4-20 mA	10-50ma
156E	10-50 mA	4-20ma
156F	0-1 mA	"
156G	0-15 mA	"
156H	40-200 v	"
156I	0-20 V	"
156J	0-1 V	"
156K	0.2-1 V	"

DIGITAL ISOLATORS

INPUT SIGNAL RANGE

Model	Input Current	Output High	Output Low
159A	10mA max.	5K - 3K	10K - 33K
159B	5 mA max.	65-106 V dc	56-34 V dc
159C	5 mA max.	65-106 V dc	56-34 V ac
159D	5 mA max.	129-208 V dc	109-66 V dc
159E	5 mA max.	129-208 V dc	109-66 V dc
159F	5 mA max.	3.3-4.1 V dc	2.9-2.0 V dc
159G	5 mA max.	10.1-15.0 V dc	8.9-5.4 V dc

2 OUTPUT SIGNAL RANGE

Output High (Logic "1"): Open Circuit, 5 V dc ± 0.5 V dc in series with 4.7 k ± 5%.

Output Low (Logic "0"): 0.4 V dc max. at 16.0 mA sink current.

ATTACHMENT 2

PERFORMANCE AND ACCEPTANCE CRITERIA

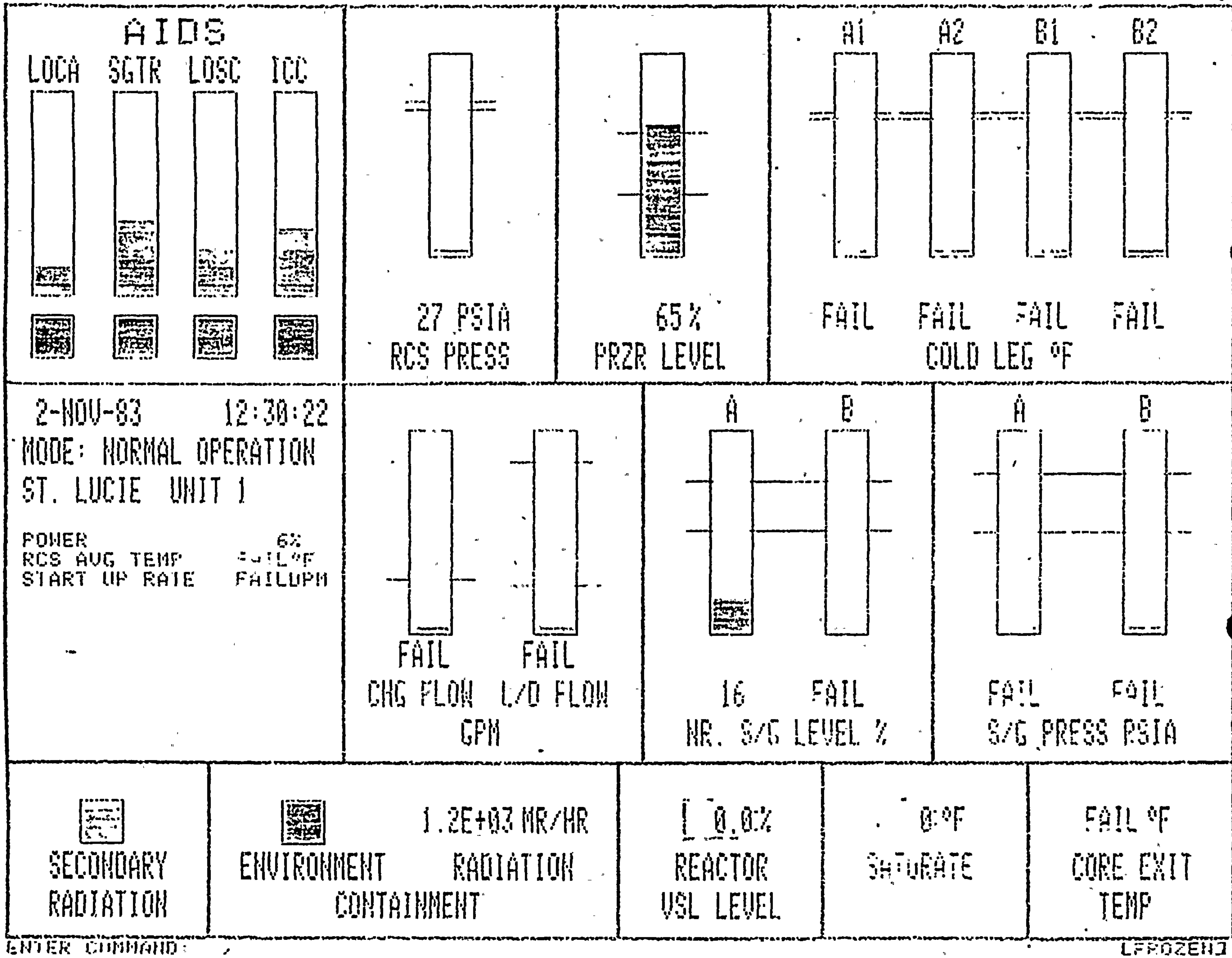
The two criteria used to determine the performance and acceptability of the system were the variation between the pre-test data and the post-test data, and also the ability to maintain the acceptable range as defined in the "Quality Control Test Procedure" (QCTP).

Acceptable ranges of performance for the system devices were pre-determined and documented in the form of baseline data collected before the test program was started. The post-production "Quality Control Test Procedure" (QCTP) data formed the baseline data for the thermal aging. The post-thermal aging functional test data then determined the baseline data for the pre-irradiation test. The post-irradiation functional test was not a complete QCTP, but rather a spot-check to determine if the system was still operative prior to the seismic test.

The final QCTP test was conducted after the EMI test.

The isolation capability of the system was demonstrated online by applying 2000 volts dc to input of one channel of each of the 980, 981, 156 and 159 respectively. The 2000 volts dc simulates the online worst-case isolation requirement for any known Design Basis Event (DBE).

Attachment 3



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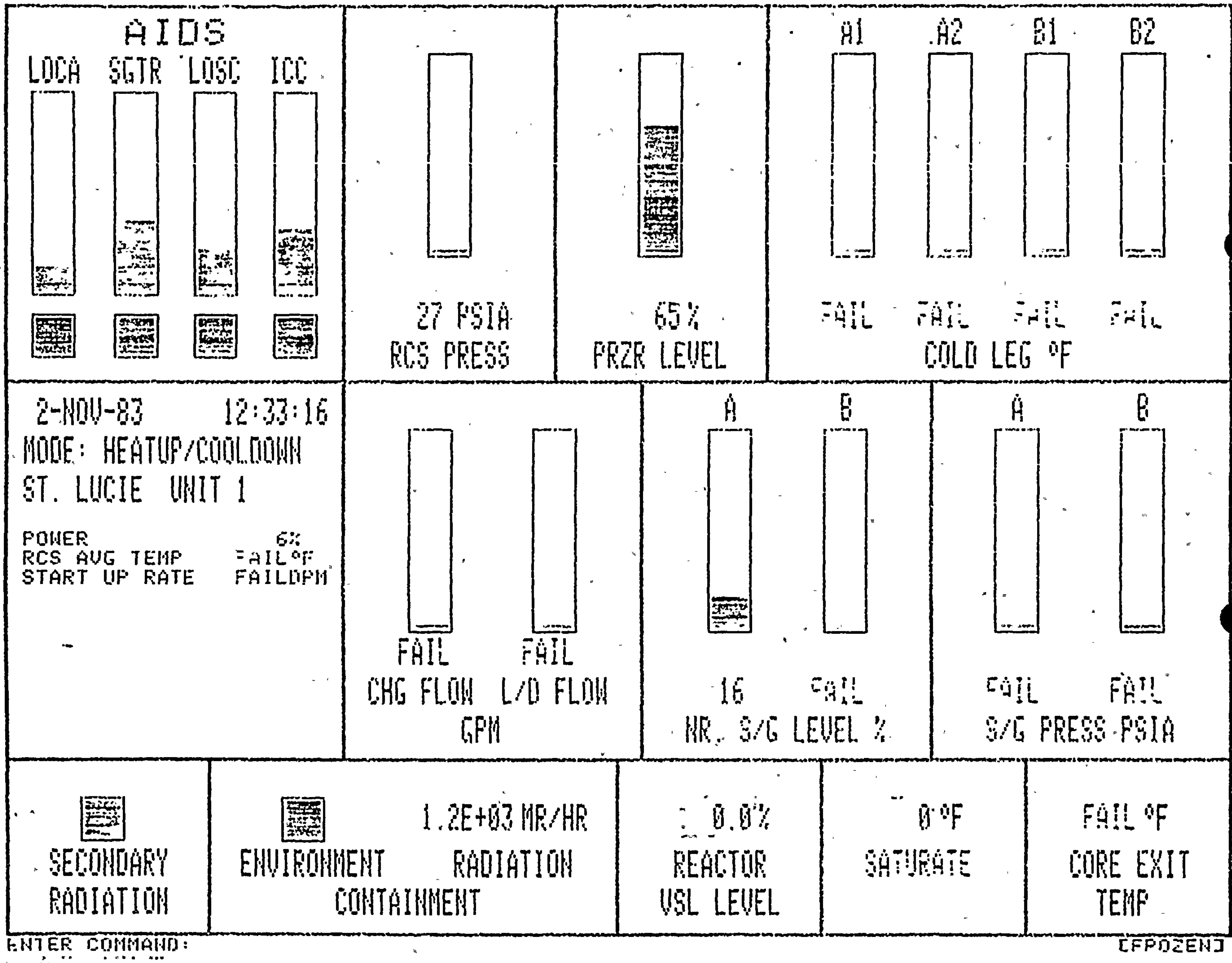

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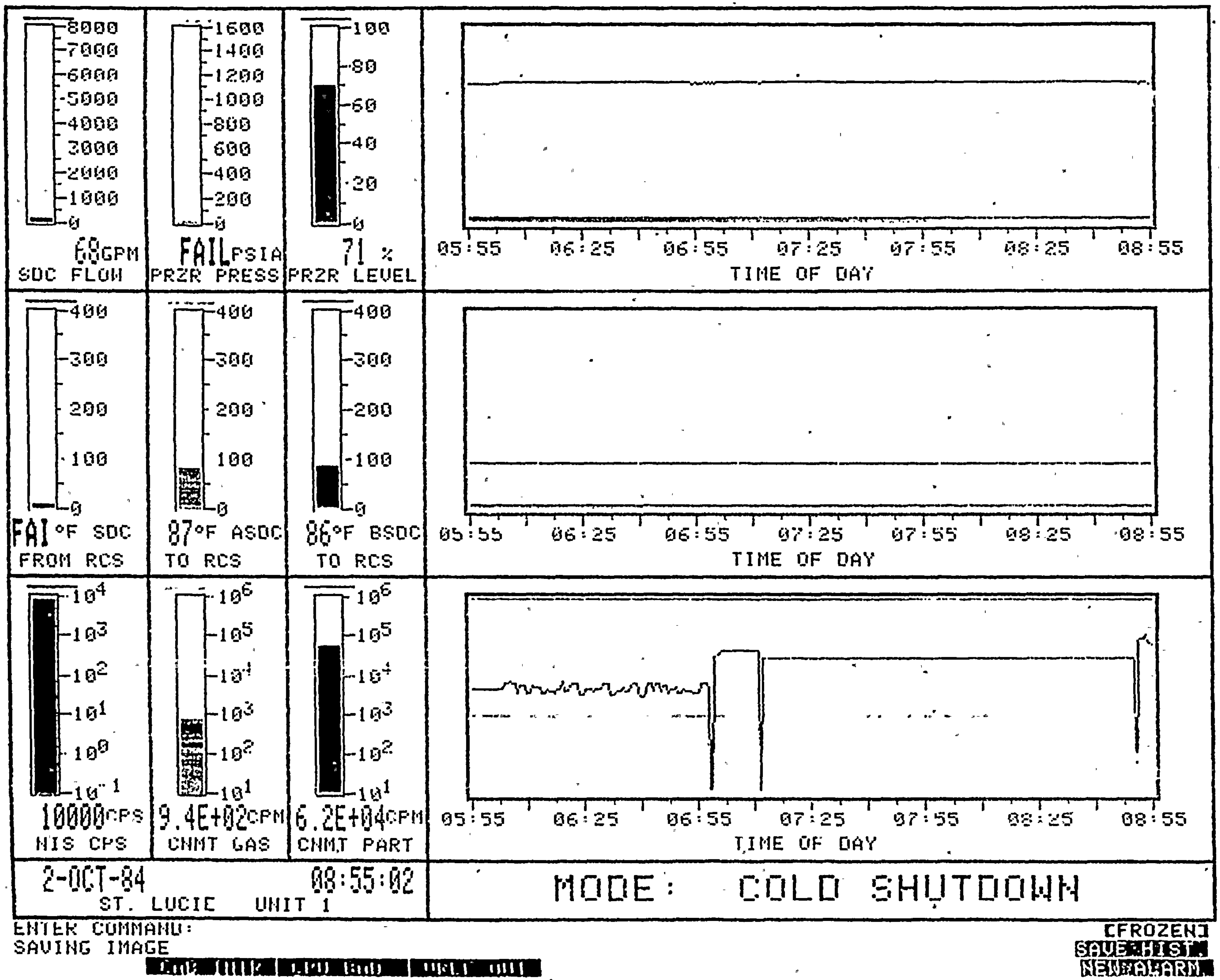

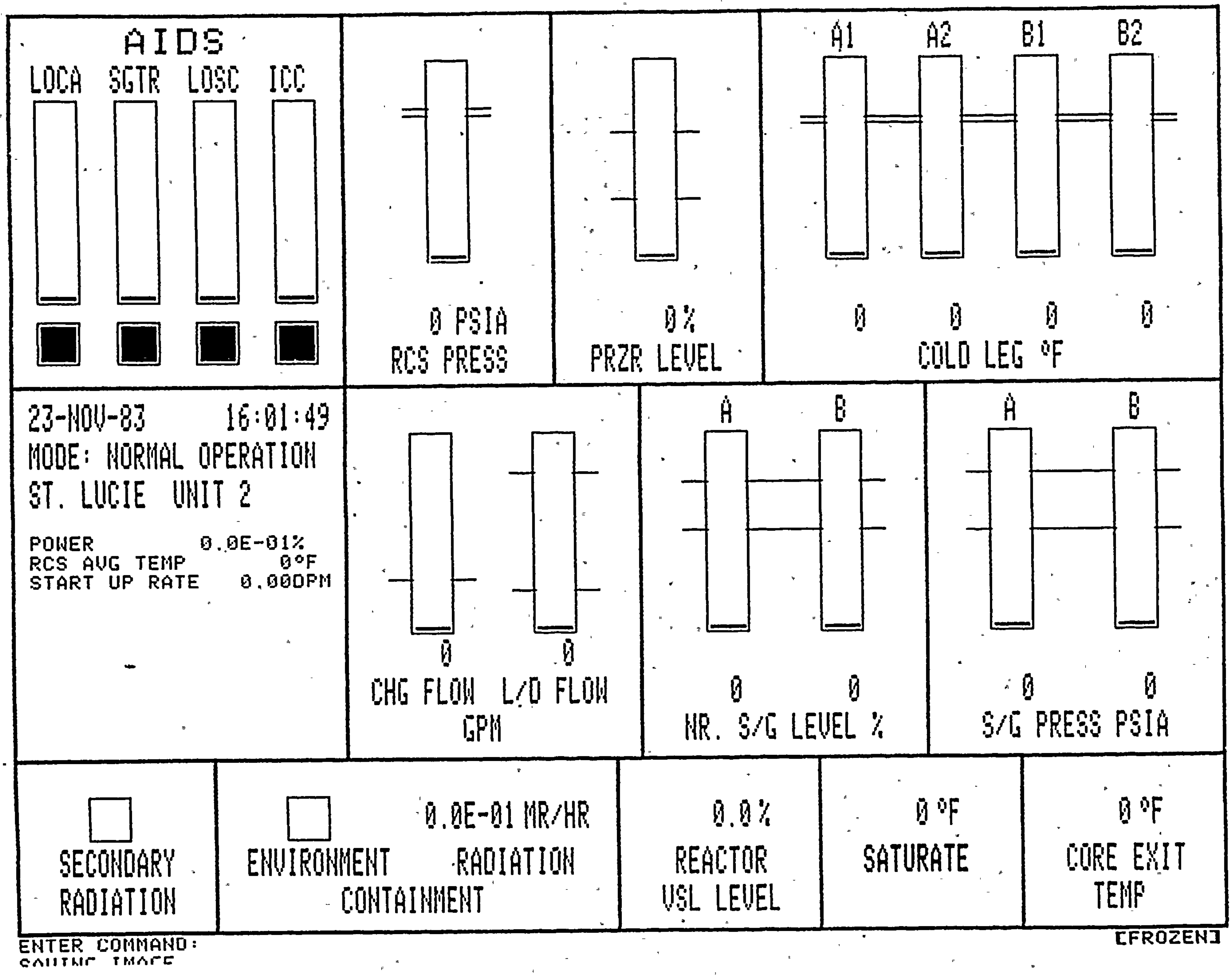
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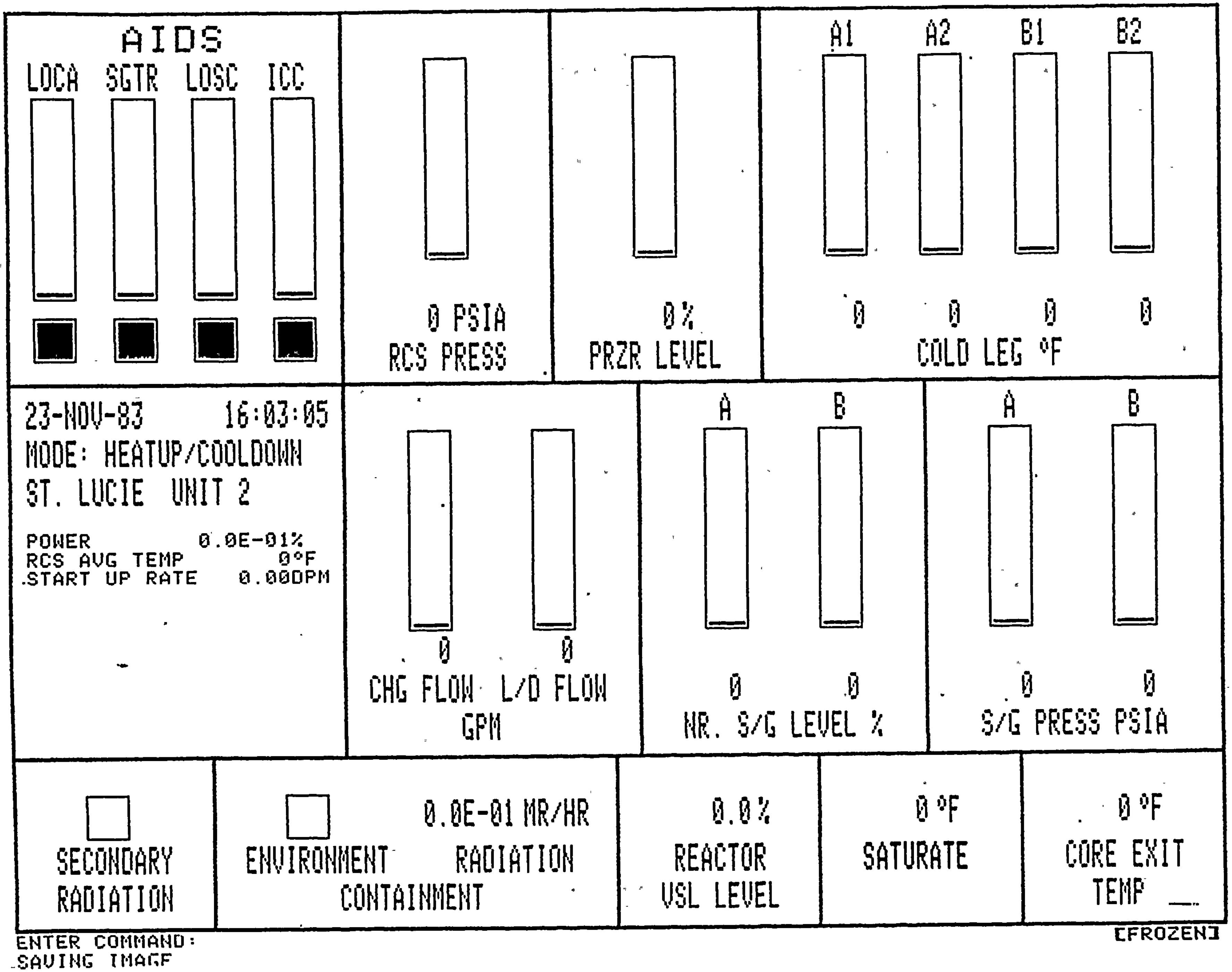
LOCA
SGTR
LOSC
ICC
0 PSIA
RCS PRESS
0%
PRZR LEVEL
A1
A2
B1
B2
0 0 0 0
COLD LEG °F
23-NOV-83 16:01:49
MODE: NORMAL OPERATION
ST. LUCIE UNIT 2
POWER 0.0E-01%
RCS AVG TEMP 0°F
START UP RATE 0.00DPM
0
0
CHG FLOW
L/D FLOW
GPM
A
B
0 0
NR. S/G LEVEL %
A
B
0 0
S/G PRESS PSIA
SECONDARY RADIATION
ENVIRONMENT
0.0E-01 MR/HR
RADIATION
CONTAINMENT
0.0%
REACTOR VSL LEVEL
0°F
SATURATE
0°F
CORE EXIT TEMP
ENTER COMMAND:
[FROZEN]


AIDS
LOCA SGTR LOSC ICC
0 PSIA
RCS PRESS
0%
PRZR LEVEL
A1 A2 B1 B2
0 0 0 0
COLD LEG °F
23-NOV-83 16:03:05
MODE: HEATUP/COOLDOWN
ST. LUCIE UNIT 2
POWER 0.0E-01%
RCS AVG TEMP 0°F
START UP RATE 0.00DPM
0 0
CHG FLOW L/D FLOW
GPM
A B
0 0
NR. S/G LEVEL %
A B
0 0
S/G PRESS PSIA
SECONDARY
RADIATION
0.0E-01 MR/HR
ENVIRONMENT RADIATION
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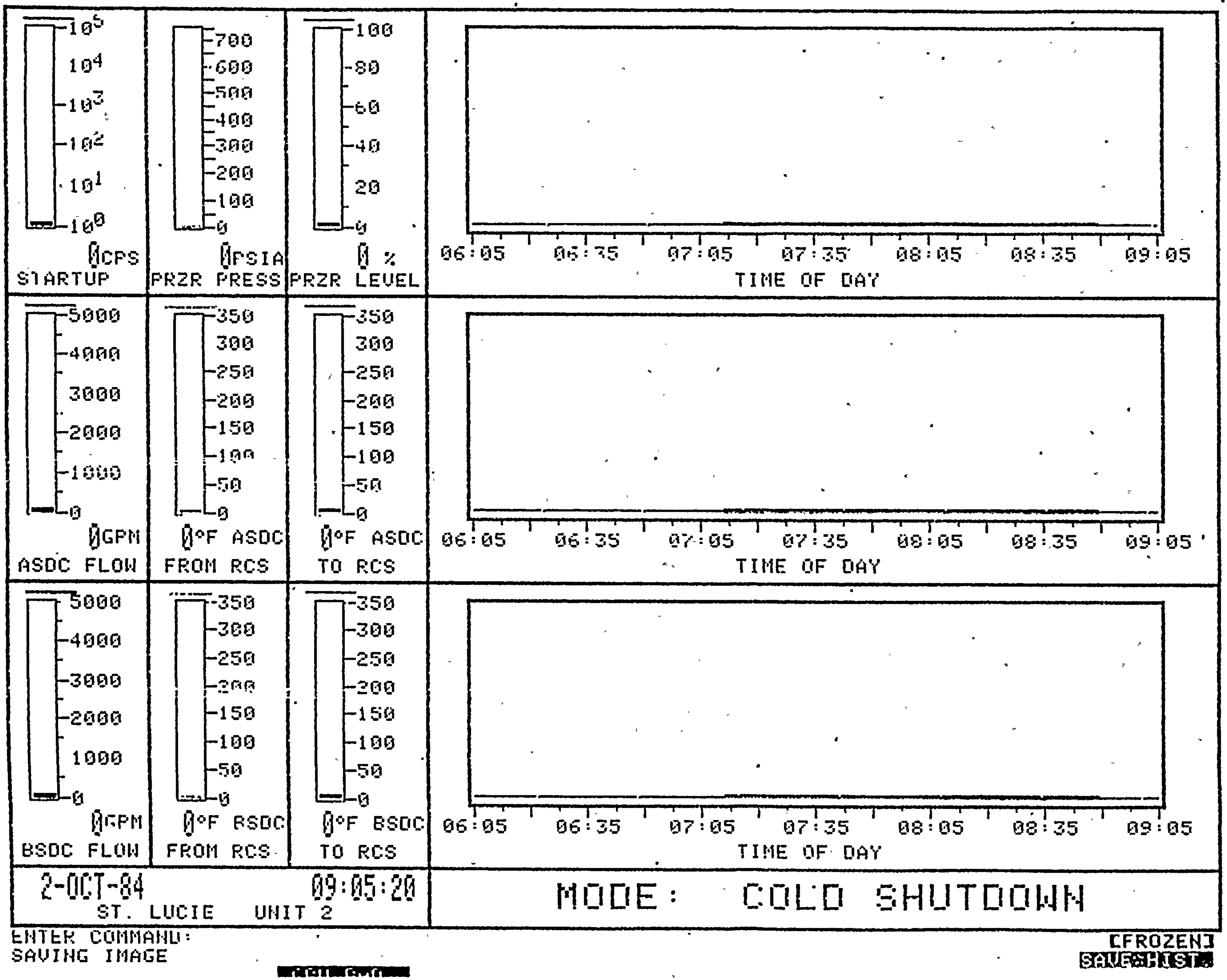
[FROZEN]

Attachment 3



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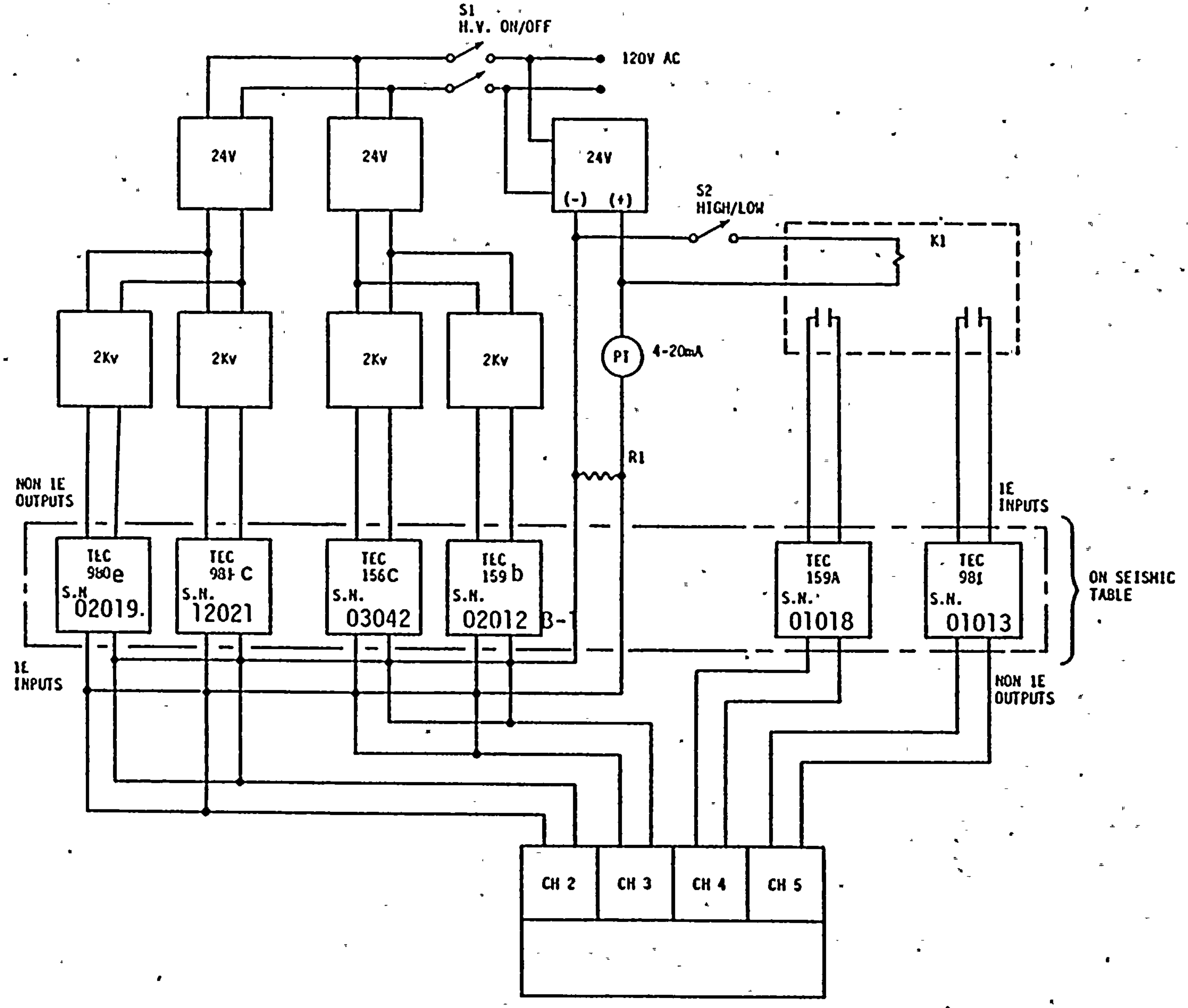


Figure 1 Diagram of Online Monitoring of Isolators

TEST SET-UP

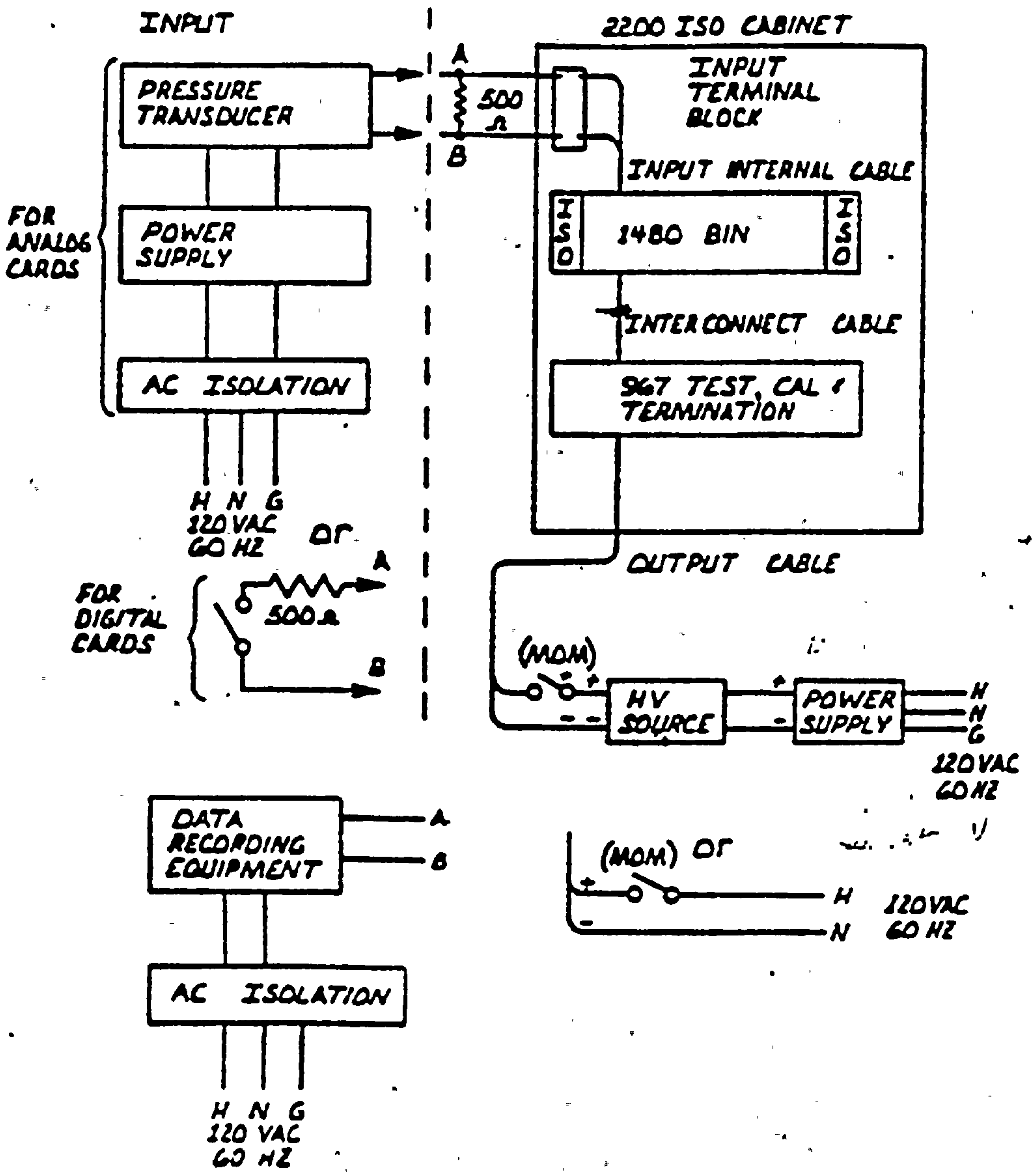
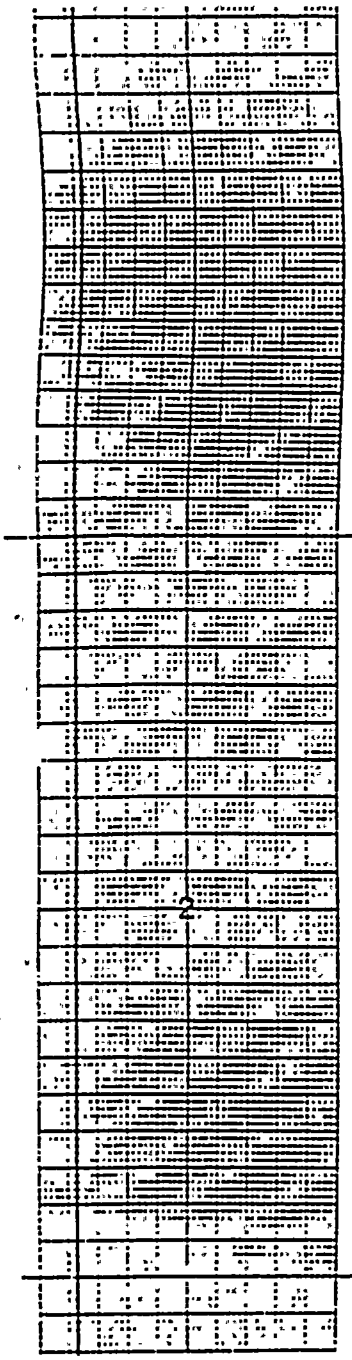
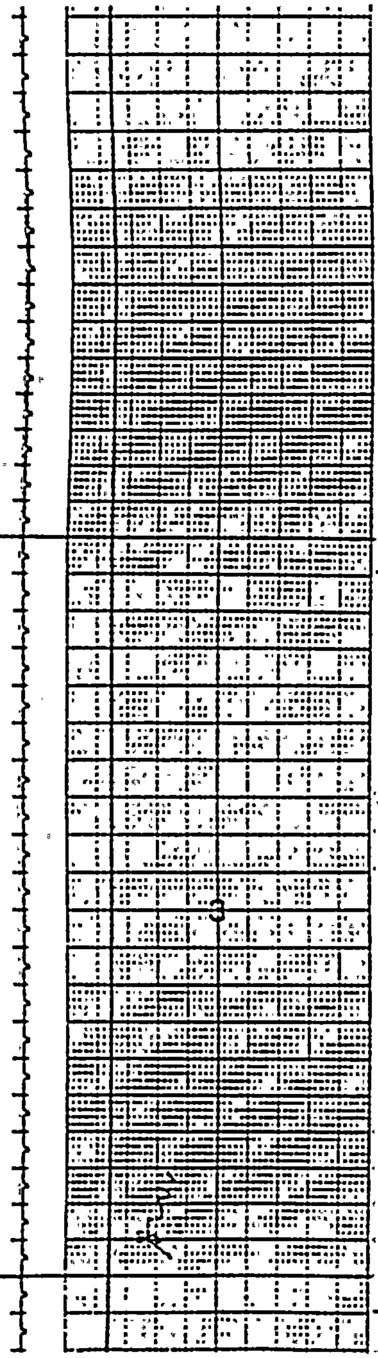


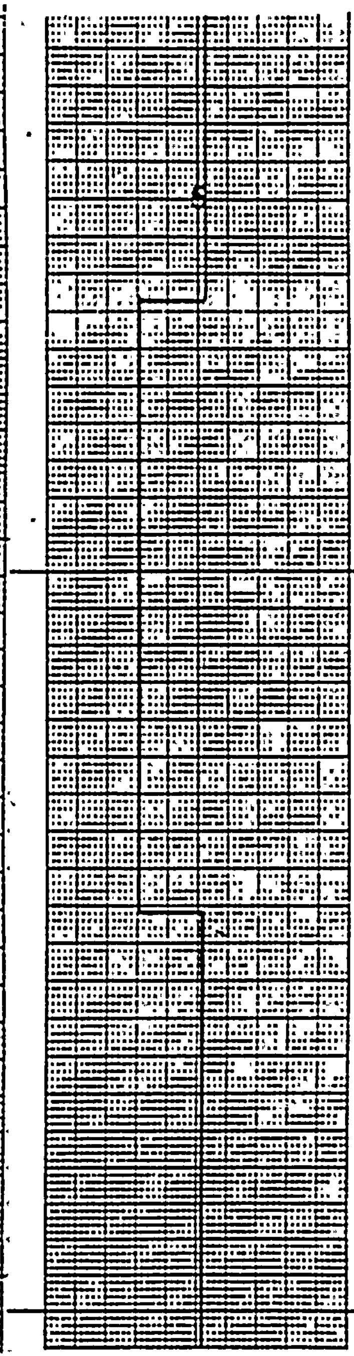
FIGURE 2



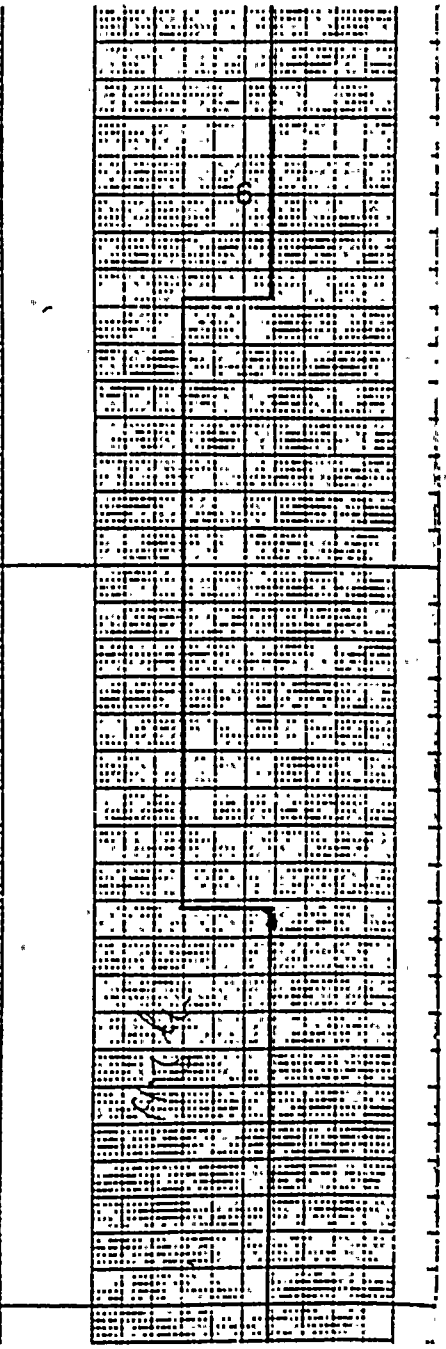
980 Output



156 Output



981 Output



159(A) Output

Figure 3 Output of Recorders During the 2000 Vdc Input Test. (No Isolation Breakdown)

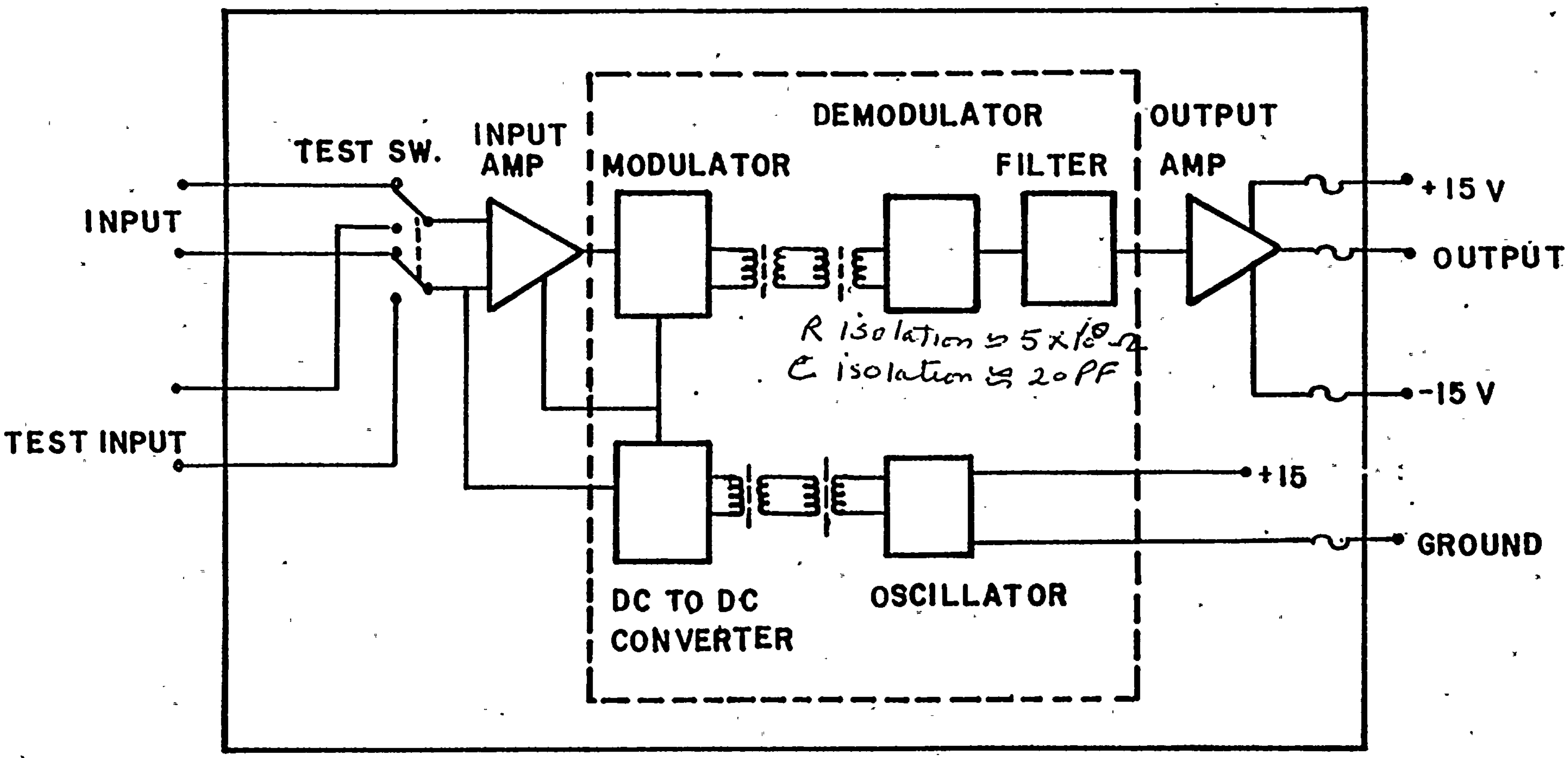


Figure 4. Block Diagram of One Channel in TEC Model 980.

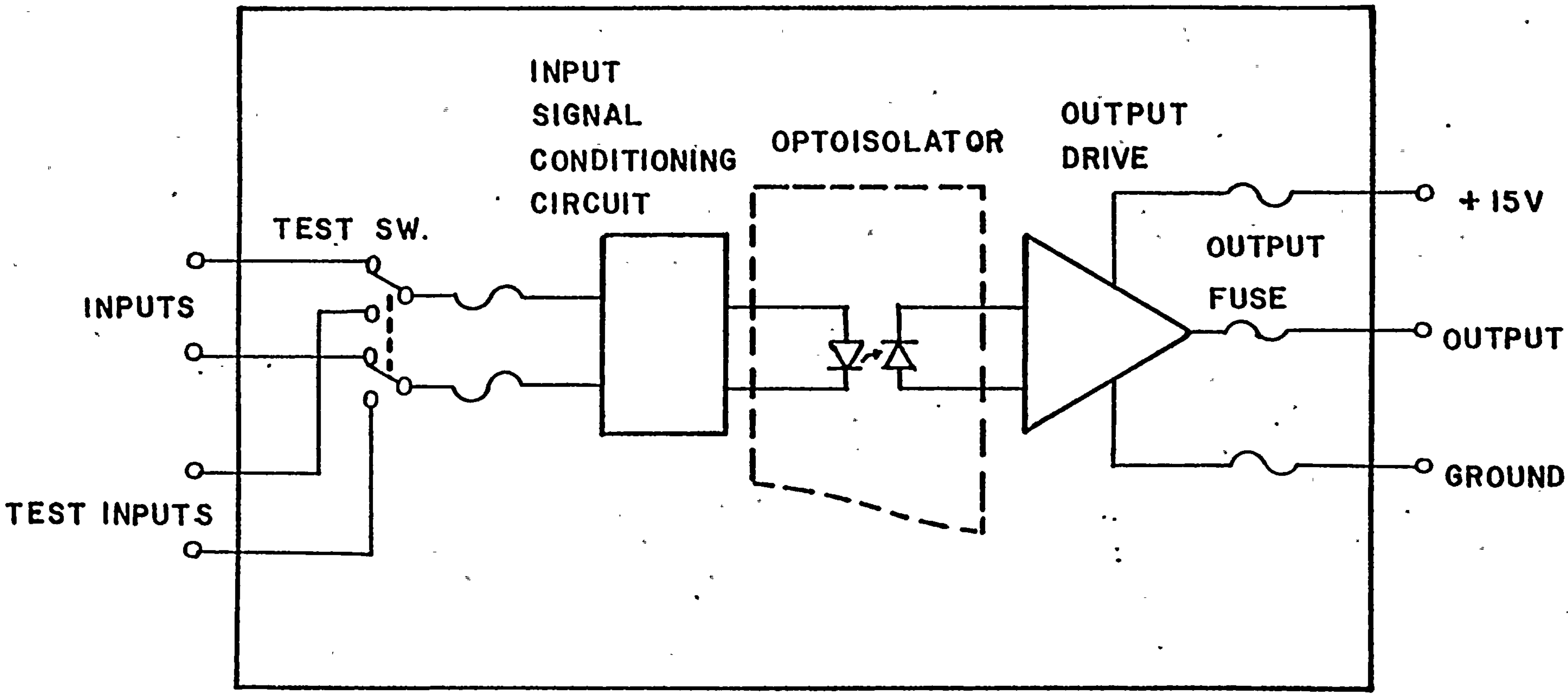


Figure 5 TEC Model 981 Block Diagram.

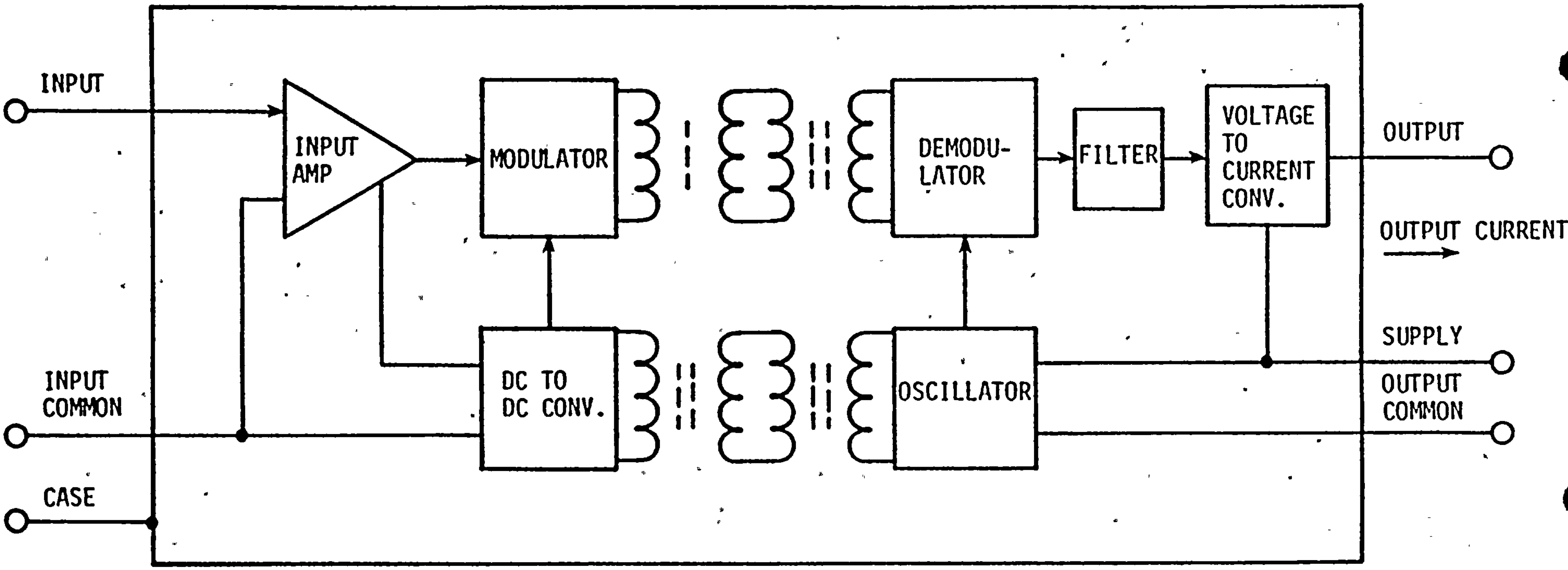
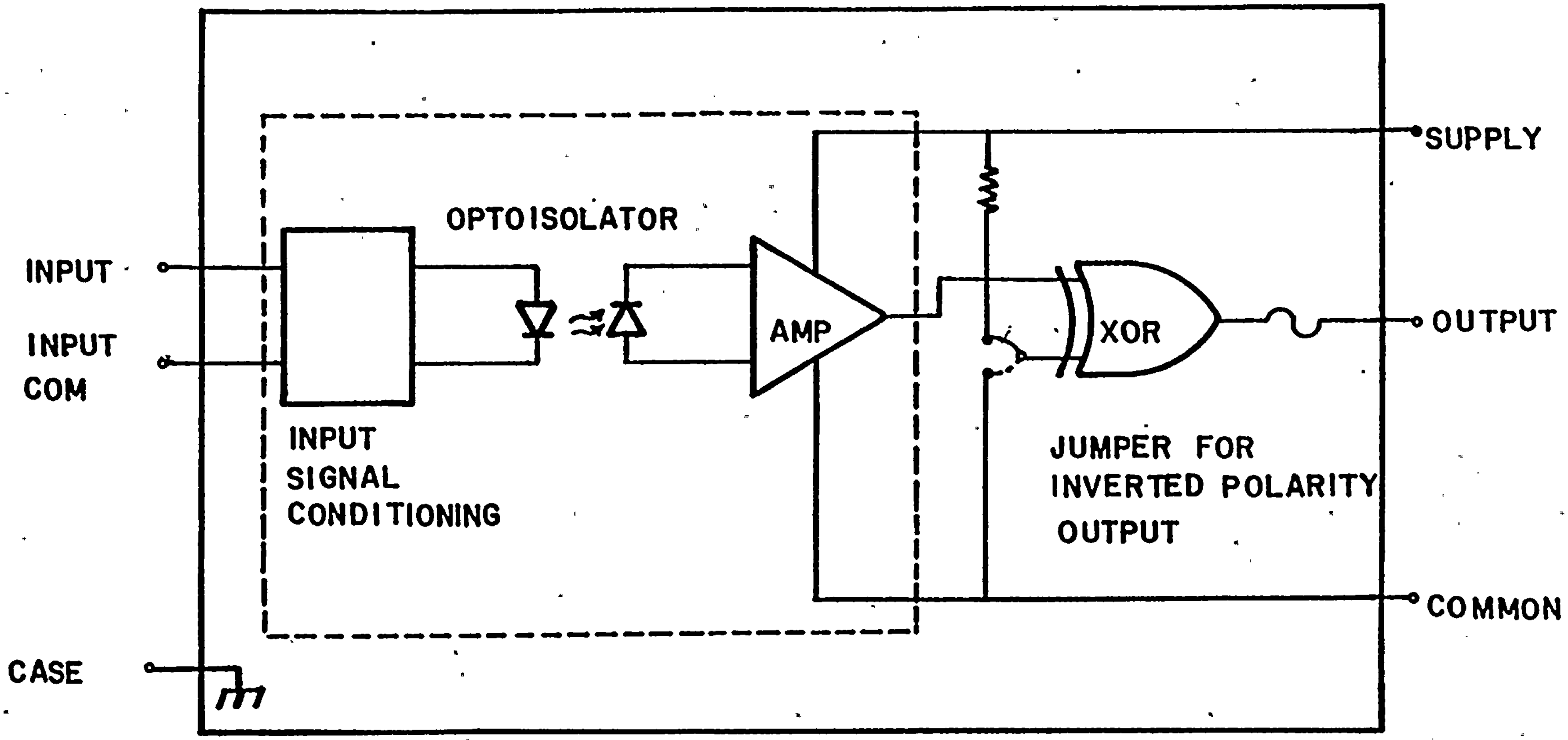


Figure 6 . MODEL 156 ANALOG ISOLATOR BLOCK DIAGRAM



159 BLOCK DIAGRAM

Figure 7 TEC Model 159 Block Diagram