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John C. Brons
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November 1, 1985
JPN-85-80

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Mr. Domenic B. Vassallo, Chief
Operating Reactors Branch No. 2
Division of Licensing

Subject: James A. FitzPatrick Nuclear Power Plant
Docket No. 50-333
Response to Request for Additional Information
Regarding SPDS/EPIC

Reference: 1. NRC letter, D. B. Vassallo to J. C. Brons, dated June 17, 1985, regarding the same subject.

Dear Sir:

In Reference No. 1, the NRC requested additional information regarding the FitzPatrick Safety Parameter Display System/Emergency and Plant Information Computer (SPDS/EPIC). Attachment No. 1 to this letter responds to each of your questions.

If you have any additional questions regarding the FitzPatrick SPDS/EPIC, please contact Mr. J. A. Gray, Jr. of my staff.

Very truly yours,

John C. Brons
Senior Vice President
Nuclear Generation

cc: Office of the Resident Inspector
U.S. Nuclear Regulatory Commission
P.O. Box 136
Lycoming, NY 13093

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Attachment No. 1 to JPN-85-80
New York Power Authority
James A. FitzPatrick Nuclear Power Plant

Response to USNRC June 17, 1985 Request for Additional Information Regarding Safety Parameter Display System

Q1a. Isolation Devices

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 where necessary to indicate the test configuration and how the maximum credible faults were applied to the devices.

R1. General Response

The EPIC/SPDS system, (Figure 1), consists of both 1E and non-1E equipment which interfaces with two Emergency Electrical Divisions (I and II) and the four Reactor Protection System Channels (A1, A2, B1 and B2) in the FitzPatrick plant.

The non-1E/SPDS equipment consists of a central computer system composed of four central processing units, their peripherals and display equipment, an uninteruptible power supply (UPS) system, and data acquisition system (DAS).

Also shown in Figure 1 is the 1E DAS, which interfaces with the two Emergency Divisions and the four RCS/PCIS Divisions. The 1E DAS equipment has been designed and tested to meet the seismic requirements of IEEE-344, "IEEE Recommended Practices from Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations" and the environmental requirements of IEEE-323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations" and can therefore, be safely connected to the 1E plant equipment. The DAS 1E equipment is isolated from the non-1E computer and power equipment in accordance with IEEE-384, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits".

There are three types of interfaces in the EPIC/SPDS system:

I. 1E Signal to Non-1E Computer Equipment, with Isolation Provided by High Speed Digital Fiber Optic Links.

The isolation between the central computers and the 1E DAS equipment is shown on Figure 2. It consists of high speed digital fiber optic links to each 1E cabinet. Each cabinet is independent of the others, connected only by the fiber optic link and the AC power supply.

II. <u>1E DAS Equipment to RPS/PCIS and ECCS Safety Channels, with Isolation Provided by the 1E Equipment Input and Output Circuits.</u>

There are plans to provide approximately 60 ATTS (Analog Transmitter Trip System) outputs from the RPS/PCIS (Reactor Protection System/Primary Containment Isolation System) that are used as input signals by the EPIC/SPDS system. These signals are located in four special RPS channels, (A1, A2, B1, and B2). As shown in Figures 2 and 3, the A1 and A2 signals are terminated in Division I DAS cabinets and the B1 and B2 signals are terminated in Division II cabinets. The ATTS auxiliary isolation amplifiers isolate the RPS trains and the Division I/Division II ECCS trains.

A similar interface is also used between ECCS inputs from the ATTS to the EPIC/SPDS DAS.

III. <u>Non-1E UPS System to 1E DAS Equipment, with Isolation Provided by Qualified Class 1E Circuit Breakers.</u>

Power to the DAS 1E equipment is provided by a UPS system and isolated from the UPS by 1E qualified circuit breakers. The isolation circuit breakers will be qualified to the requirements of IEEE 384-1981. There will be a circuit breaker for both Division I and Division II trains. The uninterruptable power supply includes feeds from both Division I and Division II of the FitzPatrick 600 Volt Emergency Power System. A single line diagram of this interface is shown in Figure 4.

Because the FitzPatrick SPDS/EPIC has three different types of isolation interfaces, each of the sub-parts of Question No. 1 (1a-1f) have been further subdivided in three sub-sections (I, II and III); one for each of the three types of isolation interfaces.

R1a. I. The EPIC/SPDS System uses fiber optic cable and modems for information transfer between the DAS equipment and the SPDS/EPIC computers (Figure 2). The fiber optic cable is constructed totally of non-conductive material with fiber optic cable between modems. Given the characteristics of fiber optics in a mild environment, there is no possibility of any voltage, current, or electromagnetic interference being passed through the cable between the optical modems.

II. The Rosemount Inc. Trip/Calibration System Model 510D modules have auxiliary analog outputs. The following tests were performed on these outputs:

1) Output shorted to power supply and chassis ground,

2) Output shorted to +24 VDC (Master Trip Unit power supply,

3) Output shorted to +125 VDC,

4) Output shorted to 115 VAC, and

5) Output disconnected from load.

The existing isolation design was based on the maximum credible voltage that could be found in the 1E qualified ATTS cabinets (115 VAC and 125 VDC). The maximum credible voltage in the EPIC/SPDS DAS cabinets is also equal to, or less than, that in the ATTS cabinets.

III. The circuit breakers will be equipped with over-current, over-voltage, and under-voltage protection. Test results will be obtained for this protection. The circuit breakers will also be tested and certified to interrupt the maximum short circuit current that could be provided by the UPS.

Q1b. 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.

R1b. I. The maximum credible voltage that could be applied to the fiber optic interface is 600 VAC, the input of the dedicated EPIC/SPDS UPS, or 452 VDC, the highest DC voltage generated on the UPS DC bus. The UPS converts input power to 440 VDC, and then recreates 120/208 volt 3-phase AC power for the SPDS/EPIC computers and DAS. The only connection between the input AC to DC charger and output DC to AC inverter is the DC bus and batteries. The input power is 600 VAC. It would take multiple failures to exceed this voltage. Additionally, surge protection devices qualified to IEEE 472, "IEEE Guide for Surge Withstand Capability (SWC) Tests", have been installed in the power distribution system between the UPS and computer (Figure 2).

II. The 1E DAS equipment is powered by the EPIC/SPDS UPS through approved 1E power isolation devices. It is isolated from the EPIC/SPDS computer equipment by high speed fiber optic links. The maximum credible voltage in the DAS cabinets from non-RPS sources is 115 VAC or 125

VDC. The following signal levels could enter the cabinet from 1E sensors and/or systems:

a. 0 - 10 VDC Analog Inputs,

b. 0 - 60 mA Analog Inputs,

c. 28 VDC Digital Inputs,

d. 115 VAC Digital and Analog Inputs,

e. 125 VDC Digital Inputs, and

f. 120 VAC Equipment Power Supply.

These maximum voltages are guaranteed by the DAS equipment input protection. All DAS inputs, both analog and digital, have IEEE-472 surge protection. Additionally, the analog inputs are transformer coupled, providing 1500 volts peak AC protection for 1 minute. They can withstand 400 VDC or 600 VAC common mode voltage indefinitely. The digital inputs are optically isolated and can withstand 2500 volt surges and 1500 volts DC or peak AC indefinitely. The incoming AC power is isolated from the non-1E UPS by a qualified 1E circuit breaker with over-voltage protection. UPS by a qualified 1E circuit breaker with over-voltage protection. The DAS power supply has been qualified to withstand electrical surges in accordance with IEEE-472. Both the DAS and ATTS cabinets are 1E seismically qualified. The maximum credible accident or failure will not cause the introduction into the cabinets of any voltages higher than those considered above.

The maximum current was not determined or measured. The maximum voltage was applied direct from power supplies, with no current limiting. Maximum current is not a concern because of the inherent limited current carrying capacity of small electronic parts and PC boards used in this equipment.

III. The maximum credible voltage is 600 VAC, the UPS supply voltage, and 452 VDC for the UPS DC bus. The maximum short-circuit current will be determined by analysis of the UPS and the supplied load center.

Q1c. 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).

R1c. I. This question is not applicable for a fiber optic link. The data is transmitted via light waves shining from the transmitter to the receiver, guided by the optical fiber. There is no signal or return conductor, no equivalent to open or short circuit, and no equivalent to transverse mode.

II. Refer to the tests listed in Response 1aII. Tests were performed in the transverse mode by test 3 and 4. Open circuit conditions were tested by test 5.

III. This data will be obtained by the tests listed in Response 1aIII.

Q1d. Define the pass/fail acceptance criteria for each type of device.

R1d. I. The pass/fail criteria to the DAS equipment is that no electrical failures can be propagated through the non-1E/1E barrier. Since there is no electrical connection, no electrical effects of any kind can be passed through the fiber optic cable.

II. The pass/fail criteria was that no damage occurred to the ATTS modules, including the auxiliary output circuit.

III. The pass/fail criteria will be proper operation of the breaker to the faults applied. The breaker should not be damaged by the maximum interrupt current test. The breaker should trip within 2 cycles of over-voltage or over-current events.

Q1e. Provide a commitment that the isolation devices comply with the environmental qualifications (10 CFR 50.49) and with the seismic qualifications which were the basis for plant licensing.

R1e. I. SPDS/EPIC isolation devices will be located in mild environment areas. Therefore, the requirements of 10 CFR 50.49 do not apply. However, SPDS/EPIC isolation devices will meet the environmental qualification requirements of IEE-323-1974 and the design basis seismic qualifications. The portion of the isolation device in the data acquisition cabinets (the far-end fiber optic modem) has been fully qualified to IEEE-323-1974 (environmental) and IEEE-344 (seismic) guidelines for class 1E equipment. The seismic, radiation and environmental tests guarantee that the qualified portion of the equipment is adequate for connection to Class 1E systems.

II. SPDS/EPIC isolation devices will be located in mild environment areas. Therefore, the requirements of 10 CFR 50.49 do not apply. The isolation device is a part of the existing FitzPatrick 1E RPS isolation system. The 1E qualification of the RPS meets the environmental qualifications and the seismic qualifications which were the basis for plant licensing.

III. The required commitment will be obtained from the vendor.

Q1f. 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.

R1f. I. The 1E and non-1E portions of the EPIC/SPDS are separated by fiber optic cable. It is virtually impossible for any electromagnetic interference to be passed this far and be introduced to the system. Additionally, the 1E portions are installed in NEMA-12 cabinets, fully surrounding the equipment with a metallic shield. To insure there is no interference between the DAS equipment and the plant equipment, a Parallel Operations Test (POT) has been conducted. This test connected DAS equipment in parallel with the existing plant computer and plant sensors. Although the test connected only non-1E equipment, the results will be valid for the 1E equipment because the 1E and non-1E equipment are electrically identical.

II. The DAS and RPS equipment is enclosed in full metal cabinets and the connecting cables will be installed in metal conduit. This will eliminate any electrostatic coupling and EMI. Common Mode protection was considered in previous answers.

III. The power supplies in the DAS equipment have surge protection that meets the requirements of IEEE-472. They also have input transformers, providing protection from electrostatic coupling, EMI, common mode voltage, and crosstalk.

Q2. <u>Human Factors Program</u>

Provide a description of the display system, its human factor 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.

Include a discussion of any tests of operator comprehension/man-in-the-loop simulation that may be planned as part of the design or validation phases.

The staff notes that the licensee has committed to meeting the requirements of Supplement 1 to NUREG-0737 (Reference 2, Section 3.0). However, a commitment to providing continuous display was omitted (SIC). The staff position is that the SPDS parameters must be continuously displayed (e.g., dedicated display) or an alerting mechanism provided so that the operator is aware of changes in critical safety function status and can easily access the parameter(s) that are affecting the status of the critical safety function (e.g., continuously displayed status lights combined with function key access to detailed data).

R2. Display System Description

The JAFNPP SPDS/EPIC will use CRT display hardware located in the Control Room. The SPDS will display critical plant variables required to verify the safety status of the plant. The critical plant variables will be presented as real-time data within a static mimic representation of key plant components including the reactor vessel, drywell, suppression pool, and reactor building. The SPDS parameters will be presented and backlit in colors selected to enable rapid recognition by plant operators. The SPDS colors for dynamic parameters are:

GREEN - Normal
YELLOW - Caution - for secondary containment area temperature and radiation levels.
RED - Danger (EOP entry condition met)

In addition to these color changes, audible alarms at the terminals will sound when SPDS parameters change from one alarm state to another. The final SPDS display will represent the completed efforts of the human factors program outlined below to ensure the displayed information can be readily perceived and comprehended so as not to mislead the operator.

Human Factors Program

The SPDS display is being designed by a team of human factors engineers, JAFNPP operators, nuclear engineers, and computer software engineers. This team approach has also been applied to development of the EPIC displays and control room operator work stations.

The ongoing SPDS human factors program includes the following elements:

1. Ergonomic review
2. Interviews with plant operators
3. Review SPDS for compatibility with EOPs
4. Functional verification

From generic work performed by the BWROG, a plant-specific display was created.

Interviews with plant operators were then conducted to review the preliminary SPDS/EPIC display. This included reviews of colored hardcopies and static CRT displays on hardware similar to that which will be used in the control room. Several accident scenarios were used as the method to ensure all parameters and their presentation on the SPDS/EPIC display were examined. A human factors evaluation of the operator observations and recommendations was performed.

Next, a more detailed human factors review emphasized ergonomics, (display format, clutter, color, etc.) This review also independently confirmed SPDS display compatibility with the JAFNPP EOPs.

After the SPDS display has been finalized, the design team will review the SPDS display on a CRT. This will verify that design input was considered in the final design.

Written scenarios will be developed and executed with plant operations staff at a SPDS display terminal to functionally verify the SPDS using man-in-the-loop simulation. Human factors engineers will evaluate the operator's ability to determine plant safety status. At this time an evaluation of the interface hardware (keyboard, trackball, etc.) will also be performed. These scenarios will also be used to confirm that the SPDS/EPIC provides secondary information to the operator to make decisions about corrective action. This program will be performed using simulated plant inputs at an offsite location.

Continuous SPDS Display

The JAFNPP SPDS display will not be continuously displayed in the Control Room. The SPDS/EPIC system will however include alarm propagation to alert the operator to a change of state in any SPDS parameter using both audible and visual cues even if the SPDS display is not being viewed. Each SPDS display console will be equipped with a dedicated function button that will "bring-up" and refresh the SPDS display in approximately two seconds.

The SPDS/EPIC system displays are arranged in a hierarchical fashion. This allows rapid access to any specific display while imposing a logical order on the sequence of the display. Within this hierarchical display structure, the SPDS display is a single display at the highest level and contains the status of all critical safety functions (see Reference 3 and the response to Question 4). Lower-level displays are part of the EPIC system. Hence in the SPDS/EPIC system, the operators are alerted to important changes in SPDS parameters while retaining the flexibility to move quickly down the display structure to obtain more detailed information. The Authority wants to make clear the distinction between the SPDS and non-SPDS portions of the EPIC system. The SPDS is only one display within the EPIC system. EPIC performs many non-SPDS functions.

Q3. Data Validation

Describe the method used to validate data displayed in the SPDS. Also describe how invalid data is defined to the operator.

R3. Data Validation Method and Presentation to the Operator

Table 1 summarizes the quality tags used in the FitzPatrick SPDS/EPIC system and how they are displayed to system operators. Quality tags for analog, digital and analog and digital composed points (C-points) are described below.

Each analog input signal is checked for valid range. Analog signals falling outside their allowable range band are tagged BAD RANGE (BR). A BAD HEALTH (BH) quality tag is associated with all potentially affected points when the data acquisition system (DAS) indicates a problem that could affect data quality. Analog inputs that carry a BH or BR quality tag are overwritten with question marks on displays.

Digital input signals carry BH quality tags which can be set either manually or by program logic based on the analysis of other input signals. Digital input signals with a BAD HEALTH quality tag will undergo a display color change.

Composed points are defined in a manner similar to functions using either sensor inputs or other composed points as function input arguments. Like discrete points, analog C-points that carry either a BH or BC quality tag are overwritten with question marks on displays.

Manually entered data is tagged MA. Manually entered analog signals or analog C-points are also preceded by a single asterisk (*) on displays. Analog or digital points that are "removed from scan" are tagged RS. Analog points carrying RS quality tags are overwritten with asterisks on display; digital points undergo color changes. Analog, digital and C-points in an alarm state are tagged AL and undergo color changes on displays.

Three additional quality tags are used in the system but do not affect the dynamic displays: INHIBITED ALARM CHECKING (IA); INHIBITED ALARM MESSAGE (IM); and INHIBIT OPERATOR ACTION (IO).

Q4. Parameter Selection

The staff's review of the variables selected for display on the FitzPatrick SPDS identified the following omissions:

1. Primary Containment Radiation

2. Primary Containment Isolation Status

3. Combustible Gas Concentration in the Primary Containment

4. Source Range Monitors

The licensee should provide justification for why these variables are not needed for display on the SPDS. Discussion should address the Containment Integrity, Reactivity Control and Radioactivity Control functions in particular; e.g., containment isolation is an important parameter for use in making a rapid assessment of Containment Integrity. A determination that known process pathways through containment have been secured provides significant additional assurance of Containment Integrity.

Combustible gas (hydrogen, oxygen) parameters will be identified in future revisions of the EPGs and provisions should be made to include these parameters. These parameters are related to the Containment Integrity critical safety function.

R4. A summary of primary containment isolation status has been added to the SPDS display. This summary will readily indicate whether containment isolation is required and whether it occurred satisfactorily or not. Unsuccessful isolation can be investigated through lower level displays in the EPIC system.

The issued and approved EPGs (Emergency Procedure Guidelines) do not presently include primary containment combustible gas concentrations as a primary factor. Consequently, the Authority does not agree that these parameters (hydrogen, oxygen) should be included at this time. Since the addition of these parameters to the SPDS display is relatively easy, the Authority will reassess their significance when future revisions of the EPGs are issued and approved. Primary containment combustible gas concentration will however be available in the lower-level EPIC displays.

Source range nuclear instrumentation or primary containment radiation are not considered critical plant variables. They should not be included on the SPDS display if, as specified by NUREG-0737, the SPDS is to provide a concise display. EPGs do not require source range instrumentation to be monitored but rely on Average Power Range Monitor (APRM) readings, scram requirements and control rod position. Reactor power (by APRMs) and the requirement for a scram are provided on the SPDS. The SPDS display also indicates the successful insertion of all control rods. The status of individual control rods will be readily accessible on a lower order display in the EPIC system.

At present, FitzPatrick's hierarchy of SPDS/EPIC displays does not address primary containment radiation. However, a change will be made to include this variable in the lower-level EPIC displays associated with radioactivity release control.

Accident analyses show that primary containment radiation is a poor indicator of an accident. In most cases, other monitored parameters detect the occurrence of an accident (LOCA) well before containment radiation level. The EPGs do not require containment radiation as an entry condition.

Q5. Unreviewed Safety Questions

Provide conclusions regarding unreviewed safety questions and changes to technical specifications.

R5. Modifications associated with the SPDS/EPIC system will be reviewed in accordance with NYPA procedures to determine if they involve an unreviewed safety question or require changes to the Technical Specifications. While these evaluations have not been completed, no unreviewed safety question or change to the Technical Specifications has been identified to date. In the event that SPDS/EPIC system implementation involves an unreviewed safety question or requires change to the Technical Specifications, an application for amendment to the Operating License will be submitted.

References:

1. USNRC Generic Letter No. 82-33 dated December 17, 1982 to all Licensees of Operating Reactors, Applicants for Operating Licensees, and Holders of Construction Permits regarding Supplement No. 1 to NUREG-0737 - Requirements for Emergency Response Capability.

2. USNRC letter dated June 12, 1984, D. B. Vassallo to J. P. Bayne, regarding Issuance of Order Confirming Licensee Commitments on Emergency Response Capability.

3. NYPA letter dated November 30, 1984, C. A. McNeill, Jr. to D. B. Vassallo, (JPN-84-79) regarding SPDS Safety Analysis.

4. NYPA letter dated November 30, 1984, C. A. McNeill, Jr. to D. B. Vassallo, (JPN-84-78) regarding SPDS Implementation Plan.

5. PASNY letter, dated April 15, 1983, J. P. Bayne to D. B. Vassallo, (JPN-83-33) regarding Requirements for Emergency Response Capability.

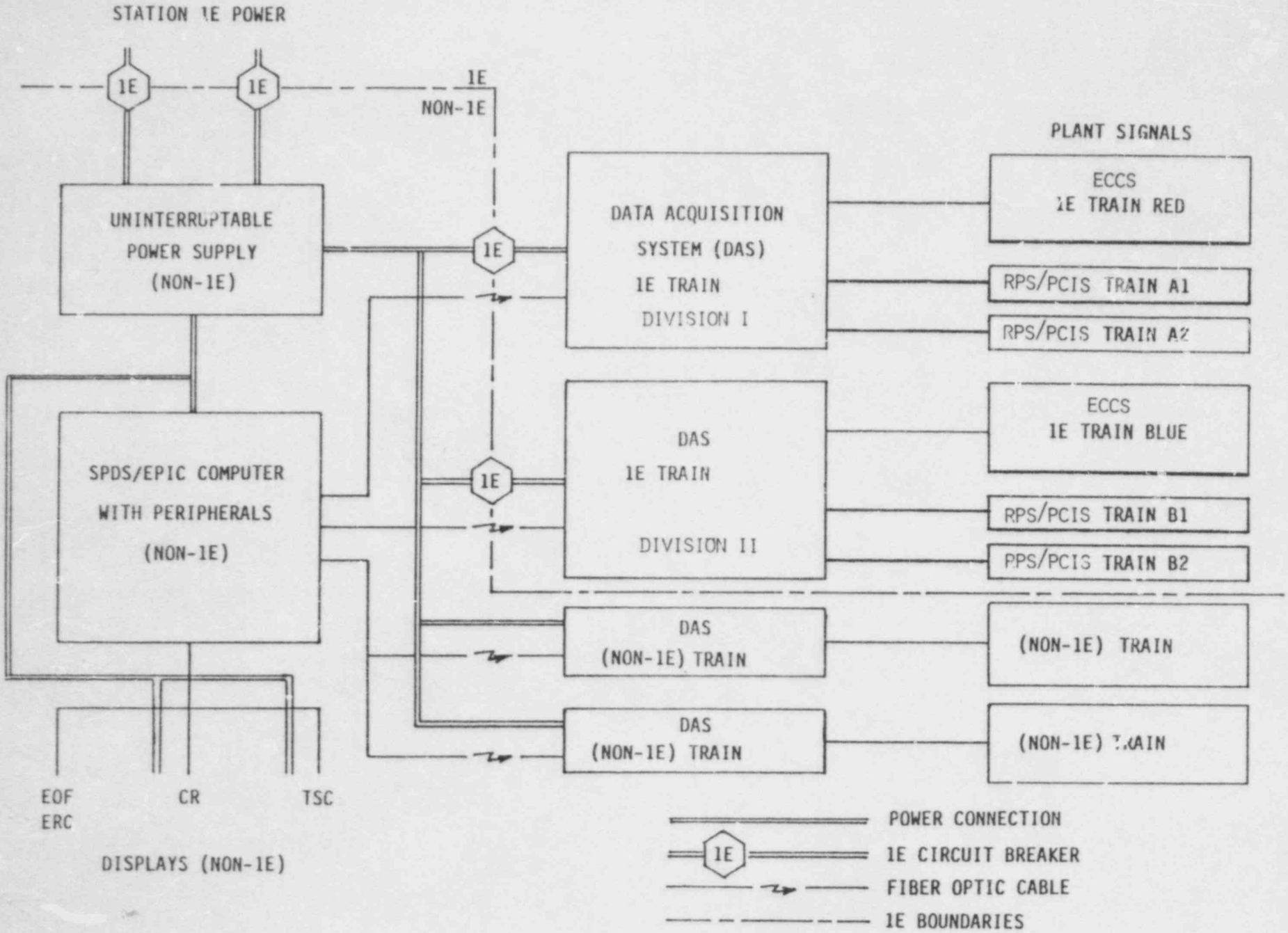


FIGURE 1
OVERVIEW OF SYSTEM

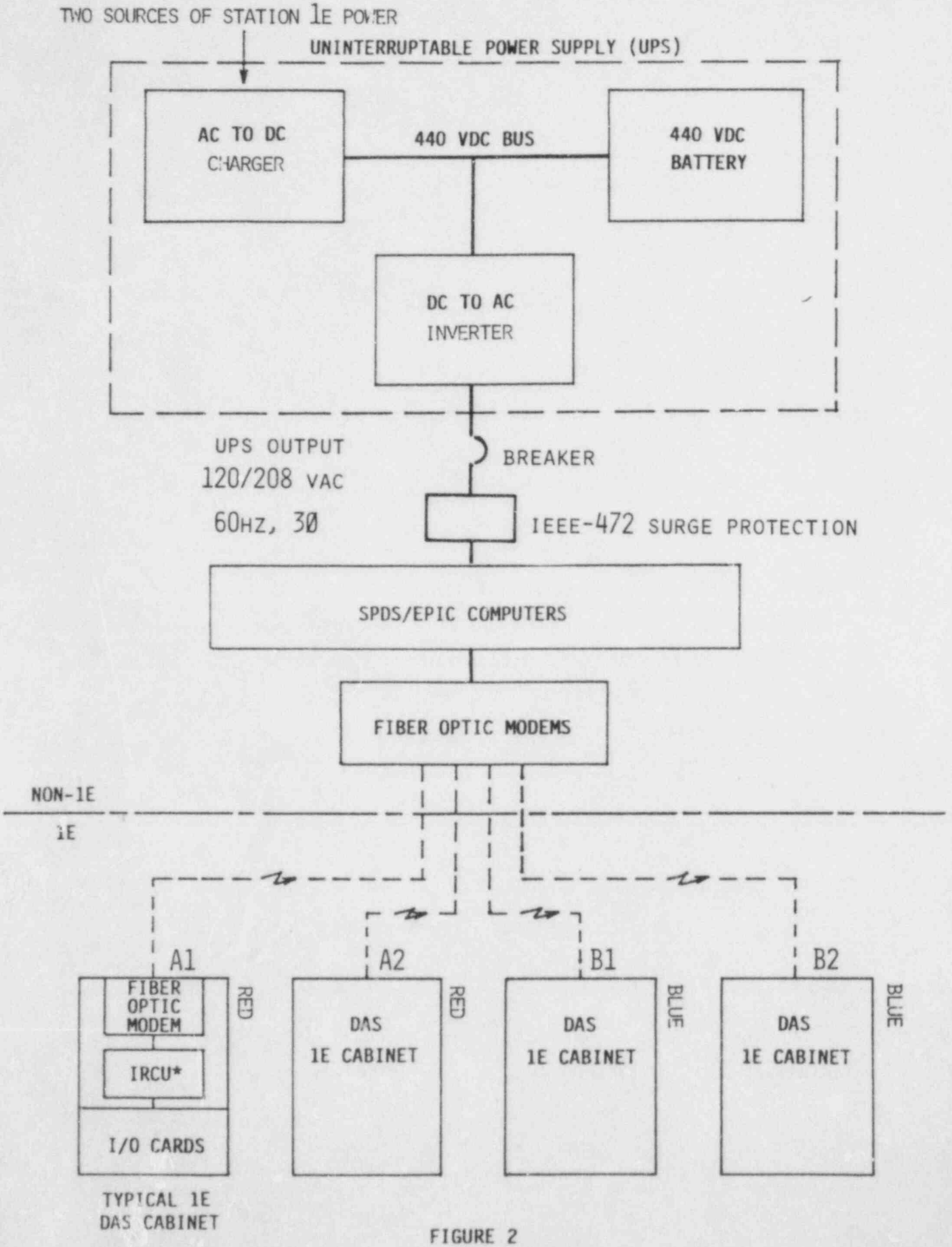


FIGURE 2

NON-1E SPDS/EPIC COMPUTERS TO 1E DAS INTERFACE

* INTELLIGENT REMOTE CONTROL UNIT

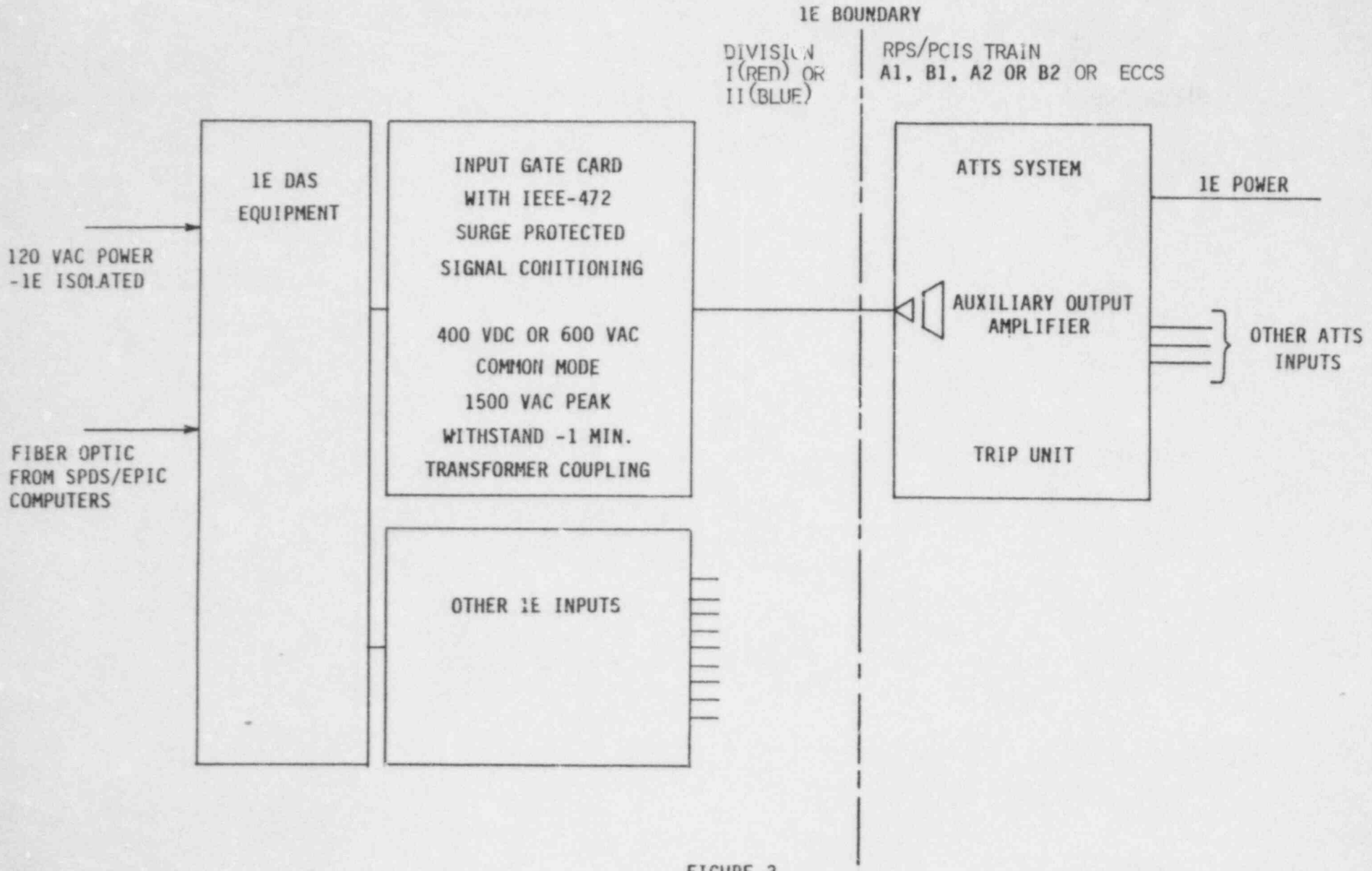


FIGURE 3
1E DAS TO 1E ATTS INTERFACE

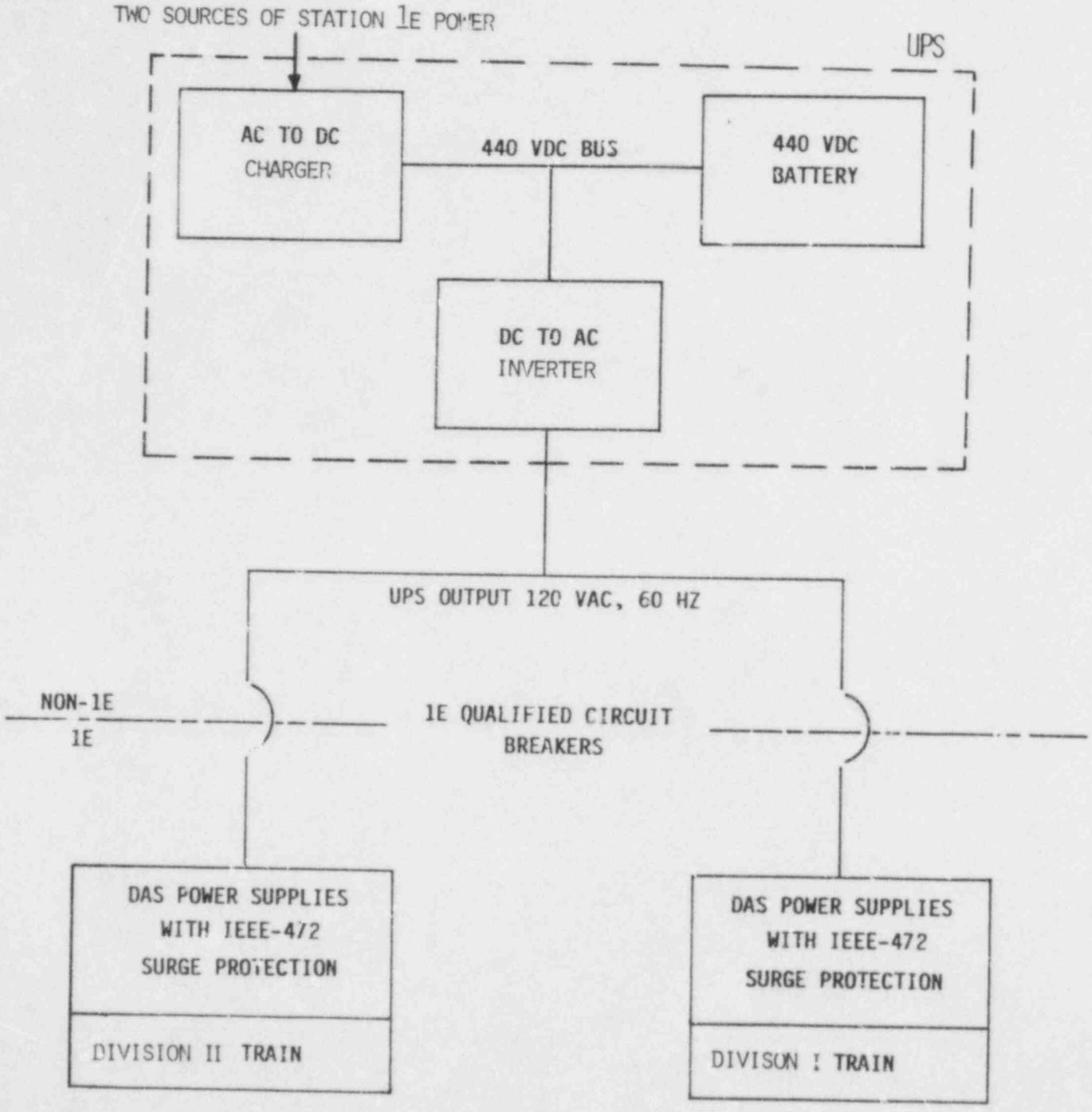


FIGURE 4

1E DAS TO NON-1E UNINTERRUPTABLE POWER SUPPLY (UPS)

Description	Tag Mnemonics	Precedence[1]	Dynamically Displayed			
			Analog	Analog C-Point	Digital	Digital C-Point
Invalid, Cabinet Health Check	BH	1	????	????	CC	CC
Invalid, Sensor Range	BR	2	????	N/A	N/A	N/A
Invalid, C-Point	BC	3	N/A	????	N/A	CC
Substitution C-Point	SU	4	N/A	?NNN	N/A	NC
Manually Entered	MA	5	*NNN	*NNN	NC[2]	NC
Removed from Scan	RS	6	****	N/A	CC	N/A
In Alarm	AL	7	CC	CC	CC	CC
Inhibited Alarm Checking	IA	8	NC	NC	NC	NC
Inhibited Alarm Message	IM	9	NC	NC	NC	NC
Inhibit Operator Action	IO	10	NC	NC	NC	NC

Notes for Table 1:

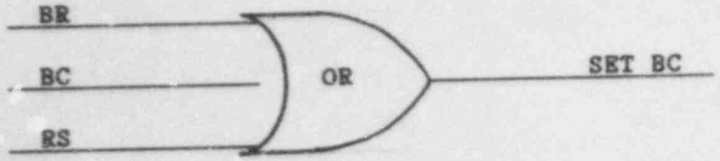
(1) Precedence for purposes of showing "most important tag" with quality tag function button.

(2) Digital points removed from scan can have their state manually changed in the data base; however, this change will not be displayed.

(3) CODE

CC - Denotes color change
N/A - Denotes not applicable
NC - Denotes no change

Table 1 - SPDS/EPIC QUALITY TAGS



	Analog C-Points Display	Digital C-Point Display
IF BH — SET BH	????	Color Change
BR, BC, RS — OR — SET BC	????	Color Change
IF MA — SET MA	*NNN	(To Be Determined)
IF SUBSTITUTE CALCULATION IS USED — SET SU	?NNN	No Change

C-Point Quality Tags:

1. BH (BAD HEALTH)
2. BC (BAD C-POINTS)
3. SU (SUBSTITUTE)
4. MA (MANUALLY ENTERED)
5. AL (ALARM)
6. IA (INHIBIT ALARM CHECK)
7. IM (INHIBIT ALARM MESSAGE)
8. IO (INHIBIT OPERATOR ACTION)

FIGURE 5 C-POINT QUALITY TAG LOGIC