UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

January 23, 1992

Docket No. 50-302

LICENSEE: Florida Power Corporation

FACILITY: Crys... River Unit 3 (CR-3)

SUBJECT: SUMMARY OF DECEMBER 4, 1991 MEETING

On December 4, 1991, representatives of Florida Power Corporation (FPC) met with members of the NRC staff at NRC headquarters in Rockville, Maryland. Subjects discussed included cable separation criteria, emergency diesel generator performance, Electrical Calculation Enhancement Program, and an intermediate building steam line break. A list of attendees (Enclosure 1) and the slides presented during the meeting (Enclosure 2) are enclosed.

Cable Separation Criteria

FPC reported that as a result of specific violations of cable separation criteria identified during the NRC maintenance team inspection in early 1991, FPC reviewed the licensing basis criteria and developed supplemental interim criteria addressing areas not previously covered by the original criteria. Plant walkdowns against both these sets of criteria resulted in 1502 potential discrepancies. Enhanced separation criteria were then finalized, which were used to disposition these discrepancies. Six hundred and two (602) items were determined not to be discrepancies, and the remaining 900 are in various stages of disposition. Copies of the enhanced criteria have been made available to the NRC staff and are included as part of Enclosure 2.

During the meeting, NRC staff members questioned earlier acceptance of some deviations from the original criteria as well as the practice of putting low-voltage power cables in the same tray as control cables. FPC indicated they would respond to these questions.

The NRC indicated that the enhanced separation criteria would be examined and any concerns regarding these criteria would be discussed with the licensee.

Emergency Diesel Generator (EDG) Performance

FPC described its efforts to correct EDG voltage dips which exceeded Regulatory Guide (RG) 1.9 guidance during previous block load tests. Tests performed during the recent maintenance outage indicated that voltage dips for EDG-1B were within the guidance, but that f Block 1 on EDG-1A, the voltage dip slightly exceeded RG 1.9 values.

In response to questions posed by NRC staff, FPC noted that newly installed EDG monitoring equipment will be capable of monitoring the performance of the

EDGs. In addition, digital instrumentation will be installed to more accurately assess conformance with RG 1.9. FPC again noted that although it had committed to pursue conformance to the criteria of RG 1.9 as a goal and believed it was proceeding toward that goal, it had not specifically committed to conform to those criteria.

Electrical Calculation Enhancement Program

As covered in Enclosure 2, FPC updated the status of this effort.

Intermediate Building Steam Line Break

The licensee described the problem of a particular 6" steam line break not being bound, as previously assumed, by the large steam line break. Interim corrective actions until the end of Refuel 8 had previously been approved by the NRC. FPC also discussed its approaches to a permanent fix (see Enclosure 2) and noted that a formal submittal to NRC would be made.

/s/
Harley Silver, Sr. Project Manager
Project Directorate II-2
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosures:
1. Meeting Attendance List
2. Meeting Handouts

cc w/enclosures:
See next page

DISTRIBUTION:
See next page

OFC	:LA:PDII-2	:PM:PDII-2	:D:PDII-2	:	:	:
NAME	:D. Miller	:H. Silver	:H. Berkow	:	:	:
DATE	:1/21/92	:1/21/92	:1/21/92	:	:	:

OFFICIAL RECORD COPY
DOCUMENT NAME: MTGSUM.HS

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ENCLOSURE 1

NRC - FPC MEETING

DECEMBER 4, 1991

ATTENDANCE LIST

NAME	AFFILIATION
H. Silver	NRC/NRR/PDII-2
S. N. Saba	NRC/NRR/SELB
D. Thatcher	NRC/NRR/SELB
M. Pratt	NRC/NRR/SELB
M. U. Rahman	FPC/NUCL ENGINEERING
A. Friend	FPC/LICENSING
D. Peltoca	ABB/IMPELL
C. Doyel	FPC/NUCL ENG SUPR
G. Halnon	FPC/SYSTEMS ENGR MGR
P. Tanguay	FPC/DIR NUCL OPS ENGR
P. Rubio	FPC/NUC ENG SUPR
S. Jasien	FPC/NUC ELEC ENGR
D. Shook	FPC/NUC ENG SUPR
H. Berkow	NRC/NRR/PDII-2
R. Lobel	NRC/NRR/SELB
O. P. Chopra	NRC/NRR/SELB
T. L. Chan	NRC/NRR/EMEB
M. Hartzman	NRC/NRR/EMEB
J. Fair	NRC/NRR/EMEB
B. LeFave	NRC/NRR/DST/SPLB
C. Y. Li	NRC/NRR/SPLB

DISTRIBUTION LIST FOR MEETING SUMMARY
DATED: January 23, 1992

Docket File
NRC & Local PDRs
PDII-2 RDG
T. Murley/F. Miraglia
J. Partlow
S. Varga
G. Lainas
H. Berkow
H. Silver
D. Miller
OGC
E. Jordan
S. N. Saba
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M. Hartzman
J. Fair
B. Lefave
C. Y. Li
ACRS (10)
J. Wechselberger, EDO, 17-G-21
M. Sinkule, RII

AGENDA
FPC - NRC MEETING
DECEMBER 4, 1991

Cable Separation Criteria

Original Criteria Criteria Enhancement New Separation Criteria Tables Summary of Walkdown Findings Follow-up Activities to Correct Discrepancies Root Cause of Discrepancies	P. M. Rubio
Discussion	All

Emergency Diesel Generator Performance

Governor and Voltage Regulator Adjustments
Timer Replacement
Surveillance Testing
    Load Test
    Block Loading Test
        Voltage Regulation
        Frequency Regulation
        Timer Performance
        Significance of Results
	G. H. Halnon

Discussion	All

Electrical Calculation Enhancement Program

Status Update	D. A. Shook
Discussion	All

Intermediate Building Steam Line Break

HELB Criteria History Equipment Qualification Problems Resolution Alternatives Considered	C. B. Doyel
Break Size Change	D. W. Peltola
Discussion	All

<u>Attendees:</u>

P. R. Tanguay	D. W. Peltola	D. A. Shook
G. H. Halnon	M. U. Rahman	A. E. Friend
S. M. Jaisen	P. M. Rubio	

- **NRC MAINTENANCE TEAM INSPECTION**
  JANUARY 14 THRU MARCH 1, 1991

  - FINDINGS

    - CABLES OUT OF CABLE TRAY.
    - CABLES CROSSING DIVISION BOUNDARIES.
    - FLOOR PENETRATIONS SEPARATION PROBLEMS.
    - 6 INCH FREE AIR SEPARATION PROBLEMS.
    - MISSING CABLE TRAY COVERS.
    - TIE WRAPPING OF REDUNDANT DIVISION CONDUCTORS IN MAIN CONTROL BOARD.
    - EXCESSIVE COILED LENGTH OF CABLES TIE-WRAPPED OUTSIDE OF TRAYS.

  - VIOLATION

    - SEVERITY LEVEL IV VIOLATION ISSUED PER NRC LETTER DATED 4/11/91.

- **CR3 SEPARATION CRITERIA**
  - CRITERIA WAS DIVIDED INTO EXTERNAL AND INTERNAL CRITERIA
    - EXTERNAL IS THE CRITERIA APPLIED TO CONDUITS, CABLE TRAYS, AND CABLES OUTSIDE OF CONTROL PANELS AND CABINETS.
    - INTERNAL IS THE CRITERIA APPLIED INSIDE MAIN CONTROL BOARDS, CONTROL PANELS AND CABINETS.

- ORIGINAL CONSTRUCTION

  - EXTERNAL CRITERIA FOUND IN:

    - 1971 - "CRITERIA RELATING TO ELECTRICAL CIRCUIT PHYSICAL SEPARATION AND CABLE TRAY LOADING."

    - FSAR SECTION 8.2.2.12

  - REQUIREMENTS

    - ADDRESSES SEPARATION BETWEEN REDUNDANT SAFEGUARDS CHANNELS AND TRAINS FOR CONDUITS, TRAYS AND CABLES.

    - ADDRESSES SEPARATIONS BETWEEN A SAFEGUARD CHANNEL POWER, CONTROL AND INSTRUMENT CABLE TRAY.

    - DID NOT ADDRESS SPECIFIC SEPARATION BETWEEN 1E AND NON-1E CONDUIT CABLES AND TRAYS.

    - USES CONDUIT AS A BARRIER BUT DID NOT ADDRESS DISTANCES BETWEEN CONDUIT IN 1E AND NON-1E APPLICATION.

- ORIGINAL CONSTRUCTION

  - INTERNAL CRITERIA FOUND IN:

    - 1972 "CONTROL BOARD AND RELAY RACK ENGINEERED SAFEGUARDS SEPARATION CRITERIA REPORT."

  - CRITERIA LATER EVOLVED INTO THE FOLLOWING DOCUMENTS (CRITERIA IS THE SAME IN ALL DOCUMENTS).

    - 1989 - CR3-E247-A "ELECTRICAL SEPARATION CRITERIA FOR CLASS 1E CONTROL BOARDS, EQUIPMENT CABINETS, AND RELAY RACKS."

    - 1991 - E91-0001 CALCULATION ISSUED WITH SAME TITLE AS ABOVE.

  - REQUIREMENTS

    - ADDRESSES SEPARATION BETWEEN REDUNDANT AND ASSOCIATED SAFEGUARDS CHANNELS AND TRAINS FOR CABLES, WIRING AND COMPONENTS INSIDE MAIN CONTROL BOARDS, CONTROL PANELS, AND CABINETS.

    - ADDRESSES ELECTRICAL ISOLATION METHODS TO MAINTAIN INDEPENDENCE OF REDUNDANT CIRCUITS.

    - INTERNAL PANEL CRITERIA REQUIRED SIX INCHES SEPARATION BETWEEN CLASS 1E CIRCUITS.

- CORRECTIVE ACTIONS
  - WALKDOWN OF ELECTRICAL INSTALLATIONS
    - ASSESS EXTENT OF PROBLEM
    - GATHER DATA FOR ROOT CAUSE DETERMINATION
    - ASSESS POTENTIAL CORRECTIVE ACTIONS
  - CORRECT EXAMPLES IDENTIFIED DURING THE MAINTENANCE INSPECTION

- **RESULT OF WALKDOWNS**
  - WALKDOWNS PERFORMED TWICE
    - CONTRACTOR/FPC (≈1500 POTENTIAL DISCREPANCIES)
    - GILBERT/COMMONWEALTH (CONFIRMED 1502 POTENTIAL DISCREPANCIES)
    - SUMMARY OF DISCREPANCIES
      - CABLE TO CABLE SEPARATION
      - WIRE TO WIRE SEPARATION BETWEEN 1" TO 6"
      - CONDUIT TO COMPONENT/CABLE/WIRE/TRAY
      - CABLE TRAY COVERS
      - CABLE/WIRE TIE-WRAPPED TO CONDUITS
      - DOCUMENTATION ONLY CHANGES
      - 35 CASES REQUIRE ADDITIONAL FIELD INFORMATION

- **ENHANCED CR3 SEPARATION CRITERIA**
    - OBTAINED OTHER UTILITY INFORMATION AND INDUSTRY TEST REPORTS
        - 1987 IEEE TRANSACTIONS REPORT ON CABLE TESTING
        - 1990 IEEE TRANSACTION REPORT ON CABLE SEPARATION TESTING PROGRAM
        - INVESTIGATION OF FIRE WRAPS
    - MODIFIED CRITERIA BASED UPON NEW INFORMATION
        - ADDRESSES CONDUIT TO CONDUIT SEPARATION
        - ADDRESSES CONDUIT TO TRAY/CABLE SEPARATION
        - ADDRESSES CABLE TO CABLE/TRAY SEPARATION
        - ADDRESSES 1E TO NON-1E SEPARATION
        - ADDRESSES THE USE OF FIRE WRAPPING TO OBTAIN SEPARATION COMPLIANCE
    - INTERNAL AND EXTERNAL DOCUMENTS WERE COMBINED TO FORM A NEW DOCUMENT WHICH HAS BEEN COMPLETED AND ISSUED
        - THIS DOCUMENT WAS USED TO DISPOSITION DISCREPANCIES IDENTIFIED DURING WALKDOWN

REDUNDANT RACEWAYS SEPARATION CRITERIA FOR 1E EXTERNAL RACEWAYS AND WIRING

	Edge to Edge Spacing[4]	Low Energy		Control		LV Power Circuits with Cable Size ≤500 MCM		LV Power Circuits with Cable Size >500 MCM and All Medium Voltage Power Circuits	
		Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard
Conduit to Conduit	Horizontal Vertical	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	Note [1] Note [1]	Note [1] Note [1]
Conduit to Tray/Cable	Horizontal Vertical	0 inches 0 inches	0 inches 0 inches	Note [2] 1 inch	Note [2] 1 inch	1 inch 1 inch	1 inch 1 inch	1 inch 1 inch	1 inch 1 inch
Cable to Cable/Tray	Horizontal Vertical	1 inch	1 inch	1 inch	1 inch 3 inches	1 inch 3 inches	6 inches 12 inches	1 inch 3 inches	3 feet 5 feet
Tray to Tray	Horizontal Vertical	1 foot 3 feet	3 feet Barriers	1 foot 3 feet	3 feet Barriers	1 foot 3 feet	3 feet Barriers	1 foot 3 feet	3 feet Barriers
Reactor Building Penetrations	Horizontal Vertical	N/A N/A	5 feet[3] 3 feet[3]	N/A N/A	5 feet[3] 3 feet[3]	N/A N/A	5 feet[3] 3 feet[3]	N/A N/A	5 feet[3] 3 feet[3]

<u>NOTES</u>:

(1) An air gap (minimum 1/16") to minimize heat transfer between the conduits. Conduits may have 0 inch separation at condulet bodies only.

(2) An air gap (minimum 1/16") to minimize heat transfer between the tray/cable to conduit.

(3) Measured between centers.

(4) All spacings shown are edge to edge of the raceway/cable and do not include attachment hardware.

SEPARATION CRITERIA FOR INTERNAL 1E TO 1E AND 1E TO NON-1E PANEL COMPONENTS AND WIRING

	EDGE TO EDGE SPACING [3]	LOW ENERGY	CONTROL
COMPONENT TO COMPONENT OR COMPONENT TO WIRE/CABLE OR CABLE TO CABLE OR WIRE TO WIRE OR WIRE TO CABLE	HORIZONTAL VERTICAL	6 inch 6 inch	6 inch 6 inch
CONDUIT TO CONDUIT	HORIZONTAL VERTICAL	0 inch 0 inch	0 inch 0 inch
CONDUIT TO CABLE/WIREWAY/WIRE	HORIZONTAL VERTICAL	0 inch 0 inch	NOTE[1] and [2], 1 inch NOTE[2]

NOTES:

(1) An air gap (minimum 1/16") or an insulating barrier to prevent thermal conductivity between the conduits.

(2) If wireways are enclosed, the wireway is considered an enclosed raceway and is equivalent to a conduit (enclosed raceway).

(3) All spacings shown are edge to edge of the raceway/cable and do not include attachment hardware.

RACEWAYS SEPARATION CRITERIA FOR 1E TO NON-1E EXTERNAL RACEWAYS AND WIRING

	Edge to Edge Spacing [4]	Low Energy		Control		LV Power Circuits with Cable Size ≤500 MCM		LV Power Circuits with Cable Size >500 MCM and All Medium Voltage Power Circuits	
		Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard
Conduit to Conduit	Horizontal Vertical	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	Note [1] Note [1]	Note [1] Note [1]
Conduit to Tray/Cable	Horizontal Vertical	0 inches 0 inches	0 inches 0 inches	Note [2] 1 inch	Note [2] 1 inch	1 inch 1 inch	1 inch 1 inch	1 inch 1 inch	1 inch 1 inch
Cable to Cable/Tray	Horizontal Vertical	1 inch 3 inches	1 inch 3 inches	1 inch 3 inches	1 inch 3 inches	1 inch 3 inches	6 inches 12 inches	1 inch 3 inches	3 feet 5 feet
Tray to Tray	Horizontal Vertical	1 inch 3 inches	1 inch 3 inches	1 inch 3 inches	1 inch 3 inches	1 inch 3 inches	6 inches 12 inches	1 inch 3 inches	3 feet 5 feet
Reactor Building Penetrations	Horizontal Vertical	N/A N/A	5 feet [3] 3 feet [3]	N/A N/A	5 feet [3] 3 feet [3]	N/A N/A	5 feet [3] 3 feet [3]	N/A N/A	5 feet [3] 3 feet [3]

NOTES:

(1) An air gap (minimum 1/16") to minimize heat transfer between the conduits. Conduits may have 0 inch separation at condulet bodies only.

(2) An air gap (minimum 1/16") to minimize heat transfer between the tray/cable to conduit.

(3) Measured between centers.

(4) All spacings shown are edge to edge of the raceway/cable and do not include attachment hardware.

- **DISPOSITION OF DISCREPANCIES**

  - ALL ITEMS DETERMINED NOT TO IMPACT OPERABILITY

  - 602 OUT OF 1502 CASES WERE FOUND NOT TO BE A DISCREPANCY

  - DISCREPANCIES WERE DISPOSITIONED AS FOLLOWS:

○ SEPARATION COMPLIANCE BY FIRE WRAP	450
○ SEPARATION COMPLIANCE BY MODIFICATION	109
○ SEPARATION COMPLIANCE BY REWORK	240
- INCLUDES RETRAINING OF CABLES, REINSTALLATION OF CIRCUITS TO DESIGN DRAWINGS, REWORKING OF CABLES BY CORRECT COLOR CODING AND OTHER NON-WRAP ACTION.	
○ NON-SEPARATION RELATED CASES AND DOCUMENTATION ONLY CHANGES	66
○ CASES NEEDING FURTHER EVALUATION	35
	900

- SUMMARY OF DISPOSITION OF ITEMS

  - ITEMS IDENTIFIED DURING INSPECTION - STATUS

    (1) CABLE SPREADING ROOM - HANGING CABLE OUTSIDE CABLE TRAY

    - COMPLETED

    (2) CABLE SPREADING ROOM - PENETRATION 30 TO 36 CABLE ROUTING PROBLEM

    - RESOLUTION OF DISCREPANCIES ARE BEING EVALUATED

    (3) CABLE SPREADING ROOM - PENETRATION 81 RED AND GREEN CROSSING - WIREWAY MISSING COVER

    - WORK REQUEST #0283065

    - NOT WORKED

    (4) MAIN CONTROL BOARD - SEPARATION BARRIER BETWEEN SPS-155 AND CABLE BUNDLE EFS-5, -6

    - REA #91-0516 - COMPLETED BY ISSUANCE OF MAR 91-08-33-01

    - MODIFICATION SCHEDULED FOR PRIOR TO REFUEL 8

- ITEMS IDENTIFIED DURING INSPECTION - STATUS (continued)

  (5) a) MAIN CONTROL BOARD/SWE591 - REDUNDANT TRAINS TIE-WRAPPED TOGETHER (SWE591/DHC171)

  - COMPLETED

  (5) b) MAIN CONTROL BOARD - INSTALL BARRIER FOR REDUNDANT CROSSOVER ON TRAYS 636 AND 645

  - REA #91-0517 - COMPLETED BY ISSUANCE OF MAR 91-08-33-01

  - MODIFICATION SCHEDULED FOR PRIOR TO REFUEL 8

- **PROGRESS TO DATE**

  - ENHANCED SEPARATION CRITERIA ISSUED TO FIELD AND ENGINEERING

  - FSAR CHANGES SUBMITTED FOR NEXT FSAR REVISION

  - MAINTENANCE PROCEDURE REVIEWED BY ENGINEERING AND COMMENTS SUBMITTED TO MAINTENANCE

  - 166 DISCREPANCIES DISPOSITIONED AND SENT TO FIELD FOR REWORK

  - FIRE WRAP EVALUATIONS BEING FINALIZED FOR INCLUSION INTO CRITERIA AND MAINTENANCE PROCEDURES

    - THIS WILL RESULT IN RESOLUTION OF 450 DISCREPANCIES

- **FOLLOW-UP ACTIVITIES**
  - FIELD REWORK OF DISCREPANCIES
  - MODIFICATIONS ARE PLANNED TO HANDLE REWORK ACTIVITIES INVOLVING DESIGN DRAWING CHANGES
    - INSTALLATION OF NEW BARRIER
    - NEW CABLE TRAY COVERS
    - THIS IS DUE TO INSTALLATIONS NOT MEETING SEPARATION CRITERIA
  - DOCUMENTATION OF ALL FIRE-WRAPS
  - COMPLETE THE EVALUATION OF 35 OUTSTANDING ITEMS

- **PRELIMINARY ROOT CAUSE**

  - TYPICAL FINDINGS WERE:

    - CIRCUIT ROUTING AND RACEWAY PENETRATIONS DID NOT AGREE WITH DESIGN DOCUMENTS

    - SIX INCH SEPARATION BETWEEN REDUNDANT CHANNELS WAS NOT MET

    - MAINTENANCE PROCEDURES DID NOT REFLECT DESIGN CRITERIA

    - SEPARATION GUIDELINES FOR OTHER THAN REDUNDANT CHANNELS (ie; 1E TO NON-1E) HAD NOT BEEN DOCUMENTED

  - PRELIMINARY ROOT CAUSE ANALYSIS

    - ALL DESIGN DOCUMENT REVIEWS SHOWED THAT PROPOSED TRAY ROUTINGS WERE CONSISTENT WITH SEPARATION CRITERIA GUIDELINES.

    - A REVIEW OF THE VARIOUS CABLE SEPARATION DISCREPANCIES FOUND THE ABSENCE OF SEPARATION GUIDELINE IMPLEMENTATION DURING INSTALLATION A COMMON FACTOR.

- **PRELIMINARY ROOT CAUSE (continued)**

  - RESULTS

    - THEREFORE THE FINDINGS SUGGEST THE ROOT CAUSE FOR SEPARATION CRITERIA DISCREPANCIES ARE:

      (1) INADEQUATE IMPLEMENTATION OF SEPARATION CRITERIA DURING INSTALLATION

      (2) LACK OF SEPARATION GUIDELINES RELATED TO OTHER THAN REDUNDANT CHANNELS

ELECTRICAL

CALCULATIONS

ENHANCEMENT

PROGRAM UPDATE

December 4, 1991

TOPICS TO BE COVERED

- WORK THROUGH LAST MEETING (MARCH 12, 1991)
- WORK COMPLETED SINCE OUR LAST MEETING (MARCH 12, 1991)
- WORK PRESENTLY BEING DONE
- LESSONS LEARNED THIS YEAR
- MODIFICATIONS
- NEXT YEAR'S WORK

WORK COMPLETED THROUGH MARCH 12, 1991

- AC & DC SHORT CIRCUIT CALCULATIONS

  THESE CALCULATIONS ESTABLISH THE AVAILABLE FAULT CURRENTS AT SWITCHGEARS, LOAD CENTERS, MCC's.

- AC & DC VOLTAGE DROP CALCULATIONS

  THESE CALCULATIONS ESTABLISH THE VOLTAGE AT RESPECTIVE SWITCHGEAR, LOAD CENTERS, MCC's AND MOTORS.

- AC & DC LOAD FLOW CALCULATIONS

  THESE CALCULATIONS ESTABLISH THE LOAD (CURRENT) AT THE RESPECTIVE SWITCHGEAR, LOAD CENTERS, MCC's AND FEEDS TO END DEVICES.

- MOTOR CONTROL CENTERS CALCULATIONS

  THESE CALCULATIONS ESTABLISH THE BREAKER SIZE, MAGNETIC SETTING AND OVERLOAD SIZE.

- VITAL BUS FAULT ANALYSIS

  THESE CALCULATIONS DETERMINE THE AVAILABLE FAULT CURRENT FOR A SHORT DOWN STREAM OF EACH FUSE. IT MAKES SURE THE FUSE WILL MELT WITHIN .01 SECONDS.

WORK COMPLETED THROUGH MARCH 12, 1991 (Continued)

- HIGH VOLTAGE PROTECTIVE RELAY CALCULATIONS

  THESE CALCULATIONS ESTABLISH THE SETTING ON THE PROTECTIVE RELAYS FROM 230KV THROUGH 4160V. CURVES ARE ALSO DRAWN.

- DC CONTROL CIRCUIT CALCULATIONS

  THESE CALCULATIONS LOOK AT VOLTAGE DROP, CONDUCTOR SIZE AND END DEVICE RATINGS WITHIN THE DC CONTROL CIRCUITS.

- DC COORDINATION CALCULATIONS

  THIS CALCULATION REVIEWS THE FUSES USED IN THE DC SYSTEM TO PROVIDE PROTECTION.

- MCC CONTROL TRANSFORMER FUSE SIZING

  THIS CALCULATION ASSURES THE PROPER PRIMARY AND SECONDARY FUSES ARE SELECTED.

- BATTERY SIZING CALCULATIONS

  THESE CALCULATIONS REVIEW THE SIZES OF THE BATTERIES AND THE BATTERY CHARGERS.

WORK COMPLETED SINCE MARCH 12, 1991

- LOW VOLTAGE PROTECTIVE RELAY COORDINATION

  THESE CALCULATIONS ESTABLISH THE SETTINGS FOR THE PROTECTIVE RELAYS AT THE 480V LEVEL. CURVES ARE ALSO DRAWN.

- SOFTWARE INSTRUCTIONS

  THIS DOCUMENTS HOW TO OPERATE SOFTWARE USED TO DO THE AC SHORT CIRCUIT, VOLTAGE DROP, AND LOAD FLOW CALCULATIONS.

- REVIEW HELB CABLES

  THIS WAS A REVIEW TO ESTABLISH WHAT POWER CABLES ARE NEEDED TO MITIGATE A HIGH ENERGY LINE BREAK (HELB) AND THE HIGHEST TEMPERATURE THEY WILL SEE.

- ACDP DISTRIBUTION PANELS

  THIS CALCULATION REVIEWED THE PROTECTIVE DEVICES USED IN (120V) SAFETY RELATED PANELS.

- MAJOR AC EQUIPMENT

  THIS CALCULATION REVIEWS THE MANUFACTURERS RATINGS OF VARIOUS LARGE PIECES OF ELECTRICAL EQUIPMENT WITH RESPECT TO VALUES CALCULATED BY WORK ALREADY COMPLETE.

WORK PRESENTLY BEING DONE

- VOLTAGE DROP DURING MOTOR STARTING

  THIS CALCULATION ESTABLISHES THE VOLTAGE AT THE TERMINALS OF 4160V AND 480V MOTORS ON THE ES BUSES DURING BLOCK LOADING. THIS DETERMINES THE ABILITY OF THE MOTORS TO ACCELERATE. THE CALCULATION USES THE LOWEST VOLTAGE CALCULATED IN THE AC VOLTAGE DROP CALCULATION TO PERFORM THIS MOTOR STARTING CALCULATION. THE CALCULATION IS IN VERIFICATION AND WILL BE ISSUED THIS YEAR.

- PT & CT BURDEN CALCULATIONS

  THIS CALCULATION REVIEWS THE BURDEN IMPOSED ON SAFETY RELATED CURRENT TRANSFORMERS (CTs) AND POTENTIAL TRANSFORMERS (PTs).

- AC & DC HELB CIRCUITS

  THIS WORK REVISES THE EXISTING AC AND DC VOLTAGE DROP AND LOAD FLOW CALCULATIONS TO INCLUDE THE EFFECTS OF HIGHER TEMPERATURES. THIS WORK IS ON GOING.

- MCC & VITAL BUS CONTROL CIRCUITS

  THESE ARE TWO LARGE CALCULATIONS DONE TO REVIEW THE CONTROL CIRCUITS ON SAFETY RELATED MCC's AND THE VITAL BUSES

  - VOLTAGE DROP TO END DEVICE
  - CABLE CURRENT CARRYING CAPACITY

WORK PRESENTLY BEING DONE (Continued)

- MCC & VITAL BUS CONTROL CIRCUITS (continued)

  - CONTROL TRANSFORMER SIZE
  - FUSE AMPERE RATING
  - CONSIDERS LOW VOLTAGE
  - CONSIDERS INRUSH
  - VITAL BUS FUSE COORDINATION

  THE CALCULATIONS HAVE BEEN ISSUED PRELIMINARY. THE FINAL ISSUANCE WILL BE IN MARCH TO ALLOW A REVIEW OF PROBLEMS AND TO ELIMINATE PROBLEMS CAUSED BY CONSERVATISM.

- UPDATE THE DC CALCULATIONS

  THE CALCULATIONS MUST BE MAINTAINED. MODIFICATIONS ARE REVIEWED AS THEY ARE DEVELOPED. THE CALCULATIONS ARE ONLY UPDATED ONCE A YEAR. THESE CALCULATIONS WILL BE REISSUED IN FEBRUARY 1992.

- CALCULATE SAFETY RELATED CABLE AMPACITY

  THIS CALCULATION VERIFIES THE AMPACITY, OVERLOAD PROTECTION, AND SHORT CIRCUIT WITHSTAND CAPABILITY OF EACH SAFETY RELATED POWER CABLE. A MORE DETAILED CRITERIA THAN COMMITTED TO IN THE FSAR IS BEING USED. THIS TASK IS 70% COMPLETE AND WILL BE ISSUED IN JANUARY 1992.

WORK PRESENTLY BEING DONE (continued)

- **CORRECTIVE ACTION**

ALL PROBLEMS FOUND DURING THE VARIOUS CALCULATIONS ARE IDENTIFIED AND CONTROLLED BY AN ENGINEERING PROCEDURE AND ARE IDENTIFIED ON OPEN ITEM REPORTS.

STATUS	AC	DC
TOTAL ISSUED	140	309
TOTAL CLOSED	126	77
OPEN	14	232*

*	36 -	NEW CALCULATIONS WILL RESOLVE
	70 -	PRESENTLY BEING WORKED ON
	59 -	REVISED DC CALCULATION EXPECTED TO RESOLVE
	67 -	MODIFICATION TO BE ISSUED THIS YEAR
	232	

LESSONS LEARNED THIS YEAR

- CALCULATION DEPENDANCE

  - VARIOUS CALCULATIONS HAVE BEEN PERFORMED THAT PROVIDE ADDITIONAL DATA/INPUT TO EXISTING CALCULATIONS.

  - THE CURRENT REQUIRED TO START AND RUN A MOTOR AT LOW VOLTAGE MUST BE CHECKED TO INSURE THE OVERLOAD ELEMENTS WILL NOT TRIP.

  - MCC CONTROL CIRCUIT FUSE RATINGS AND CONTROL TRANSFORMER RATINGS MUST BE EVALUATED AT DEGRADED VOLTAGES.

  - MAXIMUM DROPOUT VOLTAGES OF CONTACTORS MUST BE VERIFIED AT DEGRADED VOLTAGES.

- IMPORTANT PARAMETERS

  WE LEARNED WHICH PARAMETERS HAVE A SIGNIFICANT IMPACT ON EACH CALCULATION. THIS HELPS IN THE EVALUATION OF MODIFICATIONS.

MODIFICATIONS

- SECOND ES TRANSFORMER

  THIS WILL PROVIDE TWO SOURCES TO OUR ES BUSES FROM THE 230KV SUBSTATION. THIS WILL BE INSTALLED DURING MIDCYCLE 9M.

- CIRCULATING WATER PUMP POWER CABLES

  THESE NON-SAFETY RELATED CABLES ARE NEAR THEIR END OF LIFE. THEY ARE BEING REPLACED. THESE ARE BEING SCHEDULED.

- CONTROL COMPLEX CHILLER 3A POWER CABLE

  THIS CABLE WILL REACH ITS END OF LIFE IN ABOUT FOUR YEARS. THIS CABLE WILL BE REPLACED.

- NON ES BATTERY

  A SEPARATE BATTERY HAS BEEN INSTALLED AND MOST OF THE NON ES LOADS HAVE BEEN TRANSFERRED TO IT. THIS TASK IS COMPLETE.

- NINE 480V ES SWITCHGEAR BREAKERS

  THE NINE 600 A BREAKERS ARE BEING REPLACED WITH 1600 A BREAKERS TO INCREASE THE SHORT CIRCUIT RATING FROM 30,000 AMPS TO 50,000 AMPS. THIS WILL ALLOW CR3 TO REGAIN COORDINATION. THIS WORK IS SCHEDULED TO BE COMPLETED IN REFUEL 8.

NEXT YEAR'S WORK - 1992

- COMPLETE CALCULATIONS

  COMPLETE THOSE CALCULATIONS STARTED IN 1991. THESE WILL BE COMPLETED DURING THE FIRST QUARTER OF 1992.

- MAINTENANCE

  MAINTAIN THE CALCULATIONS ISSUED BY THIS ENHANCEMENT PROGRAM. THIS WILL BE DONE WITH LOGS AND YEARLY UPDATES.

- EDSFI

  THE ENHANCEMENT GROUP WILL PREPARE FOR THE EDSFI AND WILL BE THE LEAD ORGANIZATION FOR THE INSPECTIONS.

Florida Power Corporation

Crystal River Unit 3

Emergency Diesel Generator

Voltage Response

Design Basis

Discussion

HISTORY

Pre-Refuel 7

- LER 87-19-01 discussed design basis of electrical voltages

    - Block 1 Voltage Dip 71.1%
    - Recovered in 2.06 seconds
    - Contactor Min Volt. 65% of rated

- Due to Max rating concerns, EDG Upgrade Program was developed

    - Tripping EFP when LPI is required
    - Selectable RB Cooling Fan
    - Trip Heat Tracing load
    - Limit initial EFW flow
    - ~~High Accuracy Block Load timers~~

HISTORY

- o NRC Approved program Sept 18, 1989

- o NRC Requested testing of 480 Volt and 120 Volt to ensure design basis calculations met at contactors

Refuel 7

- o A Diesel: Block 2 dip was 27.2 % and
  Block 4 dip 28%

- o A Diesel: Block 4 came in 1 second
  early

- o B Diesel: Block 1 dip was 25.8%

- o All end device contactors were either tested or calculated to meet design basis

HISTORY

Post Refuel 7

- o Data did not meet Reg Guide 1.9 criteria
  - o Max 25% dip and restored to within 10% of nominal within 60% of block time
  - o Max 5% dip in frequency restored to 2% of nominal within 60% of block time
- o FPC not specifically committed to RG 1.9 but committed to as a goal
- o NRC and FPC agreed on Action Plan August 15, 1990 and Operation justified till Midcycle 8 Outage in October 1991.

MIDCYCLE 8 OUTAGE

- Actions

  1. Adjust and Optimize EGDG-1A Voltage Regulator

  2. Install High Accuracy Time Delay Relays (part of original Upgrade Program)

  3. Reperform PT-340 with SP-417, Engineered Safeguards Actuation with Loss of Offsite Power

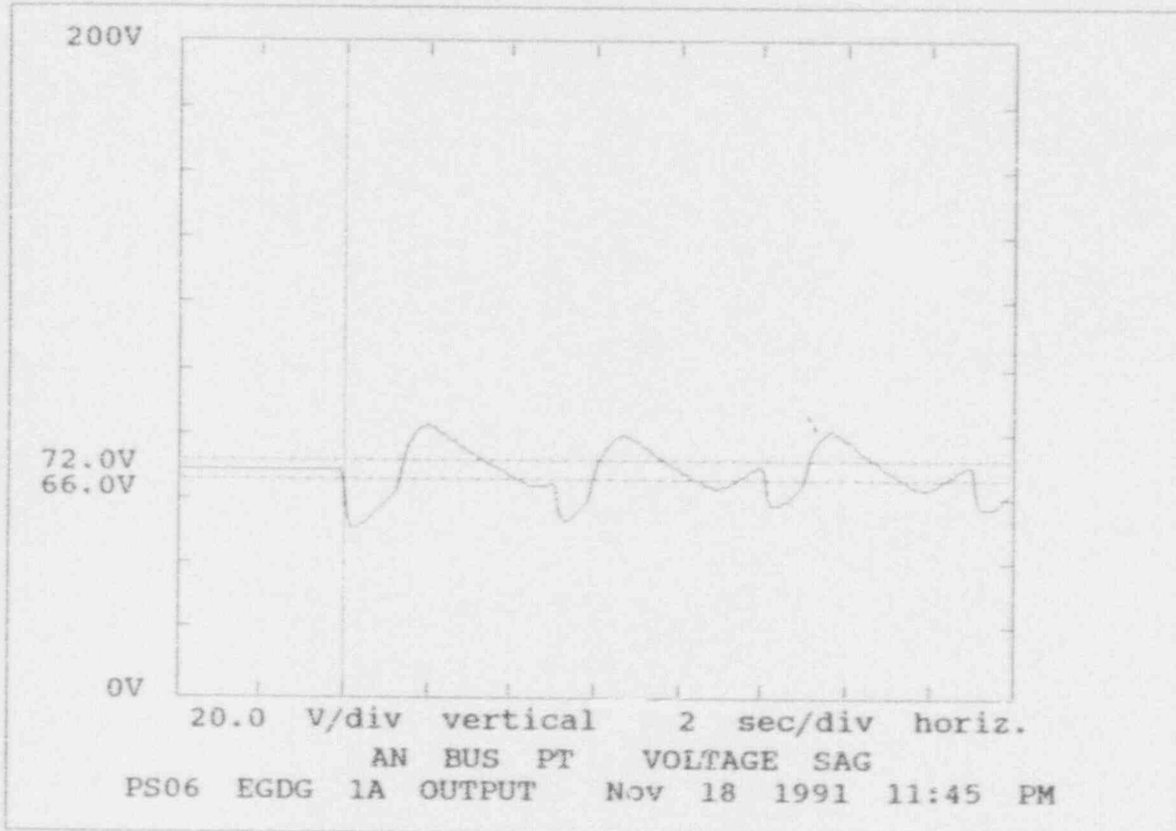
- o Adjustment Results
  - o EGDG-1A Regulator optimized
  - o EGDG-1B found to be optimal

- o Test Results
  - o EGDG-1A Block 1 dip was 0.6 ~~volt~~ % below 75% nominal voltage
  - o EGDG-1A Block 1 frequency dip was 0.07% below 95% nominal for 0.3 second
  - o All other data met Reg Guide requirements
  - o <u>All values</u> within engine and electrical system design basis

.506 EGDG 1A OUTPUT Nov 18 1991

AN BUS PT VOLTAGE SAG 11:43:20.78PM

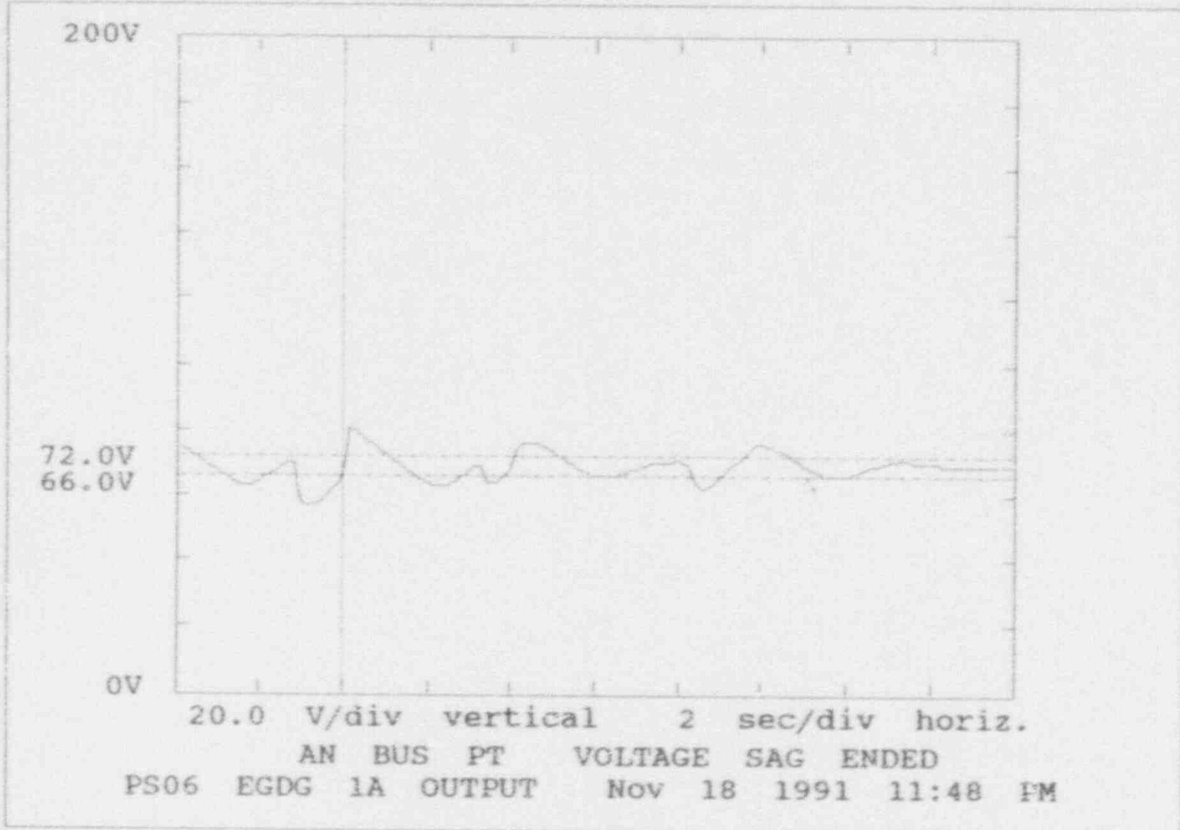
51.0 Vrms minimum
82.8 Vrms maximum
7.0 seconds below threshold
5.0 seconds above threshold



.306 EGDG 1A OUTPUT Nov 18 1991

AN BUS PT VOLT. SAG END 11:43:37.08PM

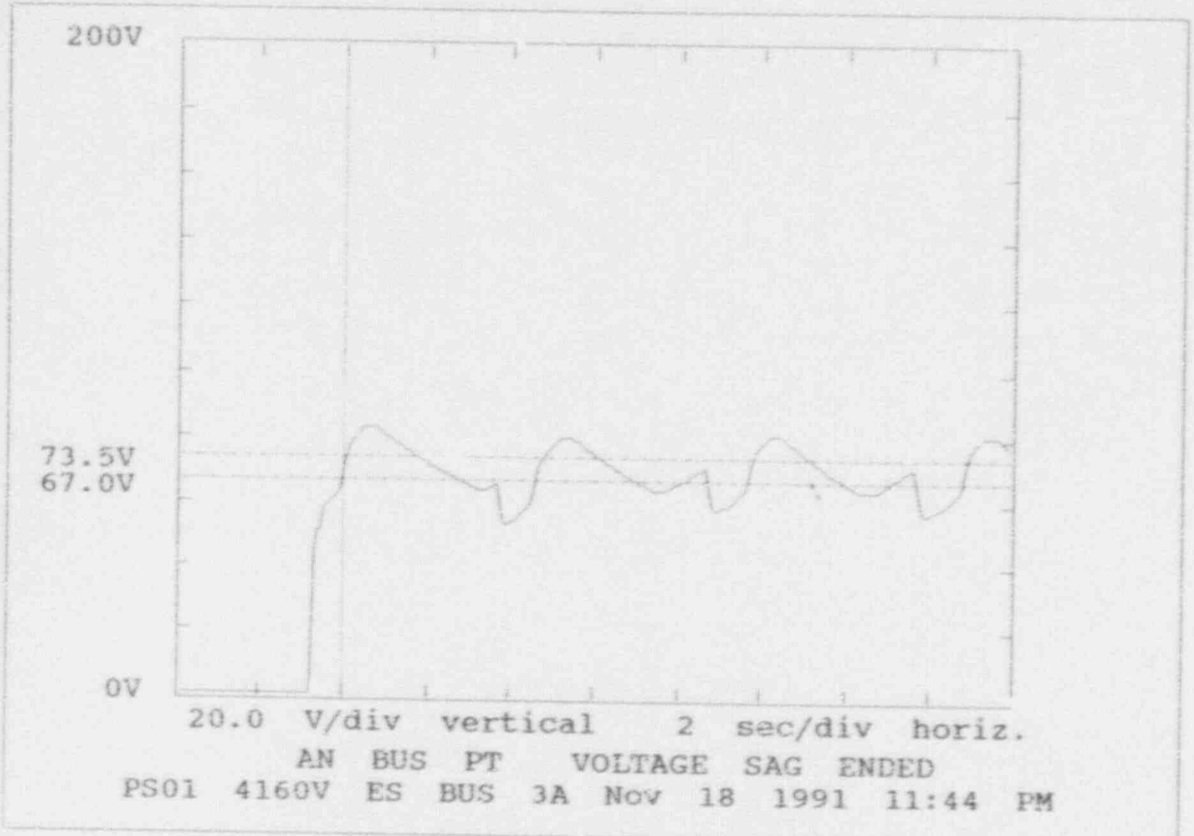
56.6 Vrms minimum
80.9 Vrms maximum



.01 4160V ES BUS 3A   Nov 18 1991

AN BUS PT VOLT. SAG END 11:43:23.74PM

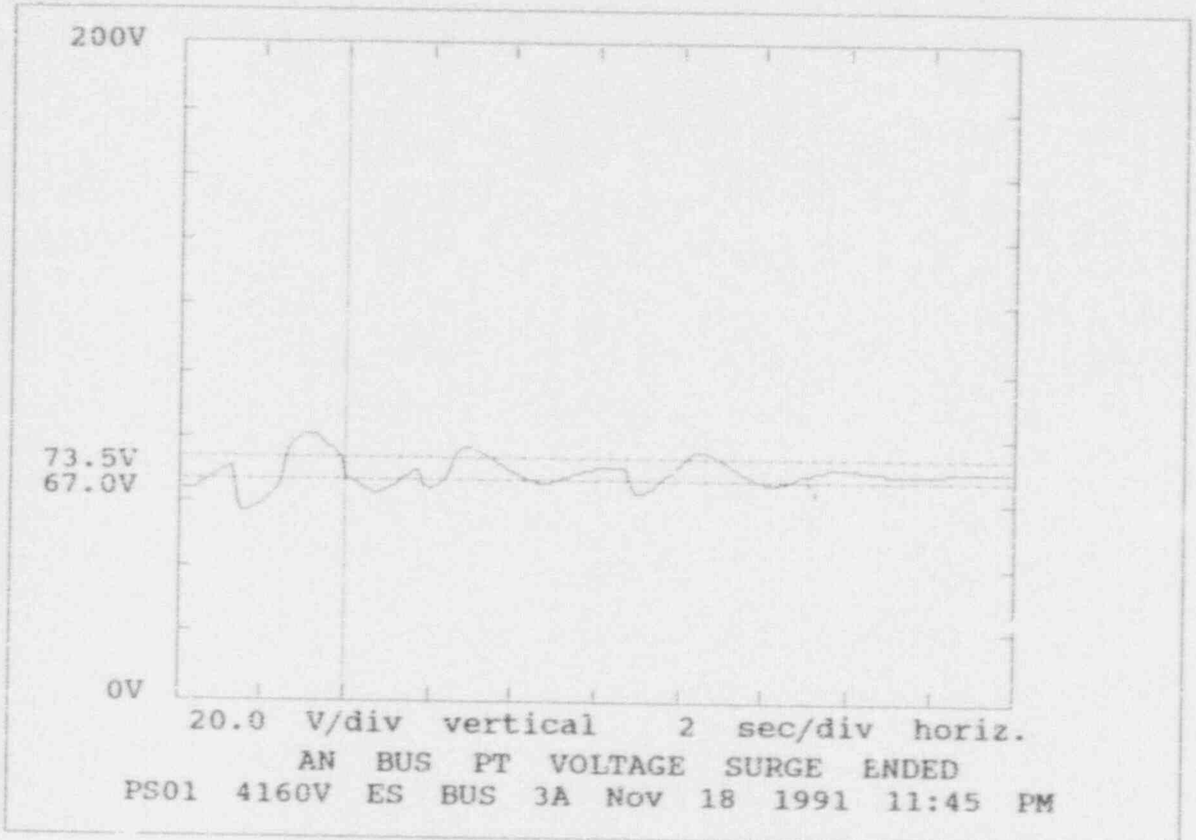
0.0 Vrms minimum
83.4 Vrms maximum



01 4160V ES BUS 3A Nov 18 1991

AN BUS PT VOLT SURGE END 11:43:40.75PM

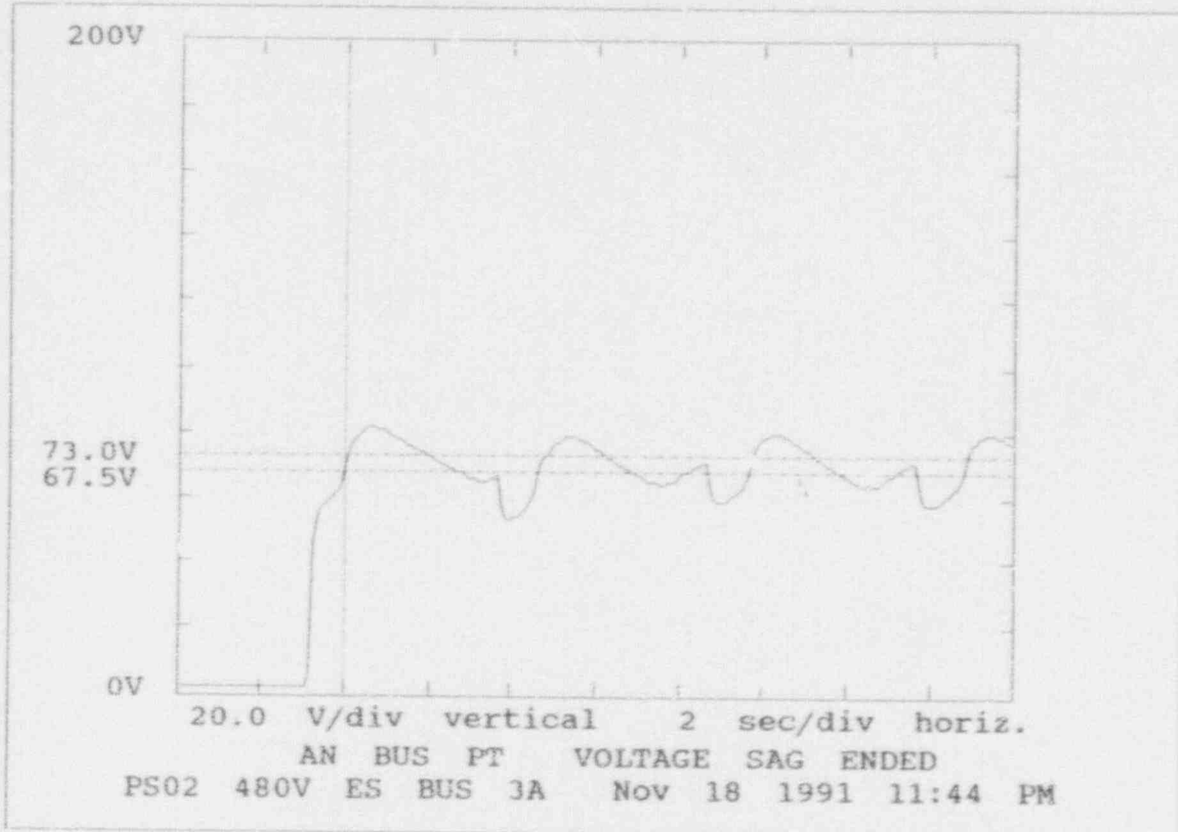
81.5 Vrms maximum
57.0 Vrms minimum



.S02 480V ES BUS 3A Nov 18 1991

AN BUS PT VOLT. SAG END 11:43:21.25PM

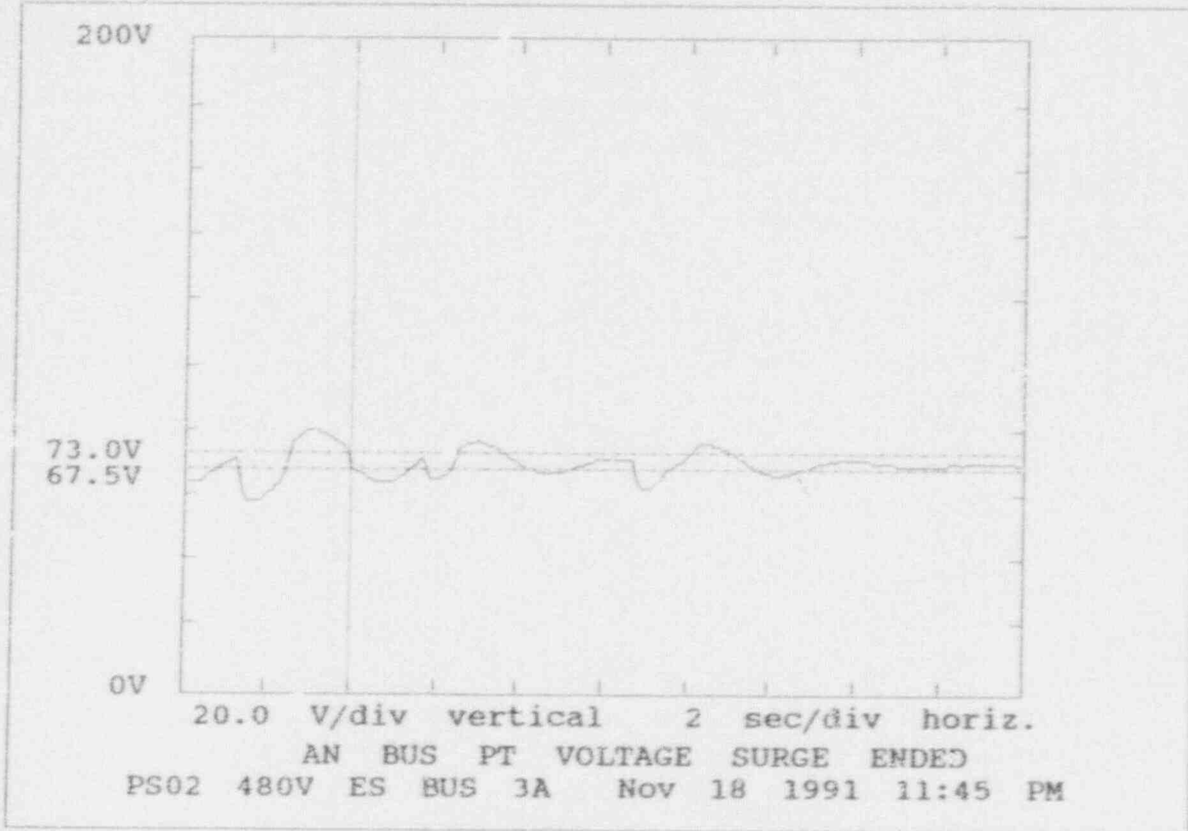
0.7 Vrms minimum
82.1 Vrms maximum



.S02 480V ES BUS 3A Nov 18 1991

AN BUS PT VOLT SURGE END 11:43:38.26PM

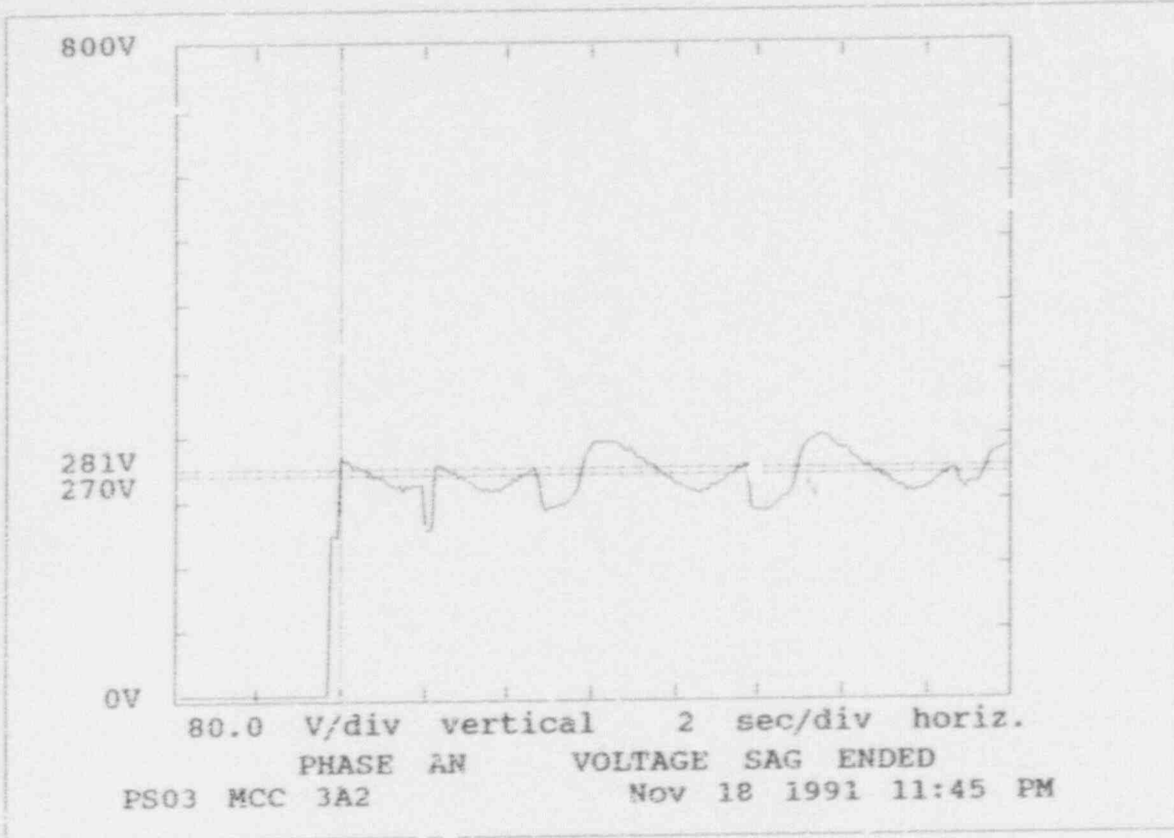
80.5 Vrms maximum
57.7 Vrms minimum



.S03 MCC 3A2 Nov 18 1991

PHASE AN VOLT. SAG END 11:43:18.70PM

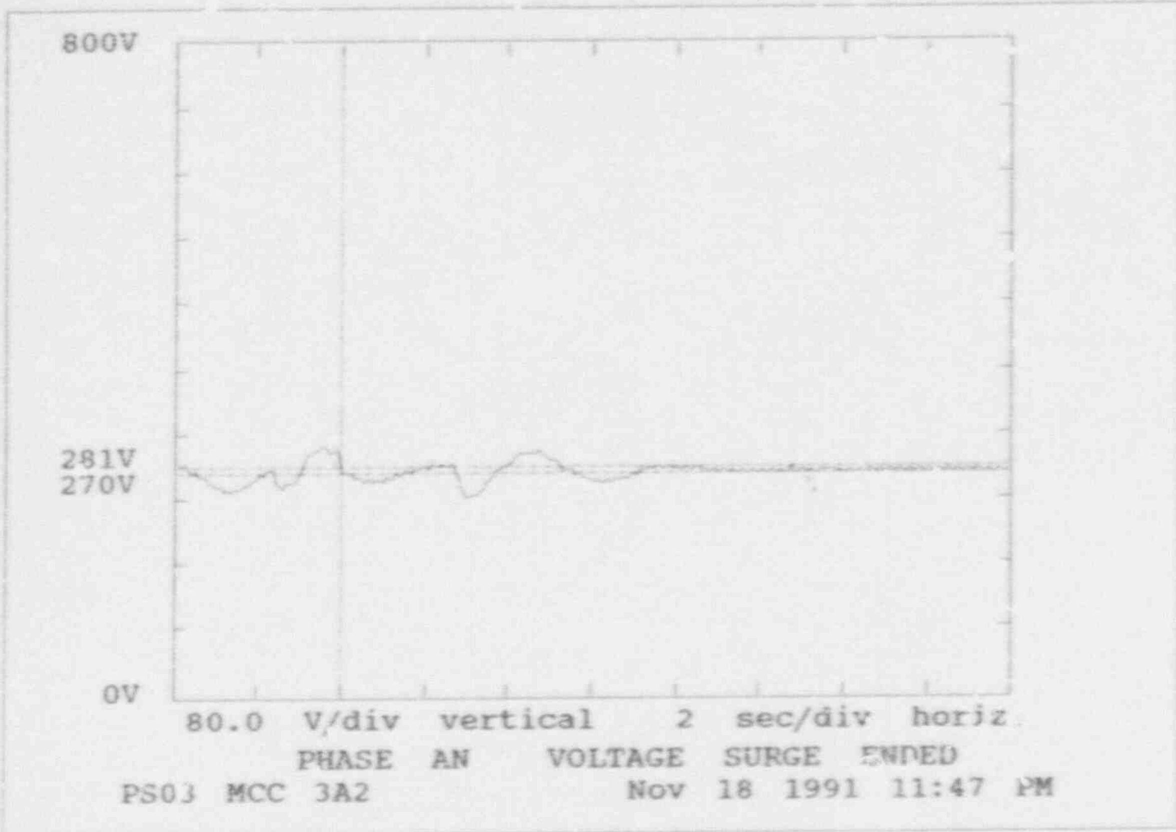
0.0 Vrms minimum
319.7 Vrms maximum



..03 MCC 3A2 Nov 18 1991

PHASE AN VOLT SURGE END 11:43:37.86PM

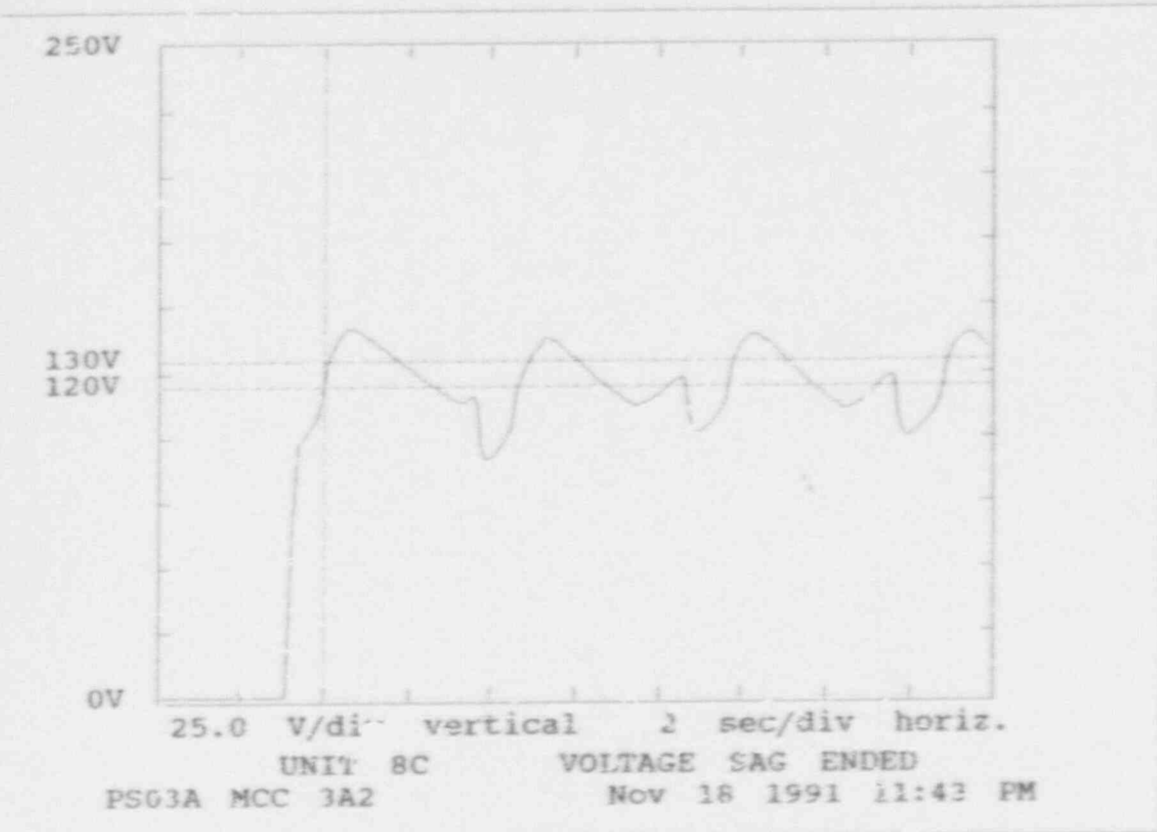
304.6 Vrms maximum
241.6 Vrms minimum



.S03A MCC 3A2 Nov 18 1991

UNIT 8C VOLT. SAG END 11:43:20.79PM

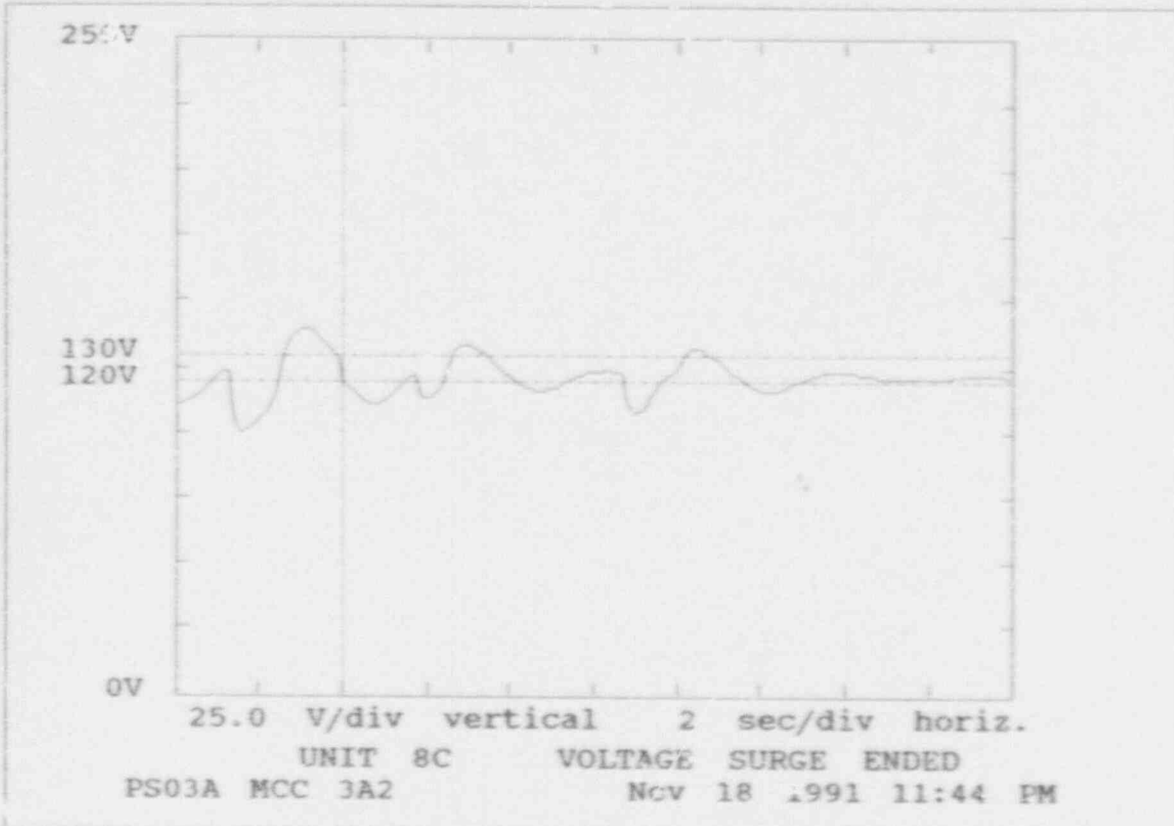
0.0 Vrms minimum
142.8 Vrms maximum



PS03A MCC 3A2 Nov 18 1991

UNIT 8C VOLT SURGE END 11:43:37.80PM

140.2 Vrms maximum
100.4 Vrms minimum



EGDG-1A BLOCK LOADING / EGDG OUTPUT

PHASE A

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	3098.99	4166.00	74.39	4551.48	109.25
BLOCK 2	3198.41	4166.00	76.77	4167.14	100.03
BLOCK 3	3500.30	4166.00	84.02	4216.85	101.22
BLOCK 4	3434.83	4166.00	82.45	3930.72	94.35
BLOCK 5	3885.86	4166.00	93.28	4016.80	96.42
BLOCK 6	3794.92	4166.00	91.09	4112.58	98.72

PHASE B

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	3086.86	4166.00	74.10	4556.33	109.37
BLOCK 2	3203.20	4166.00	76.89	4232.61	101.60
BLOCK 3	3508.79	4166.00	84.22	4170.78	100.11
BLOCK 4	3368.15	4166.00	80.85	3918.59	94.06
BLOCK 5	3901.62	4166.00	93.65	3996.19	95.92
BLOCK 6	3782.80	4166.00	90.80	4001.04	96.04

PHASE C

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	3069.89	4166.00	73.69	4477.52	107.48
BLOCK 2	3194.77	4166.00	76.69	4199.88	100.81
BLOCK 3	3491.81	4166.00	83.82	4204.73	100.93
BLOCK 4	3385.12	4166.00	81.26	3881.01	93.16
BLOCK 5	3873.73	4166.00	92.98	3992.55	95.84
BLOCK 6	3794.92	4166.00	91.09	4030.14	96.74

EGDG-1A BLOCK LOADING / 4160 VOLT ES BUS A

PHASE A

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	4166.00	0.00	NO DATA	0.00
BLOCK 2	3198.41	4166.00	76.77	3782.[illegible]0	90.80
BLOCK 3	3522.13	4166.00	84.54	4113.79	98.75
BLOCK 4	3445.74	4166.00	82.71	3935.57	94.[illegible]7
BLOCK 5	3905.25	4166.00	93.74	3990.13	95.78
BLOCK 6	3690.65	4166.00	88.59	4062.87	97.52

PHASE B

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	4166.00	0.00	NO DATA	0.00
BLOCK 2	3198.41	4166.00	76.77	4122.28	98.95
BLOCK 3	3432.41	4166.00	82.39	4096.82	98.34
BLOCK 4	3377.85	4166.00	81.08	3893.13	93.45
BLOCK 5	3710.05	4166.00	89.06	3973.15	95.37
BLOCK 6	3756.13	4166.00	90.16	4041.05	97.00

PHASE C

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	4166.00	0.00	NO DATA	0.00
BLOCK 2	3276.00	4166.00	78.64	4178.05	100.29
BLOCK 3	3530.61	4166.00	84.75	4178.05	100.29
BLOCK 4	3445.74	4166.00	82.71	3893.13	93.45
BLOCK 5	3918.59	4166.00	94.06	4062.87	97.52
BLOCK 6	3756.13	4166.00	90.16	4062.87	97.52

EGDG-1A BLOCK LOADING / 480 VOLT ES BUS A

PHASE A

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	486.19	0.00	NO DATA	0.00
BLOCK 2	366.64	486.19	75.41	477.91	98.30
BLOCK 3	409.87	486.19	84.30	473.06	97.30
BLOCK 4	401.56	486.19	82.59	453.66	93.31
BLOCK 5	452.13	486.19	93.00	464.33	95.50
BLOCK 6	432.74	486.19	89.01	468.21	96.30

PHASE B

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	486.19	0.00	NO DATA	0.00
BLOCK 2	369.55	486.19	76.01	474.58	97.61
BLOCK 3	403.50	486.19	82.99	469.18	96.50
BLOCK 4	396.29	486.19	81.51	453.66	93.31
BLOCK 5	449.78	486.19	92.51	455.60	93.71
BLOCK 6	432.74	486.19	89.01	465.71	95.79

PHASE C

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	486.19	0.00	NO DATA	0.00
BLOCK 2	367.06	486.19	75.50	476.94	98.10
BLOCK 3	408.35	486.19	83.99	470.56	96.79
BLOCK 4	397.68	486.19	81.79	445.76	91.68
BLOCK 5	449.78	486.19	92.51	465.71	95.79
BLOCK 6	432.74	486.19	89.01	470.16	96.70

EGDG-1A BLOCK LOADING / ES MCC 3A2

PHASE A

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	474.03	0.00	NO DATA	0.00
BLOCK 2	NO DATA	474.03	0.00	NO DATA	0.00
BLOCK 3	399.06	474.03	84.19	462.94	97.66
BLOCK 4	396.02	474.03	83.54	466.96	98.51
BLOCK 5	438.00	474.03	92.40	478.05	100.85
BLOCK 6	415.69	474.03	87.69	458.65	96.75

PHASE B

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	474.03	0.00	NO DATA	0.00
BLOCK 2	NO DATA	474.03	0.00	NO DATA	0.00
BLOCK 3	NO DATA	474.03	0.00	NO DATA	0.00
BLOCK 4	NO DATA	474.03	0.00	NO DATA	0.00
BLOCK 5	NO DATA	474.03	0.00	NO DATA	0.00
BLOCK 6	NO DATA	474.03	0.00	NO DATA	0.00

PHASE C

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	474.03	0.00	NO DATA	0.00
BLOCK 2	399.06	474.03	84.19	445.07	93.89
BLOCK 3	391.03	474.03	82.49	450.06	94.94
BLOCK 4	448.95	474.03	94.71	475.00	100.20
BLOCK 5	423.04	474.03	89.24	475.97	100.41
BLOCK 6	NO DATA	474.03	0.00	NO DATA	0.00

EGDG-1A BLOCK LOADING / 120 VOLT CONTACTOR

ES MCC 3A2

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	122.46	0.00	NO DATA	0.00
BLOCK 2	92.73	122.46	75.72	121.38	99.11
BLOCK 3	103.00	122.46	84.11	122.08	99.69
BLOCK 4	100.78	122.46	82.29	115.43	94.26
BLOCK 5	113.38	122.46	92.58	115.95	94.68
BLOCK 6	109.30	122.46	89.25	120.13	98.09

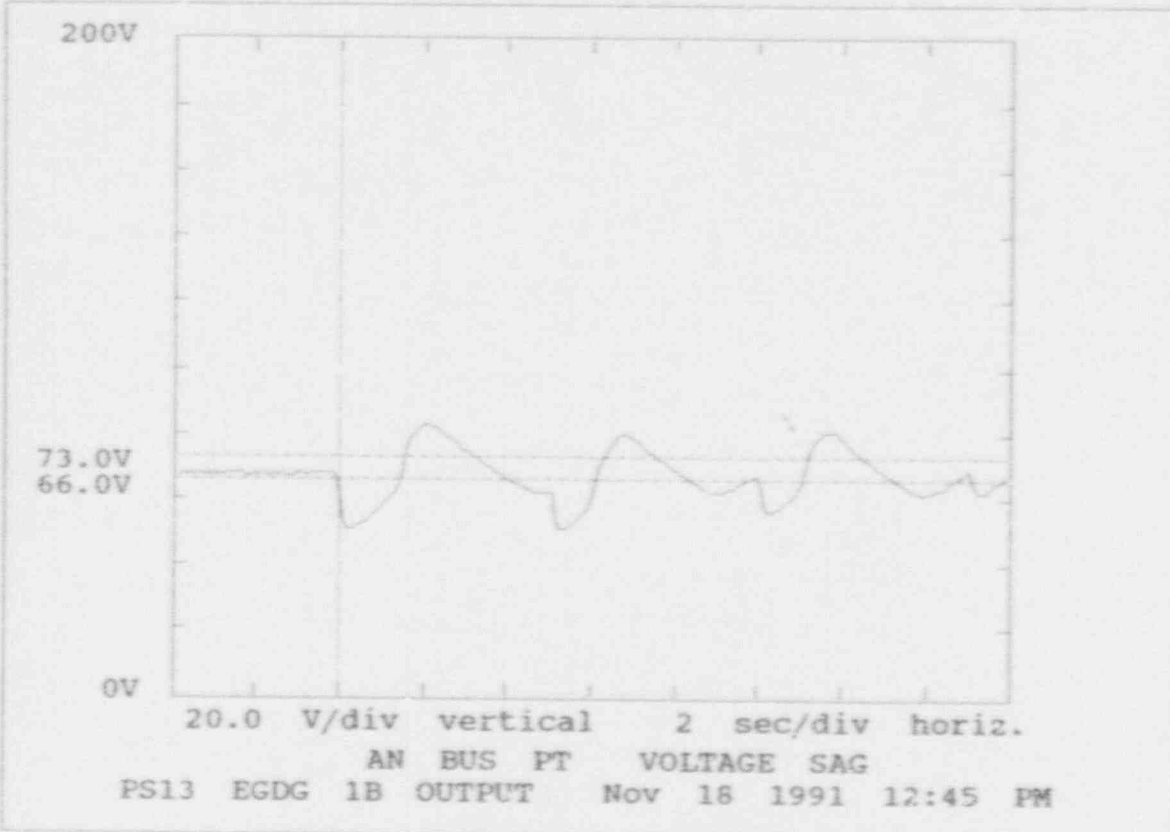
ES MCC 3A2

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	120.96	0.00	NO DATA	00.00
BLOCK 2	91.25	120.96	75.44	122.15	100.98
BLOCK 3	102.85	120.96	85.03	118.13	97.66
BLOCK 4	99.83	120.96	82.53	113.75	94.04
BLOCK 5	113.93	120.96	94.18	116.95	96.68
BLOCK 6	108.05	120.96	89.33	118.93	98.32

.S13 EGDG 1B OUTPUT Nov 18 19?1

AN BUS PT VOLTAGE SAG 12:44:19.?1PM

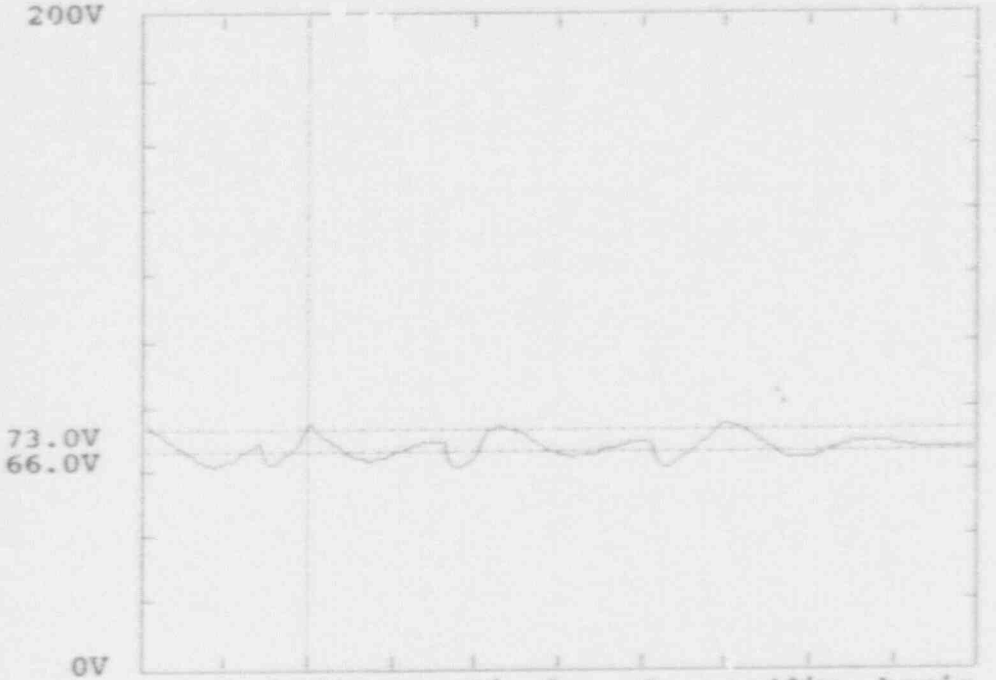
51.0 Vrms minimum
83.4 Vrms maximum
8.0 seconds below threshold
4.2 seconds above threshold



13 EGDG 1B OUTPUT Nov 18 1991

AN BUS PT VOLTAGE SURGE 12:44:35.60PM

75.4 Vrms maximum
61.1 Vrms minimum
7.3 seconds below threshold
1.5 seconds above threshold



20.0 V/div vertical 2 sec/div horiz.

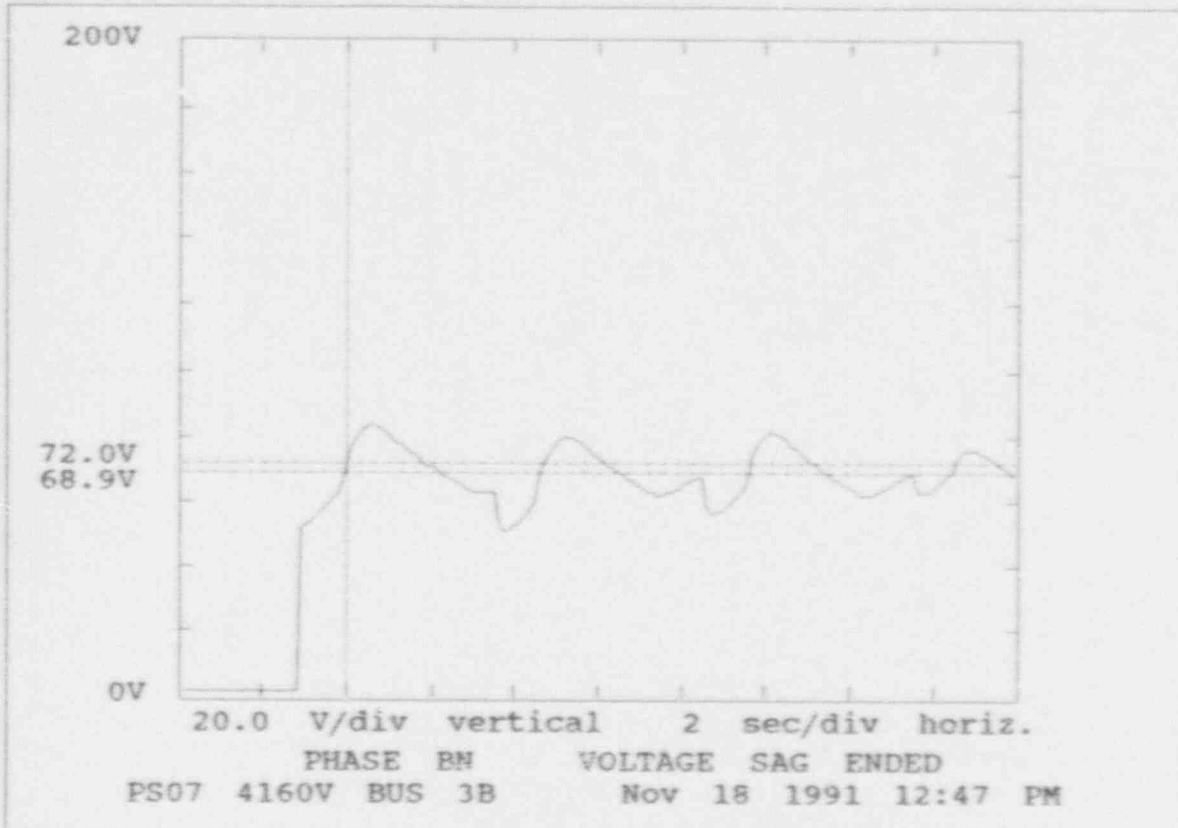
AN BUS PT VOLTAGE SURGE

PS13 EGDG 1B OUTPUT Nov 18 1991 12:47 PM

PS07 4160V BUS 3B   Nov 18 1991

PHASE BN VOLT. SAG END 12:44:23.84PM

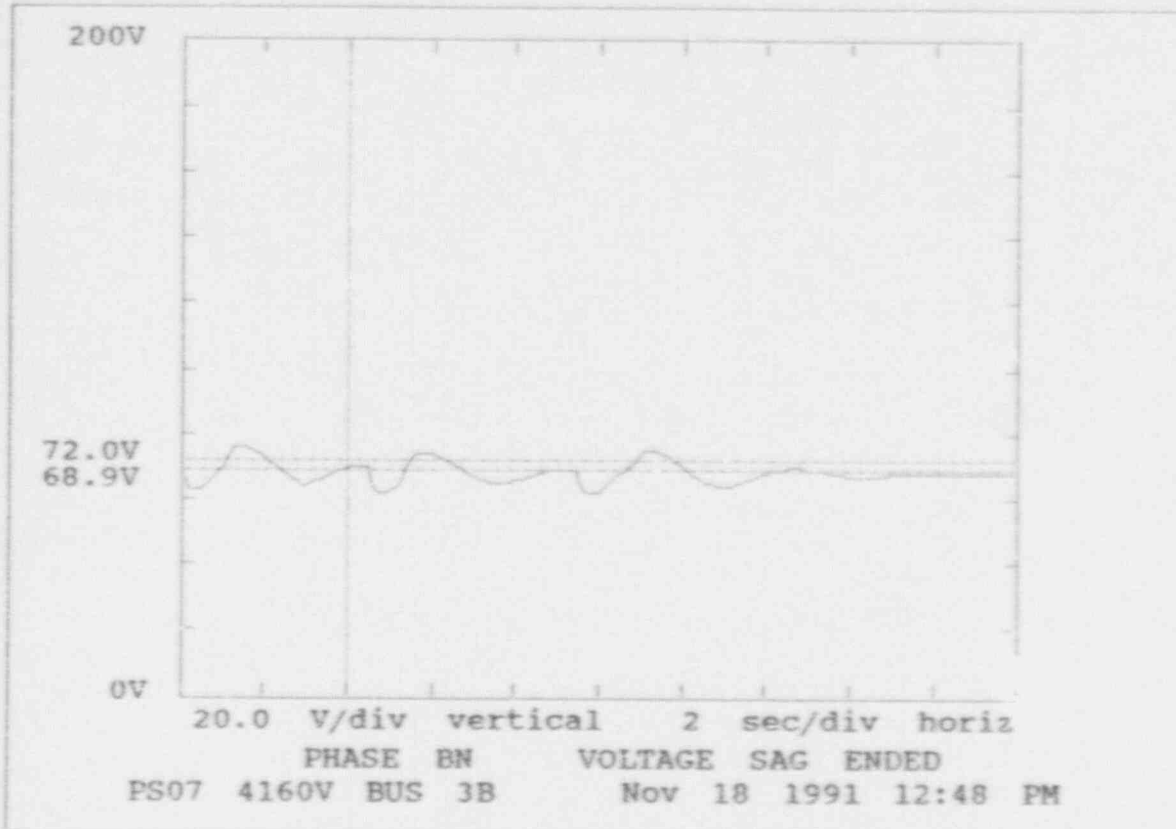
0.0 Vrms minimum
83.9 Vrms maximum



PS07 4160V BUS 3B   Nov 18 1991

PHASE BN   VOLT. SAG END   12:44:41.95PM

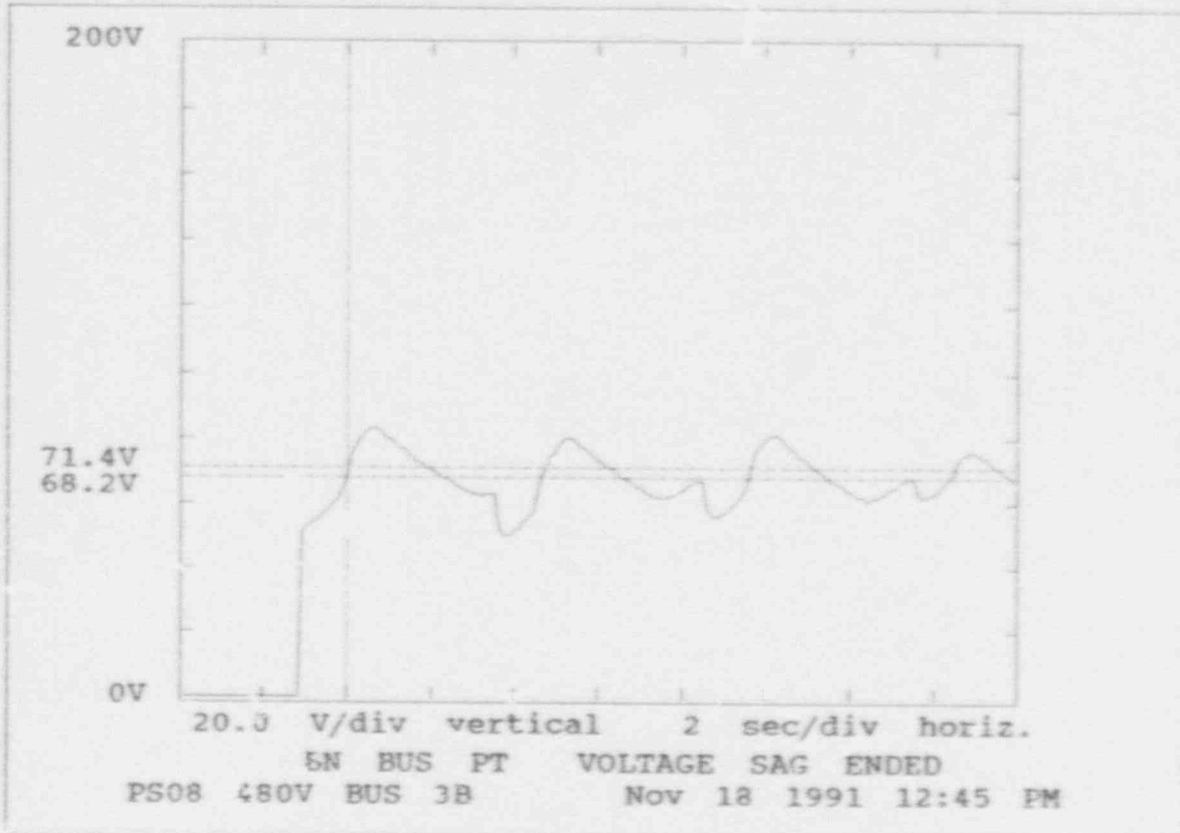
61.6 Vrms minimum
76.4 Vrms maximum



PS08 480V BUS 3B Nov 18 1991

BN BUS PT VOLT. SAG END 12:44:10.87PM

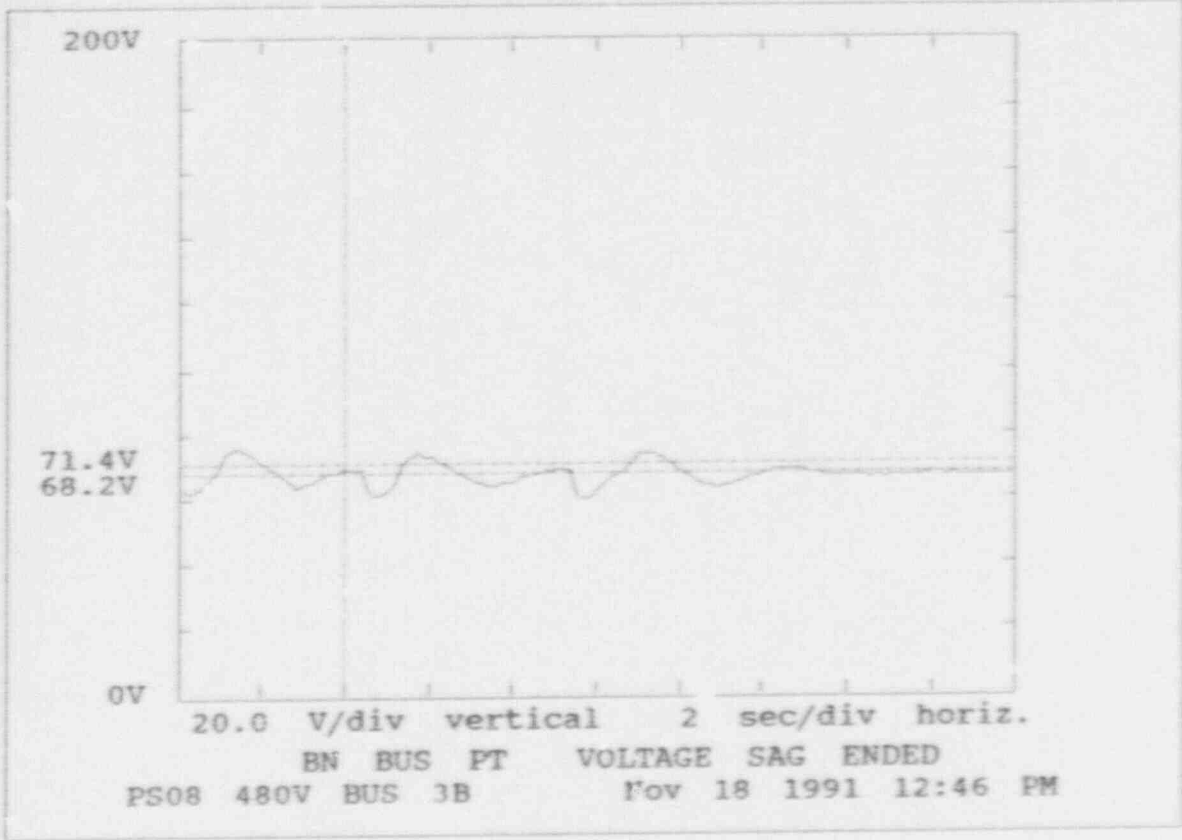
0.0 Vrms minimum
82.7 Vrms maximum



PS08 480V BUS 3B Nov 18 1991

BN BUS PT VOLT. SAG END 12:44:29.03PM

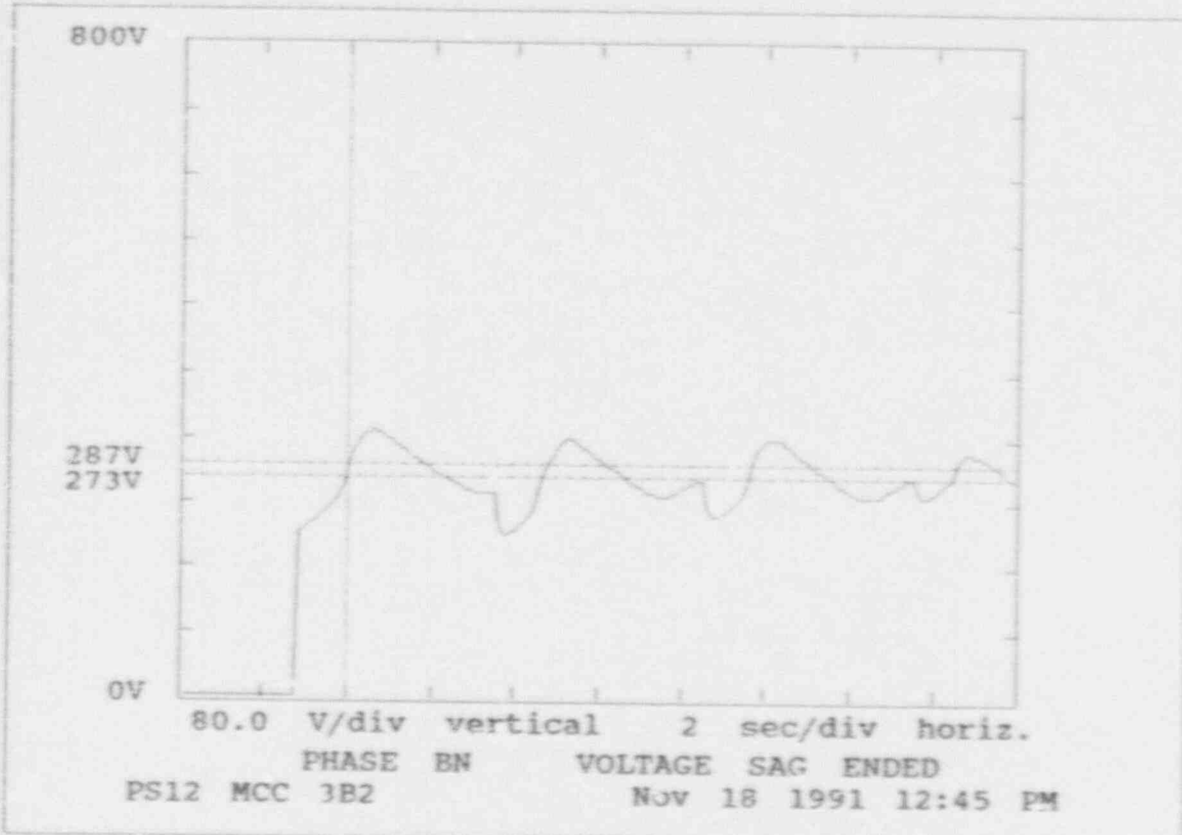
59.8 Vrms minimum
75.8 Vrms maximum



PS12 MCC 3B2 Nov 18 1991

PHASE BN VOLT. SAG END 12:44:07.80PM

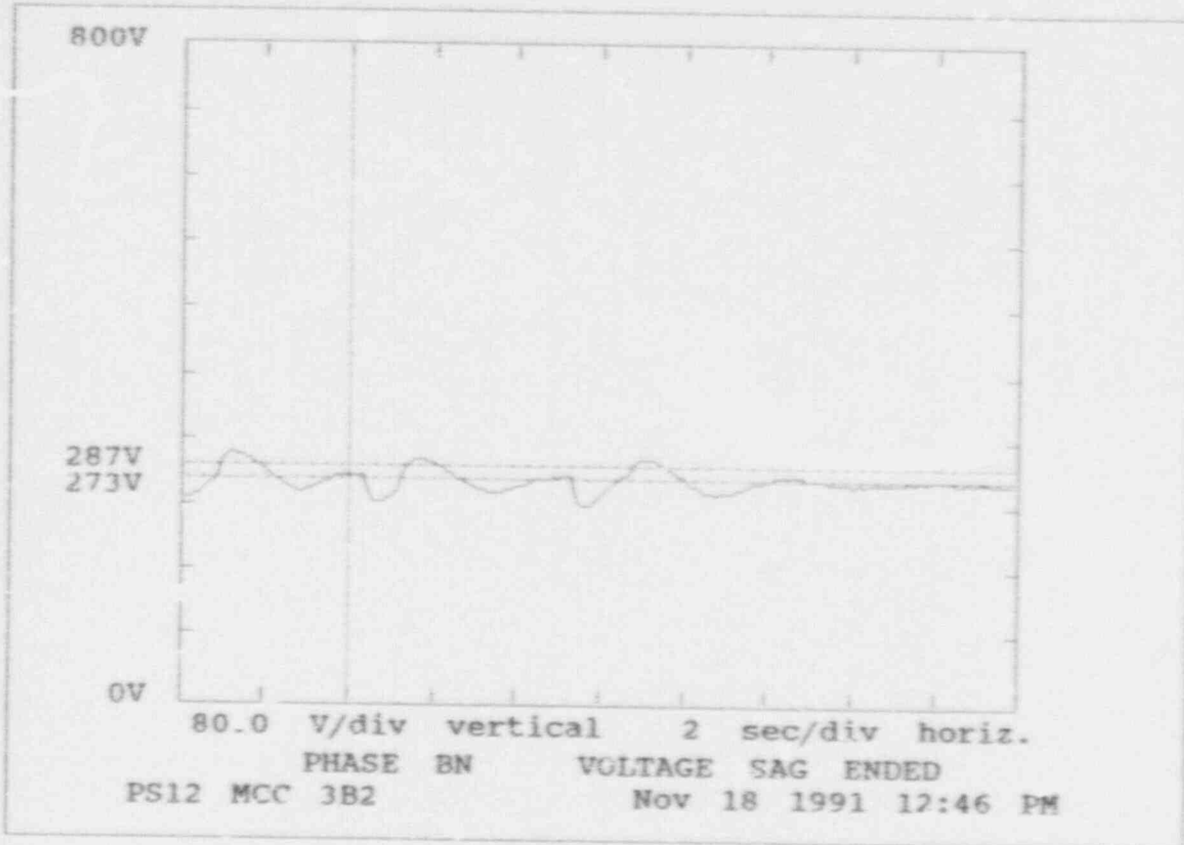
0.0 Vrms minimum
330.8 Vrms maximum



PS12 MCC 3B2 Nov 18 1991

PHASE BN VOLT. SAG END 12:44:26.03PM

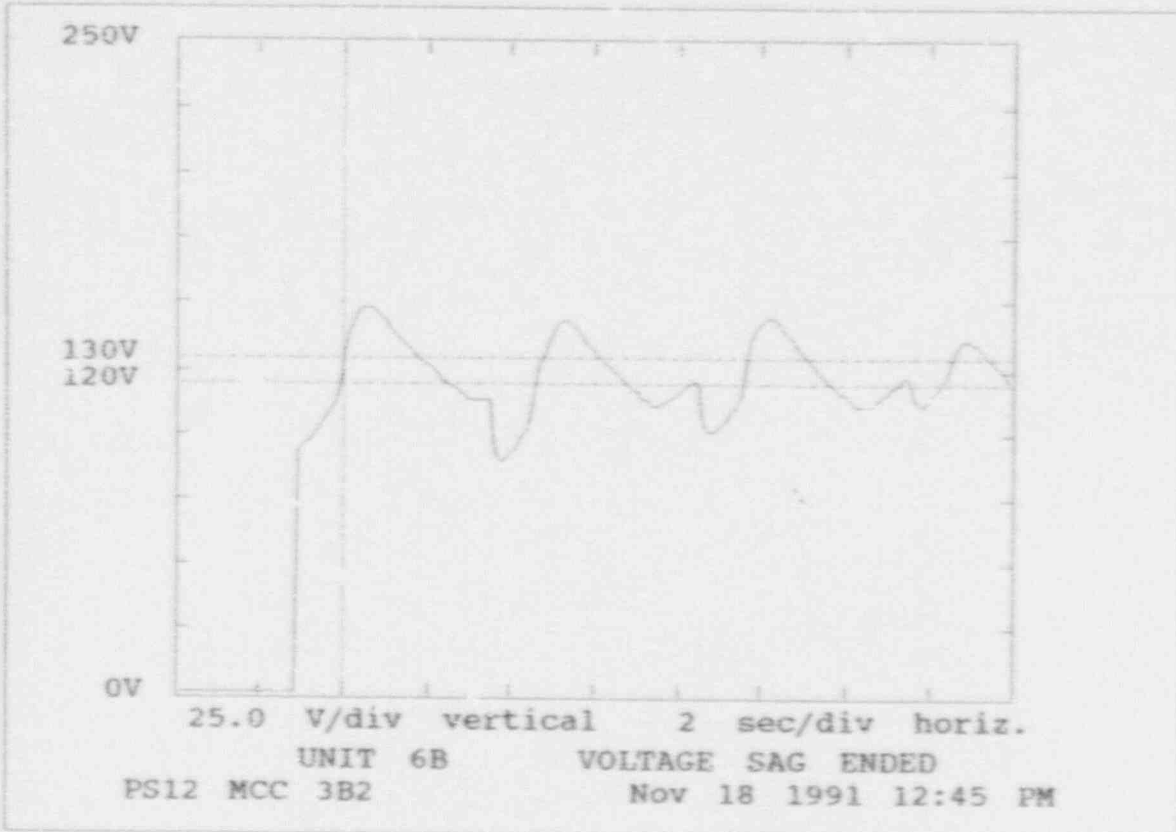
239.0 Vrms minimum
302.8 Vrms maximum



PS12 MCC 3B2 Nov 18 1991

UNIT 6B VOLT. SAG END 12:44:07.78PM

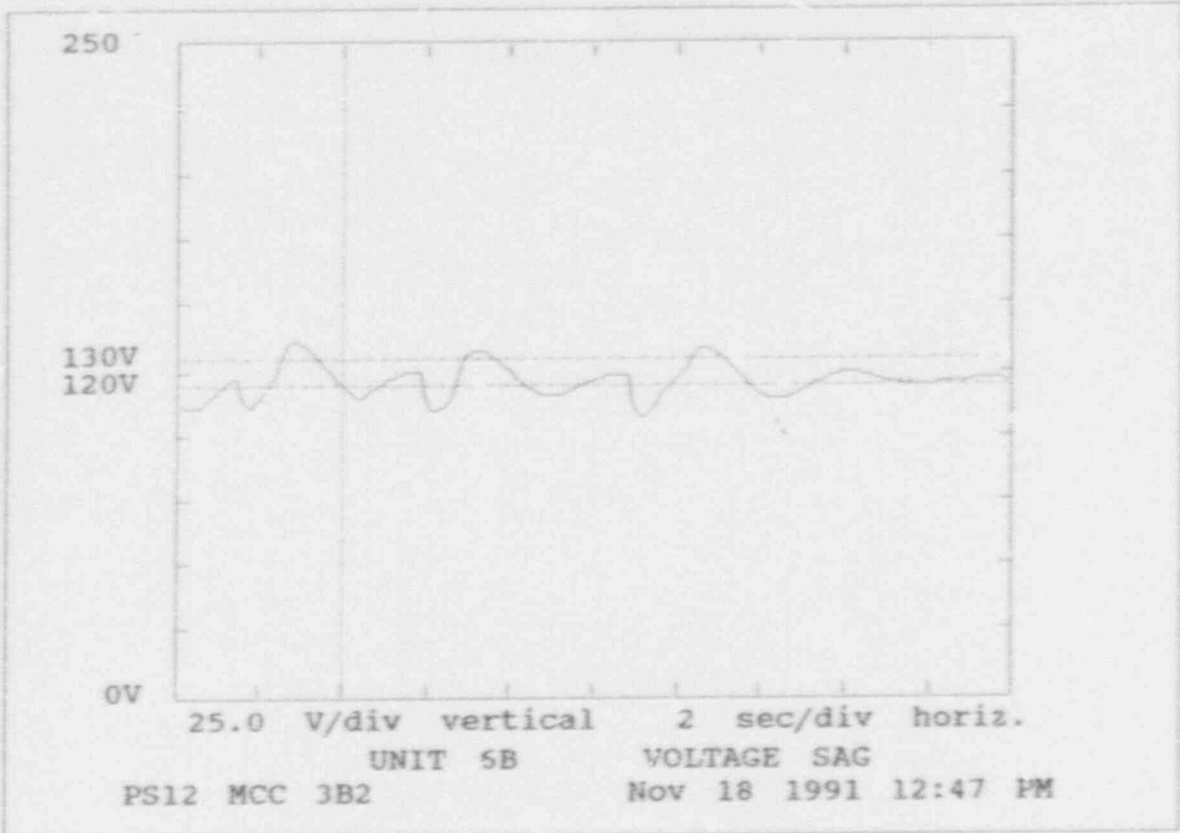
0.0 Vrms minimum
149.3 Vrms maximum



.S12 MCC 3B2 Nov 18 1991

UNIT 6B VOLTAGE SAG 12:44:23.93PM

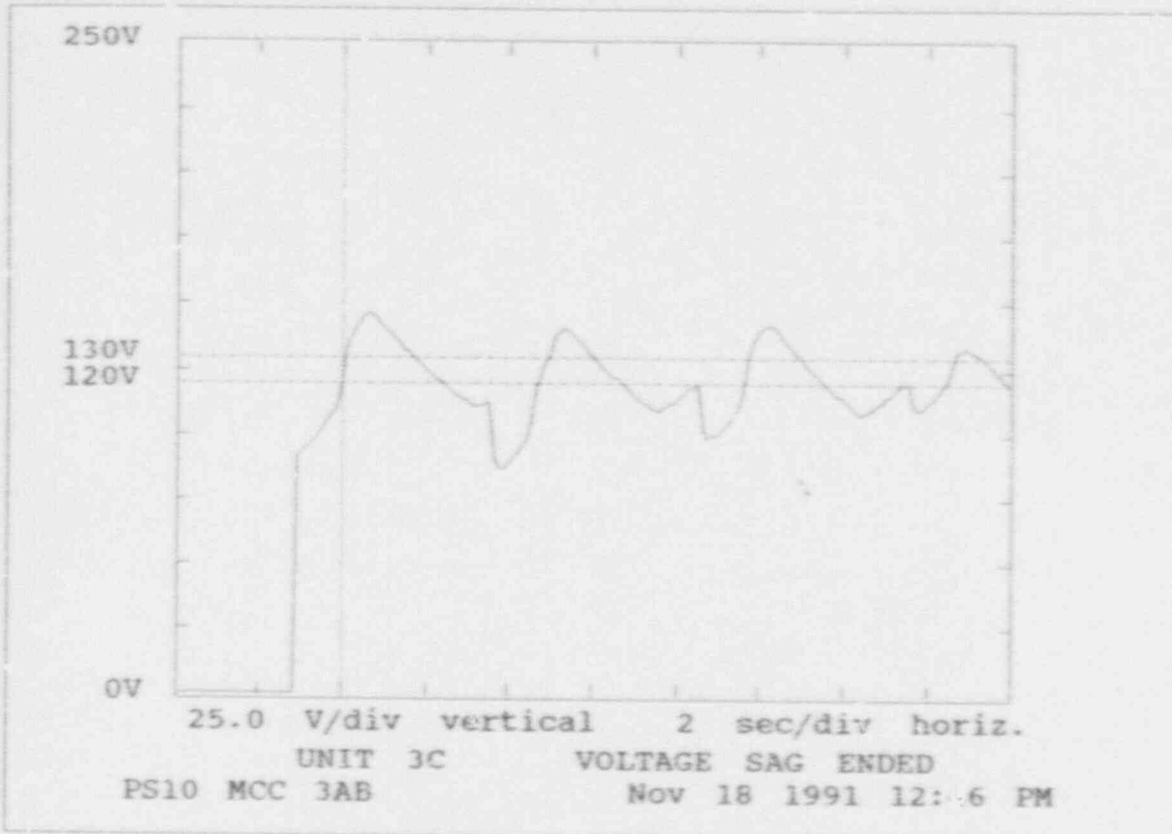
107.7 Vrms minimum
136.1 Vrms maximum
7.5 seconds below threshold
2.3 seconds above threshold



.S10 MCC 3AB Nov 18 1991

UNIT 3C VOLT. SAG END 12:44:20.38PM

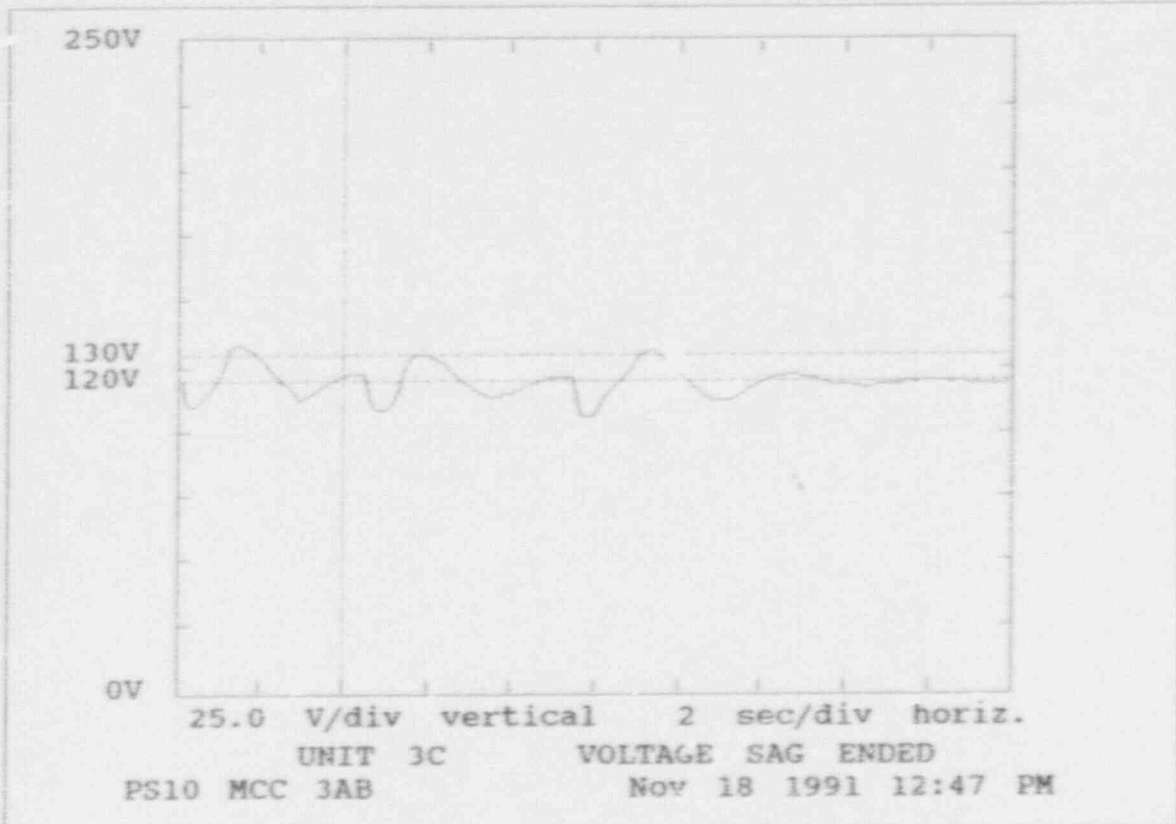
0.0 Vrms minimum
147.0 Vrms maximum



.S10 MCC 3AB Nov 18 199.

UNIT 3C VOLT. SAG END 12:44:38.48PM

106.0 Vrms minimum
133.8 Vrms maximum



EGDG-1B BLOCK LOADING / EGDG OUTPUT

PHASE A

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	3086.86	4075.00	75.75	4535.24	111.29
BLOCK 2	3083.22	4075.00	75.66	4055.25	99.52
BLOCK 3	3349.95	4075.00	82.21	4067.66	99.82
BLOCK 4	3765.82	4075.00	92.41	3918.69	96.16
BLOCK 5	3699.37	4075.00	90.78	3869.04	94.95
BLOCK 6	3699.37	4075.00	90.78	3860.76	94.74

PHASE B

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	3086.86	4075.00	75.75	4465.40	109.58
BLOCK 2	3066.25	4075.00	75.25	4121.45	101.14
BLOCK 3	3397.24	4075.00	83.37	4030.42	98.91
BLOCK 4	3711.79	4075.00	91.09	3964.66	97.29
BLOCK 5	3699.37	4075.00	90.78	3889.49	95.45
BLOCK 6	3699.37	4075.00	90.78	3914.55	96.06

PHASE C

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	3086.86	4075.00	75.75	4510.43	110.69
BLOCK 2	3103.83	4075.00	76.17	4171.11	102.36
BLOCK 3	3380.27	4075.00	82.95	4063.52	99.72
BLOCK 4	3731.87	4075.00	91.58	3960.07	97.18
BLOCK 5	3699.37	4075.00	90.78	3910.42	95.96
BLOCK 6	3699.37	4075.00	90.78	3914.55	96.06

EGDG-1B BLOCK LOADING / 4160 VOLT ES BUS B

PHASE A

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	3083.32	4075.00	75.66	4481.46	109.97
BLOCK 2	3037.29	4075.00	74.53	3984.89	97.79
BLOCK 3	NO DATA	4075.00	0.00	NO DATA	0.00
BLOCK 4	NO DATA	4075.00	0.00	NO DATA	0.00
BLOCK 5	NO DATA	4075.00	0.00	NO DATA	0.00
BLOCK 6	NO DATA	4075.00	0.00	NO DATA	0.00

PHASE B

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	3082.81	4075.00	75.65	4291.11	105.30
BLOCK 2	3037.29	4075.00	74.53	4084.21	100.23
BLOCK 3	3384.88	4075.00	83.06	4038.62	99.11
BLOCK 4	3844.21	4075.00	94.34	4018.00	98.60
BLOCK 5	3773.86	4075.00	92.61	3976.79	97.59
BLOCK 6	3773.86	4075.00	92.61	3976.79	97.59

PHASE C

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	3074.54	4075.00	75.45	4286.97	105.20
BLOCK 2	3062.12	4075.00	75.14	4059.38	99.62
BLOCK 3	3372.47	4075.00	82.76	4452.49	109.26
BLOCK 4	3831.79	4075.00	94.03	4237.32	103.98
BLOCK 5	3782.55	4075.00	92.82	3960.07	97.18
BLOCK 6	3728.24	4075.00	91.49	3943.52	96.77

EGDG-1B BLOCK LOADING / 480 VOLT ES BUS B

PHASE A

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	354.72	471.81	75.18	480.95	101.94
BLOCK 2	346.17	471.81	73.37	469.60	99.53
BLOCK 3	387.79	471.81	82.19	450.22	95.42
BLOCK 4	436.03	471.81	92.42	453.05	96.02
BLOCK 5	415.69	471.81	88.11	449.74	95.32
BLOCK 6	415.69	471.81	88.11	448.32	95.02

PHASE B

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	354.72	471.81	75.18	480.95	101.94
BLOCK 2	346.17	475.81	72.75	469.60	98.69
BLOCK 3	387.79	471.81	82.19	450.22	95.42
BLOCK 4	436.03	471.81	92.42	453.05	96.02
BLOCK 5	415.69	471.81	88.11	449.74	95.32
BLOCK 6	415.69	471.81	88.11	448.32	95.02

PHASE C

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	354.72	471.81	75.18	480.95	101.94
BLOCK 2	346.17	471.81	73.37	469.60	99.53
BLOCK 3	387.79	471.81	82.19	450.22	95.42
BLOCK 4	436.03	471.81	92.42	453.05	96.02
BLOCK 5	415.69	471.81	88.11	449.74	95.32
BLOCK 6	415.69	471.81	88.11	448.32	95.02

EGDG-1B BLOCK LOADING / ES MCC 3B2

PHASE A

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	472.85	0.00	NO DATA	0.00
BLOCK 2	342.80	472.85	72.50	458.26	96.91
BLOCK 3	382.43	472.85	80.88	462.51	97.81
BLOCK 4	429.88	472.85	90.91	441.23	93.31
BLOCK 5	426.57	472.85	90.21	455.42	96.31
BLOCK 6	415.69	472.85	87.91	457.31	96.71

PHASE B

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	358.05	472.85	75.72	477.64	101.01
BLOCK 2	346.13	472.85	73.20	458.26	96.91
BLOCK 3	387.31	472.85	81.91	462.51	97.81
BLOCK 4	429.88	472.85	90.91	441.23	93.31
BLOCK 5	426.57	472.85	90.21	455.42	96.31
BLOCK 6	415.69	472.85	87.91	457.31	96.71

PHASE C

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	472.85	0.00	NO DATA	0.00
BLOCK 2	348.48	472.85	73.70	458.26	96.91
BLOCK 3	388.67	472.85	82.20	462.51	97.81
BLOCK 4	429.88	472.85	90.91	441.23	93.31
BLOCK 5	426.57	472.85	90.21	455.42	96.31
BLOCK 6	415.69	472.85	87.91	457.31	96.71

EGDG-1B BLOCK LOADING / 120 VOLT CONTACTOR

ES MCC 3B1

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	120.00	0.00	NO DATA	0.00
BLOCK 2	89.59	120.00	74.66	119.37	99.48
BLOCK 3	100.00	120.00	83.33	118.86	99.05
BLOCK 4	111.95	120.00	93.29	112.54	93.78
BLOCK 5	1[illegible].79	120.00	90.66	114.42	95.35
BLOCK 6	105.03	120.00	87.53	115.61	96.34

ES MCC 3B2

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	92.41	121.00	76.37	128.75	106.40
BLOCK 2	89.43	121.00	73.91	118.60	98.02
BLOCK 3	100.00	121.00	82.64	116.47	96.26
BLOCK 4	111.60	121.00	92.23	116.21	96.04
BLOCK 5	111.10	121.00	91.82	117.06	96.74
BLOCK 6	107.51	121.00	88.85	115.36	95.34

ES MCC 3B3

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	NO DATA	118.00	0.00	NO DATA	0.00
BLOCK 2	87.71	118.00	74.33	116.64	98.85
BLOCK 3	97.01	118.00	82.21	114.85	9[illegible].33
BLOCK 4	108.62	118.00	92.05	111.26	94.29
BLOCK 5	106.91	118.00	90.60	113.31	96.03
BLOCK 6	105.29	118.00	89.23	114.25	96.82

EGDG-1B BLOCK LOADING / 120 VOLT CONTACTOR

ES MCC 3AB

BLOCK NUMBER	MINIMUM VALUE	NOMINAL VALUE	% OF NOMINAL	60% VALUE	% OF NOMINAL
BLOCK 1	90.88	119.00	76.37	123.21	103.54
BLOCK 2	86.10	119.00	72.35	119.45	100.38
BLOCK 3	100.00	119.00	84.03	117.83	99.02
BLOCK 4	110.92	119.00	93.21	115.27	96.87
BLOCK 5	108.62	119.00	91.28	114.08	95.87
BLOCK 6	106.05	119.00	89.12	114.16	95.93

INTERMEDIATE BUILDING STEAM LINE BREAK

I. BACKGROUND

- DISCOVERY OF GENERAL HELB DISCREPANCY - 1988
- SCHEDULE FOR RECOVERY AND EXEMPTION GRANTED UNTIL END OF REFUEL 7
- REVISION OF GENERAL HELB CRITERIA APPROVED BY NRC
- DESIGN APPROACH OF CORRECTIVE ACTION
- INSTALLATION OF NEW SHIELDS AND RESTRAINTS PRIOR TO AND DURING REFUEL 7

INTERMEDIATE BUILDING STEAM LINE BREAK

II. IMPACT OF HELB ON ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION PROGRAM

- FOR INTERMEDIATE BUILDING, 24" MSLB ASSUMED TO BE BOUNDING

- TO CONFIRM THAT ASSUMPTION - RELAP 5 MODEL OF INTERMEDIATE BUILDING BREAKS WAS DONE CONSIDERING EACH RESULT:

  - 6" MSLB @ EFWPT LINE
  - 1½" CHEMICAL CLEANING LINES
  - 24" MSLB LEAK CRACK BREAKS

  EACH OF THESE EXTENDED THE COMPOSITE QUALIFICATION CURVE

- EQUIPMENT EFFECTED

  - MAIN STEAM LINE PRESSURE TRANSMITTERS
  - LOCAL CONTROL STATIONS, MOTOR STARTERS
  - CABLE
  - TERMINAL BLOCKS

INTERMEDIATE BUILDING STEAM LINE BREAK

II. IMPACT OF HELB ON ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION PROGRAM (continued)

- IMMEDIATE RESOLUTION
  - RECALCULATED IB TEMPERATURE CURVE TAKING CREDIT FOR APPENDIX R SPRINKLERS
  - INSULATED TRANSMITTERS AND ELECTRICAL EQUIPMENT ENCLOSURES IN 7R TO ACHIEVE NECESSARY THERMAL LAG TIME
- CORRECTIVE ACTION DUE BY END OF REFUEL 8

INTERMEDIATE BUILDING STEAM LINE BREAK

III. POST REFUEL 7 CORRECTIVE ACTION

1. REDUCE SEVERITY OF ENVIRONMENT

   - SUCCESSFUL FOR 1½" AND 24" MSLB LEAK CRACK BREAKS BELOW 300°F

2. FIND QUALIFIED EQUIPMENT

   - SOME EQUIPMENT FOUND, BUT NOT ALL

3. MULTIDISCIPLINE TASK FORCE - APRIL 1991 ACTIONS PROPOSED:

   - ENHANCED VENTILATION (HOLE) FOR INTERMEDIATE BUILDING
   - SAFETY RELATED PURGE FANS
   - SAFETY RELATED SPRINKLER SYSTEM
   - REACTOR TRIP BASED ON IB TEMPERATURE ARRAY
   - ELIMINATE THE 6" BREAK
   - FMEA ON 6" BREAK
   - SIMULATOR ANALYSIS OF SCENARIO

INTERMEDIATE BUILDING STEAM LINE BREAK

III. POST REFUEL 7 CORRECTIVE ACTION (continued)

3. CORRECTIVE ACTIONS PURSUED

- FMEA
- OPENINGS IN IB
- SIMULATOR ANALYSIS
- ELIMINATE BREAK

INTERMEDIATE BUILDING STEAM LINE BREAK

IV. FMEA

- CONFIRMED THAT THE 6" BREAK WOULD DISABLE ENOUGH EQUIPMENT TO MAKE IT DIFFICULT TO SAFELY SHUTDOWN THE PLANT.

- COMPLETED END OF SEPTEMBER 1991.

INTERMEDIATE BUILDING STEAM LINE BREAK

V. OPENINGS IN INTERMEDIATE BUILDING

- BUILDING WAS WALKED DOWN
- PRACTICALLY - ONLY 35 SQUARE FEET ADDITIONAL OPENINGS AVAILABLE. REQUIRED 782 SQUARE FEET
- PREPARED TO MODIFY TO GET THE ADDITIONAL 35 SQUARE FEET IF NECESSARY

INTERMEDIATE BUILDING STEAM LINE BREAK

VI. SIMULATOR ANALYSIS

- PURPOSE: TO CONFIRM OPERATOR RECOGNITION AND ACTION IN THIS SCENARIO AND TO DISCOVER ANY OTHER UNDISCOVERED SYSTEMS PHENOMENON.

- 2 RUNS WITH 6" BREAK

  - CONFIRMED 10 MINUTE TRIP

  - OPERATOR EASILY RECOGNIZED SCENARIO

  - TRIPPED REACTOR AND ISOLATED AFFECTED STEAM GENERATOR. EXPECTED OPERATOR RESPONSE TIME 3 TO 6 MINUTES.

INTERMEDIATE BUILDING STEAM LINE BREAK

VII. ELIMINATE TWO SIX INCH BREAKS

- INITIAL PURPOSE: TO COMBINE FRACTURE MECHANICS AND INSPECTION TECHNIQUES TO ASSURE THIS BREAK WILL NOT OCCUR.

- METHODOLOGY: REVIEW MATERIAL CERTIFICATIONS, WELD RECORDS AND INSPECTIONS TO ESTABLISH INSPECTION CRITERIA AND POTENTIAL FLAW SIZES IMPACTING THE WELD INTEGRITY.

- RESULTS: AFTER EXAMINING THE GEOMETRY OF THE BREAK LOCATION, THIS BREAK CAN BE JUSTIFIABLY POSTULATED AS A 3" BREAK.

- RERAN ENVIRONMENTAL CURVES, BREAK IS NO LONGER AN ENVIRONMENTAL PROBLEM.

- RERAN SIMULATOR ANALYSIS. SAME RESULT

INTERMEDIATE BUILDING STEAM LINE BREAK

VIII. FOLLOW ON ITEMS

- REVISE HELB CRITERIA
- REVISE ENVIRONMENTAL AND SEISMIC QUALIFICATION PROGRAM MANUAL (ENVIRONMENTAL CURVES)
- REVIEW EQUIPMENT TO NEW CURVES TO ELIMINATE INSULATION
- REPLACE MSL PRESSURE TRANSMITTERS
- INSPECT THE 6" BRANCH LINE FOR WELD PROBLEMS

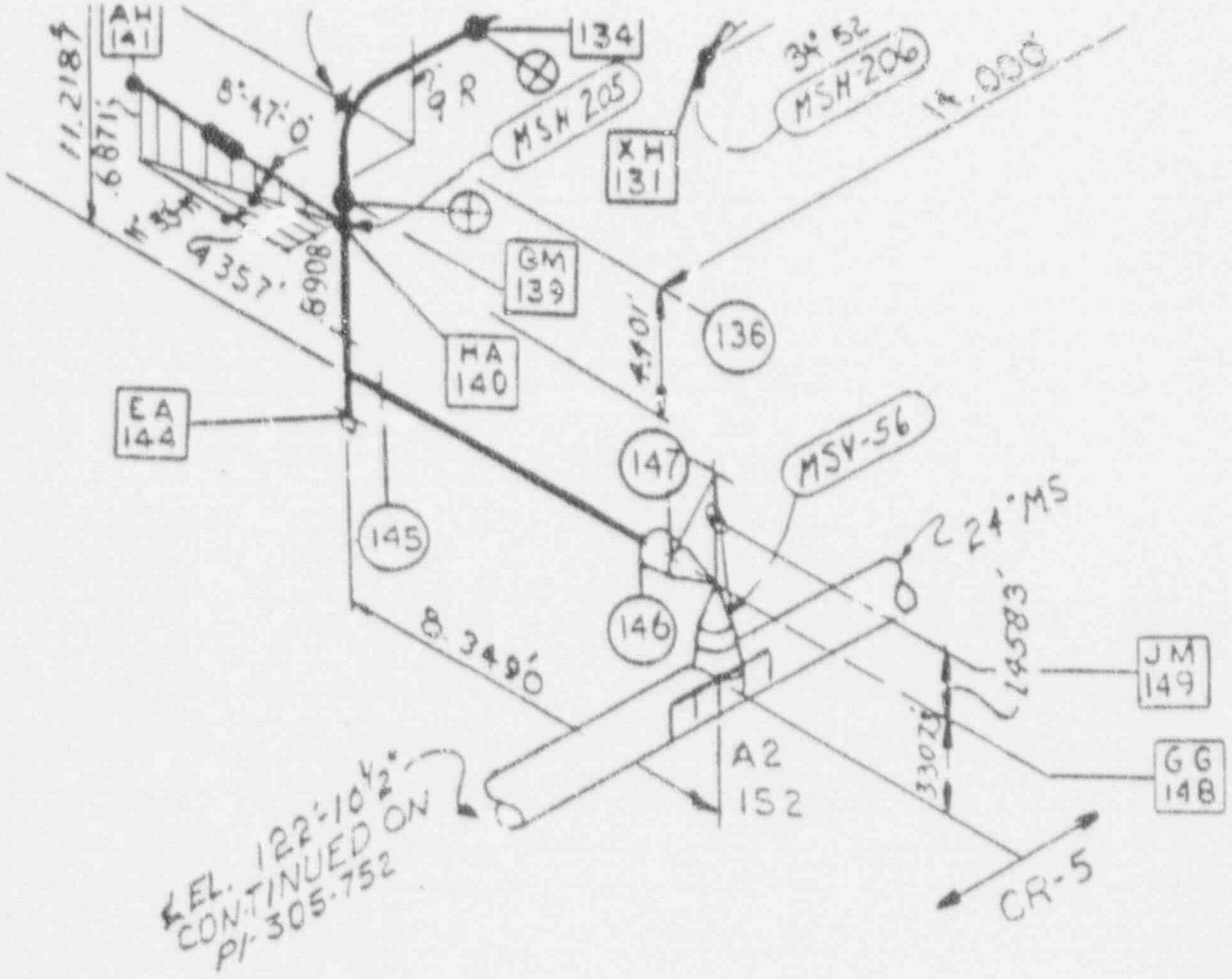
AUX STEAM
TERMINAL END BREAK EVALUATION

SUMMARY OF EVENTS

- DOCUMENTATION REVIEW TO SUPPORT A FRACTURE MECHANICS ASSESSMENT
- DETAILED REVIEW OF 1974 B31.1 STRESS ANALYSIS
- REDUCER COMPONENT NOT EXPLICITLY MODELLED
- HAND EVALUATION OF STRESS AT REDUCER ENDS

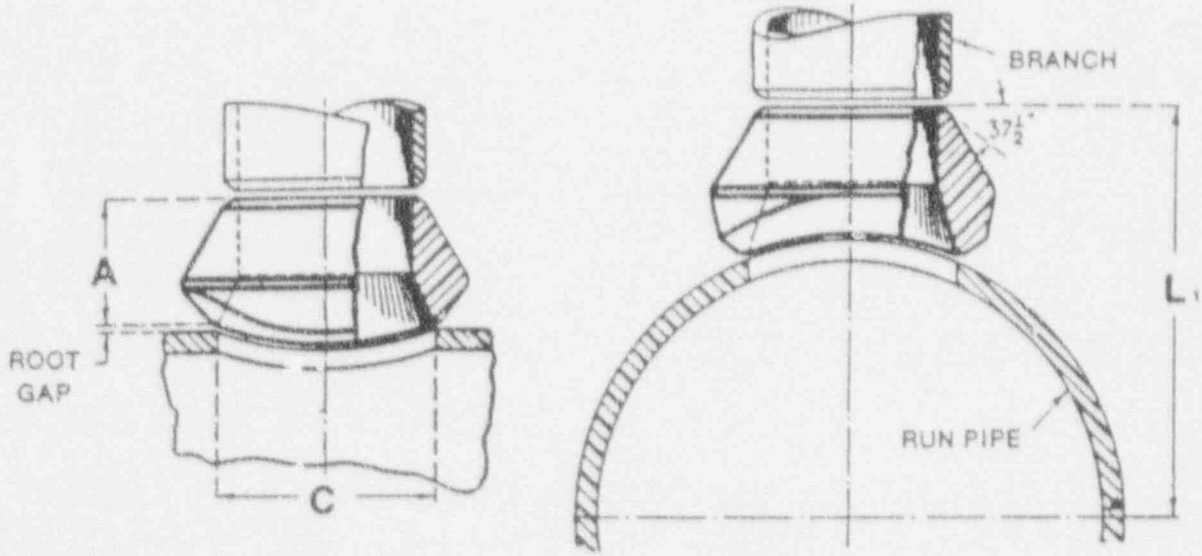
AUX STEAM
TERMINAL END BREAK EVALUATION

LOCAL PIPING GEOMETRY



AUX STEAM
TERMINAL END BREAK EVALUATION

LOCAL PIPING GEOMETRY



AUX STEAM
TERMINAL END BREAK EVALUATION

CONCLUSIONS

- 6" END HAS ABOUT 35% STRESS LEVEL OF THE 3" END
- SUGGESTED VOLUMETRIC INSPECTION TO VERIFY
    - BOTH WELDS WITHOUT IMPERFECTIONS
    - ACTUAL WALL THICKNESS OF REDUCER
    - GEOMETRY (i.e., CONE ANGLE) OF REDUCER
- SHOULD UT SHOW NO FLAWS, AND ACCEPTABLE WALL THICKNESS, ONE CAN CONCLUDE THAT 3" END IS LIMITING STRUCTURAL CROSSECTION
- TE BREAK SHOULD BE TAKEN AT 3" REDUCER

ELECTRICAL DEPARTMENT	ELECTRICAL DESIGN CRITERIA ELECTRICAL CIRCUIT PHYSICAL SEPARATION AND CABLE TRAY LOADING	 Revision 0 Date 9-13-91

ELECTRICAL DESIGN CRITERIA
ELECTRICAL CIRCUIT PHYSICAL SEPARATION AND CABLE TRAY LOADING

CRYSTAL RIVER UNIT 3

FLORIDA POWER CORPORATION

NUCLEAR SAFETY RELATED

FLORIDA POWER CORPORATION
NUCLEAR ENGINEERING DEPARTMENT
CRYSTAL RIVER - UNIT 3

REVIEWED AND ACCEPTED BY:

Engineer [signature] Date 10/9/91

Supervisor [signature] Date 11/7/91

Rev.	Description	Prepared By	Verifier	Approved
0 9/13/91	Combined and added new criteria for both inside and outside of rack, panel, etc.	[signature] [signature]	[signature] [signature]	[signature] [signature]

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ATTACHMENTS

1. Separation Criteria Exceptions

1. SCOPE

The purpose of this document is to establish separation criteria applicable to wiring and components located in Class 1E enclosures as well as for electric cable and raceway which are routed outside of Class 1E enclosures. It also establishes separation criteria for 1E to non-1E wiring, components and raceways. In addition, this document establishes the criteria for cable tray loading and cable application for electrical power, control, and instrumentation cable and raceways which are routed to safety-related equipment. The criteria contained herein is applicable to existing as well as new construction for Florida Power Corporation, Crystal River Unit 3.

The criteria identified in Section 4.A of this document applies to external field cabling and raceway starting at the opening where a cable or raceway enters/leaves safety-related equipment or enclosures.

The criteria identified in Section 4.B of this document applies to all internal cabling and wiring starting at the opening where a cable enters a Class 1E enclosure such as control boards, equipment cabinets and relay racks. It includes, but is not limited to construction and wiring practices. The panels and relay racks which are governed by this document are the following:

1) Main Control Board in Control Room (All Sections)
2) RR1
3) RR2
4) RR3
5) RR1A/RR2A
6) RR1B/RR2B
7) RR1AB/RR2AB
8) RR3A/RR3B
9) RR4A/RR4B
10) RR5B/RR5B1
11) RRHV
12) TPC
13) Nuclear Sample Panel NS
14) RRPSA
15) EFIC A, B, C, & D Cabinets
16) EFIC A & B Aux. Cabinets
17) EFIC C & D Relay Boxes
18) RSP A/RSP AB/RSP B
19) RSP-RRA/RSP-RRA1
20) RSP-RRB/RSP-RRB1
21) RSP A & B Aux. Equipment Cabinets

The separation criteria for Engineered Safeguard Actuation cabinets (4A, 4B, 4C, 4D, 5A, 5B, 5C & 5D) and Engineered Safeguard Channel cabinets (1A, 1B, 2A, 2B, 3A & 3B) are considered in Appendix 3 of this design criteria.

Any work performed as a maintenance activity on a safety related circuit located inside or outside of a Class 1E enclosure listed above must be performed in accordance with this criteria as applicable. Any future design activities to the above listed enclosures shall also observe these requirements unless otherwise justified by analysis as identified herein.

The requirements of the following documents for electrical circuit physical separation are incorporated in the design criteria:

- Draft 1 dated 10/20/71, Section 8.0 of the proposed Guide for the Design and Installation of Cable Systems in Power Generating Stations, (Ref. 3R)
- Criteria Relating to Electrical Circuit Physical Separation and Cable Tray Loading dated January 24, 1977 (Ref. 3C)
- FSAR Separation Criteria (Ref. 3E)
- E-91-0001, Rev. 0, Electrical Separation Criteria for Class 1E Control Boards, Equipment Cabinets and Relay Racks (Ref. 3A)
- Control Board and Relay Rack Engineered Safeguard Separation Criteria Report, Rev. 9, May 1975 (Ref. 3W)
- IEEE 279-1968, Criteria for Nuclear Power Plant Protection Systems

Guidance on the use of barriers for fire protection is provided in the Crystal River Unit 3, 10CFR50, Appendix R Fire Study. Circuits that are required for safe shutdown in the event of a fire are identified on the E-213 series of drawings and in Section 7 of the 10CFR50 Appendix R Fire Study Report.

2. <u>DEFINITIONS</u>

To clarify terms used within this document, the following definitions shall apply:

A. <u>Associated Circuits</u> - Non-Class 1E circuits that are routed with Class 1E circuits and are not separated from Class 1E circuits by acceptable separation distance, barriers or isolation devices. (NOTE: Crystal River Unit 3 does not use associated circuits as defined by IEEE 384. When used in this document, the term is to define non-class 1E circuits routed with Class 1E circuits.)

B. <u>Barrier</u> - A device or structure interposed between redundant Class 1E equipment or circuits, between Class 1E and Non-Class 1E equipment or circuits, or between Class 1E equipment or circuits and a potential source of damage to limit damage to Class 1E systems to an acceptable level.

C. <u>Channel</u> - The designation applied to a given system or set of components that enables the establishment and maintenance of physical, electrical, and functional independence from other redundant sets of components. The terms division, train, channel, separation group, and safety group are interchangeable in the context of this document.

D. Class 1E - The safety classification of the electrical equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling and containment and reactor heat removal, or are otherwise essential in preventing a significant release of radioactive material to the environment. This classification includes, but is not restricted to the reactor protection, engineered safeguards and EFIC systems.

E. Class 1E Cabinet - A rack, panel, switchboard, or similar enclosure fitted with Class 1E equipment. As used within the context of this document, the cabinet can be open (i.e., a frame structure without sides or doors) or closed (i.e., a complete enclosure).

Note:
- Even though the Main Control Board was built by assembling many individual sections (some safety and non-safety related), the Main Control Board is considered as one enclosure for the purposes of this document. Equipment racks located inside the Main Control Board are considered as separate Class 1E cabinets, and as such, each is to satisfy the requirements of this criteria document.
- MCC's, switchgear and HVAC cabinets also meet this definition, but are not governed by this separation criteria since separation requirements were not imposed on this equipment during procurement and construction.

F. Control Circuits - Low Voltage Control Circuits utilizing relatively low-current levels or used for intermittent operation to change the operating status of a utilization device of the plant auxiliary system.

G. Design Basis Event - A postulated abnormal event used in the design to establish the acceptable performance requirements of the structures, systems, and components.

H. Engineered Safeguard System - The equipment, instrument channels, power supplies, actuation logic and manual controls that comprise the system which takes automatic action to prevent or mitigate the effects of a design basis accident.

I. Flame Retardant - Capable of limiting the propagation of a fire beyond the area of influence of the energy source that initiated the fire.

J. Independence - The state in which there is no mechanism by which any single design basis event can cause redundant equipment to be inoperable.

K. Instrumentation Circuit - A low energy circuit used for transmitting variable current or voltage signals (analog) or those used for transmitting coded information (digital).

L. Isolation Device - A device in a circuit which prevents malfunctions in one section of a circuit from causing unacceptable influences in other sections of the same circuit or in other circuits.

M. Limited Hazard Areas - Limited hazard areas are those plant areas from which potential hazards such as missiles, exposure fires, and pipe whip are excluded.

N. Low Energy Circuit - Low energy circuits are those circuits that either are inherently limited requiring no overcurrent protection or limited by a combination of a power source and overcurrent protection (NEC Article 725-31 for Class 2 and Class 3 circuits). They are comprised of analog and digital circuits used for transmitting:

   a. Variable current or voltage signals for the control and/or instrumentation of plant equipment and systems.

   b. Coded information signals, such as those derived from the output of an analog-to digital converter or the coded output from a digital computer or other digital transmission terminals.

   For CR3, low energy circuits are defined as those having the following nominal characteristics:

   - 32-160 mV
   - 28V DC
   - 4-20 mA
   - 10-50 mA
   - 1-5V DC
   - 0-10V DC
   - 24V DC
   - 24V AC
   - -10 to +10V DC
   - 125V DC high impedence current limited annunciator logic loops

O. Low-Voltage Power Circuit - A circuit which supplies power to utilization devices of the plant auxiliary systems rated at 600V or less.

P. Medium-Voltage Power Circuit - A circuit which supplies power to utilization devices of plant auxiliary systems rated at 601 V to 15,000 V.

Q. Non-Hazard Areas - An area meeting the following requirements may be designated as a nonhazard area (e.g. cable spreading room).

(1) The area shall not contain high energy equipment such as switchgear, transformers, rotating equipment, or potential sources of missiles or pipe failure hazards, or fire hazards.

(2) Circuits in the area shall be limited to control and instrument functions and those power supply circuit cables and equipment serving the equipment located within the area.

(3) Power circuit cables in this area shall be installed in enclosed raceways.

(4) Administrative control of operations and maintenance activities shall control and limit introduction of potential hazards into the area.

R. Protection System - The protection systems, which consists of the Reactor Protection System (RPS) and the Engineered Safeguard Actuation System (ESAS), perform important control and safety functions. The protection systems extend from the sensing instruments to the final actuating devices, such as circuit breakers and pump or valve motor contactors.

S. Raceway - Enclosures such as conduit, cable tray, ducts, wireway penetrations, etc., which provide a method of routing support, and physical protection for the electrical cable system.

T. Reactor Protection System - The overall compliment of instrument channels, trip logic and wiring which make up redundant channels to form a matrix to generate a reactor trip signal.

U. Redundant Circuits, Equipment or System - Circuits, equipment or systems that duplicate the essential function of another piece of equipment or systems to the extent that either may perform the required function regardless of the state of operation or failure of the other.

V. Safety-Related (Class 1E) - The safety classification of the equipment and systems that are essential to assure the integrity of the Reactor Coolant System boundary and the capability to shutdown the reactor, to maintain it in a safe shutdown condition and to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to those referred to in 10CFR100.11.

W. Separation Distance - Space which has no interposing structures, equipment, or materials that could aid in the propagation of faults or that could otherwise disable safety-related systems or equipment.

X. Single Failure Criteria - The single failure criteria as defined in IEEE Standard No. 279-1971 states: "Any single failure within the protection system shall not prevent proper protective action at the system level when required." This is applied to all systems that have safety related functions.

3. REFERENCES

The design basis for internal and external separation requirements of safety related circuits stated in this document is provided in Appendix 1. The use of the references in the preparation of this document does not imply FPC commitment to the referenced document.

A. E-91-0001, Rev. 0, Electrical Separation Criteria for Class 1E Control Boards, Equipment Cabinets and Relay Racks (To be superceded by this criteria).

B. Crystal River Unit 3, 10CFR50, Appendix R Fire Study.

C. Criteria Relating to Electrical Circuit Physical Separation and Cable Tray Loading dated January 24, 1977 (To be superceded by this criteria).

D. Electrical Design Criteria - Cable Tray and Conduit Fill and Weight Limitations.

E. CR3 Final Safety Analysis Report, Chapter 7, paragraphs 7.1.1.1 to 4 and 7.1.3.15 and Chapter 8, paragraph 8.2.2.11 to 13.

F. Regulatory Guide 1.75, Rev. 2: Physical Independence of Electric Systems.

G. IEEE 384, IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits.

H. IEEE 420, IEEE Standard for the Design and Qualification of Class 1E Control Boards, Panels, and Racks Used in Nuclear Power Generating Stations.

I. IEEE 690, Cable Systems for Class 1E Circuits in Nuclear Power Generating Station.

J. RO-3065, Addendum G: Requirement outline for Engineered Safeguards Actuation Relay Cabinets.

K. RO-3138, Addendum M: Requirement Outline for Main Control Board, and Control Cubicle.

L. Drawing E-214-061, Miscellaneous Cable Tray Details.

M. Drawing S-520-001 thru 013, Standard Appendix R Fire Wrapping Details.

N. Electrical Design Criteria - 10CFR50 Appendix R Compliance Review Criteria.

O. Electrical Design Criteria - Cable Ampacity Sizing.

P. IEEE 384-19XX; Proposed revision to IEEE 384-1981, Draft 3.

Q. IEEE Paper 71 TP 83-PWR; Working Group Report for Design and Installation of Wire and Cable Systems in Power Generating Stations [First draft to IEEE 422. NOTE: This document is committed in FSAR Chapter 8, Section 8.2.2.12(b)].

R. IEEE 422; Guide for the Design and Installation of Cable Systems in Power Generating Stations.

S. IEEE Paper 90 WM 254-3 EC; Cable Separation - What Do Industry Testing Programs Show?

T. IEEE Paper CH2040-4184/0000-0108$01.00; Arcing Fault in Metallic Conduit at 120 and 240 volts.

U. Crystal River Unit 3, Fire Hazard Analysis.

V. RP-5515-096-1.00-CS, Rev. 0; Engineered Safeguards Actuation System Electrical Separation Considerations.

W. Control Board and Relay Rack Engineered Safeguard Separation Criteria Report, Rev. 9, May 1975.

X. IEEE 279-1968; Proposed IEEE Criteria for Nuclear Power Plant Protection Systems.

4. ELECTRICAL SEPARATION

A. FOR OUTSIDE OF PANELS, CABINETS, AND RACKS

1) General Considerations

a. Routing Location

Whenever possible, raceways carrying safety-related circuits shall be routed through non-hazardous or limited hazard areas.

In non-hazard or limited hazard environment, separation distances are based on hazards being limited to fire and faults or failures internal to the cable. Internal failures are such occurrences as short circuits, open circuits, and grounds and include raceway interaction during a seismic event.

Where raceways with safety-related circuits are located in a hazard area, they shall be analyzed such that the defined hazard will not cause a common failure of both redundant safety-related systems. Therefore, the effects of external hazards such as pipe whip, jet impingement, water/chemical sprays, flooding, radiation, pressurization, elevated temperature or humidity and missiles shall be considered. However, where such a location is unavoidable, either protective shielding is provided for redundant Class 1E raceways or only one Class 1E channel raceway is allowed to occupy the area.

b. Physical Space and Functional Limitations

The preferred method for achieving independence is to physically and electrically separate redundant systems of safety-related cables and raceways from each other. Physical space and functional limitations and considerations may warrant the grouping of Safety-related and Nonsafety-related cable within the same raceway. Where this condition occurs, the specific circuit separation criteria defined in subsection 4.A.2 below shall be met.

c. Exceptions

For those cases where the criteria are found to be impractical or unduly restrictive, relaxation of the -

requirements may be considered and exceptions to specific requirements may be approved. Nuclear Engineering must review deviations and exceptions to determine whether they are acceptable. The exception shall be adequately justified and included in Attachment 1 of these design criteria.

2) Specific Circuit Separation Criteria

a. Safety-Related (Class 1E) Circuits

In order to assure safety function integrity, a safety-related circuit of one channel shall remain independent of any other channel. The independence can be achieved by running the circuits of one channel in raceways and penetrations that are physically separated by some distance from the raceways and penetrations used by circuits of a redundant channel. If routed in cable tray, safety-related cables are designated as either train A or train B and are only permitted to route in their respective A or B cable tray.

Where the minimum physical separation distance cannot be maintained between redundant channels and Class 1E to Non-Class 1E Raceways/Cables, a separation barrier shall be provided [Refer to Subsection 4.A.4].

i. Minimum separation distance between redundant Class 1E Raceways/Cables in the field and at the Reactor Building Penetrations shall be as defined in Table C.

Note that AB cables are to run separately from A train and from B train cables (reference Table A). For valves MUV 23 and 24, their cables are train AB but are to be run separately from the cables for valves MUV 25 and 26 which are also train AB. The reason being valves MUV 23 and 24 are redundant to valves MUV 25 and 26.

ii. Minimum separation distance between Class 1E to Non-Class 1E Raceways/Cables in the field and at the Reactor Building Penetration shall be as defined in Table E.

iii. Distances between external raceways carrying circuits of the same separation group but of different voltage level and cable type should be as defined in Table F.

The recommended separation distances given in Table F are based on industry accepted installation practices and the need to reduce noise in analog circuits run in close proximity with power circuits.

b. Associated Circuits

Associated circuits as defined in Section 2 "Definitions" refers to nonsafety-related circuits routed along with safety-related circuits. If these associated circuits are routed in cable trays, they shall be given XA or XB designation and are only permitted by computer program to route in A, XA or B, XB cable trays. These circuits do not perform a safety function and once a nonsafety-related circuit has been routed with a safety-related circuit, the nonsafety-related circuit shall be treated as the same channel as the safety-related circuit to which it has been grouped. These associated circuits shall not be routed with safety-related circuits of a redundant channel [Refer to subsection 4.A.8 for redundant cable groupings].

c. Nonsafety-Related Circuits

i. Nonsafety-related circuits shall not be routed along with safety-related circuits except when defined and installed as "associated" (Refer to subsection 4.A.2.b above).

ii. Nonsafety-related power cables from redundant safety-related equipment shall <u>not</u> be routed in a common nonsafety-related raceway.

iii. Non-safety cables that are inputted to the cable routing computer program as 'xx' shall be run in trays carrying XA, X, XB, XX with non-safety and associated cables only. They shall not be run in raceways carrying safety related cables. This does not violate separation criteria as associated trays were created to allow the intersection between safety and non-safety related trays. (NOTE: CR3 is not licensed to meet the requirements of IEEE 384 regarding the separation of associated circuits).

Note: There is only one 'XX' designated tray in the plant which was installed under MAR No. 88-10-20-01. The cables in this tray have been reviewed from the CR-3 electrical separation point of view and found acceptable. However, it is highly recommended not to install XX tray in the plant in the future.

iv. Non-safety cables that are inputted to the computer as 'X' shall be only allowed to run in non-safety trays 'X' and 'XX'.

d. Separation by Voltage and Cable Type

Circuits shall be separated by nominal circuit voltage and cable types and routed within separate raceways as detailed in Section 5.

e. Vendor Supplied Cable

Cables classified as EK-X shall not be run in tray unless acceptable fire propagation as defined by IEEE 383 is assured when using vendor cable.

3) Safety-Related Raceway Routing in Hazardous Areas and Common Fire Areas

Missile producing or high energy line break areas and common fire areas should be avoided when locating redundant safety-related raceways whenever possible. However, where such a location is unavoidable, protective shielding or Appendix "R" fire wrapping (Reference 10CFR50 Appendix R Fire Study, Appendix R 213 Series Drawings and the Fire Hazards Analysis (FHA)), as applicable, shall be provided to assure functional capability is maintained.

Appendix R fire barriers shall be installed using the typical fire wrapping construction details shown on drawings S-520-001 through -013. To determine if a raceway requires Appendix "R" protection, refer to electrical design criteria - 10CFR50 Appendix R Compliance Review Criteria - Reference 3.N.

4) Separation Barriers

Separation barriers (non-Appendix R application) can be used as follows when the separation distances cannot be maintained:

a. Rigid, flexible metallic conduit and armored cable are considered barriers. When these are used as a barrier, the minimum separation distance shall be as defined in Tables C and E for conduit.

b. Separation barriers for cable tray shall be as shown per Drawing E-214-061 to maintain the acceptable separation distance and structural and mechanical integrity of the cable tray and supports.

The use of asbestos materials for separation barriers is <u>not</u> allowed. Existing installations using asbestos need not be replaced; however, new installations or individual replacements should utilize a non-combustible asbestos free, mineral fiber material as shown on Drawing E-214-061.

c. Metal Square "D" Duct is considered a barrier. When these are used as a barrier, the minimum separation distance shall be as defined in Tables C and E for conduit.

d. The metal enclosures of the panel or cabinet. When these are used as a barrier, the minimum separation distance shall be as defined in Tables C and E for conduit.

e. CR-3 approved wraps/sleeves as separation barriers (to be identified later).

5) <u>Permanent Markings</u>

a. Raceways shall be identified using permanent markings. The purpose of such markings is to facilitate cable routing identification for future modifications or additions. Refer to applicable maintenance procedure for details.

b. The permanent identification of cables and conductors shall be made at the terminal points. Refer to applicable maintenance procedure for details.

c. The color coding for permanent markers for raceway and cables is shown on Table A.

6) <u>Splices</u>

Cable Splices within raceway, except for specifically identified splice boxes, is not allowed.

7) <u>Channel Separation</u>

Refer to Table A for channels requiring separation.

8) <u>Redundant Safety-Related Cable Groups</u>

There is four channel separation for the reactor protection and three channel separation for the engineered safeguard circuits. This separation is maintained from the sensor through the analog racks to the logic or relay cabinets. Where wiring in two or more cables is joined for a common alarm or events recorder point, the cables concerned are not routed in more than one engineered safeguard channel tray where routing through engineered safeguard tray is used for necessity.

For a detailed breakdown of the allowable cable groups and color coding, refer to Table A. The following is a generalized description of the systems included within the redundant safety-related channels.

a. Reactor Protection System-Channel I (RPS I)
Engineered Safeguard-Channel A (ES A)
Emergency Feedwater Initiation and Control-Channel A (EFIC A)
Associated-Channel A
Vital Bus-Channel A

b. Reactor Protection System-Channel II (RPS II)
Engineered Safeguard-Channel B (ES B)
Emergency Feedwater Initiation and Control-Channel B (EFIC B)
Associated-Channel B
Vital Bus-Channel B

c. Reactor Protection System-Channel III (RPS III)
Engineered Safeguard-Channel AB (ES AB)
Emergency Feedwater Initiation and Control-Channel C (EFIC C) - Instrumentation cable only
Associated-Channel AB
Vital Bus-Channel III

d. Reactor Protection System-Channel IV (RPS IV)
Emergency Feedwater Initiation and Control-Channel D (EFIC D)
Vital Bus-Channel IV

e. Emergency Feedwater Initiation and Control-Channel C (EFIC C) - Control cable only

B. FOR INSIDE 1E PANELS, CABINETS AND RACKS

1) General Considerations

a. Physical separation of redundant circuits, devices, and components is to be provided within sections of Class 1E panels, cabinets and racks listed in section 1.0 so that no single credible event as defined in the FSAR can prevent the proper functions of the safeguard or protection systems as identified in IEEE 279-71.

b. Engineered Safeguard channel circuits for safe plant shutdown are defined as those circuits which run separately to form two redundant actuation trains. "A" train which is color coded red and must be separated from the "B" train which is color coded green. Likewise, the "B" train which is green is similarly separated. The AB actuation which is yellow, is not a train but a combination of A and B trains, either of which causes an AB actuation. The AB actuation must be kept separate from the A & B channels and trains except at the point of origin where reasonable isolation is required.

c. Inside a Class 1E panel, cabinet, or rack separation is required between the separation groups defined in Table B.

d. Whenever a case arises in which there is a question as to whether the separation criteria has been satisfied, the case will be resolved by Nuclear Engineering via REA. Some examples would include:

i. Any cable running between the RPS, ES, or EFIC cabinets or internal wiring for these cabinets where two different color wires terminate on the same device, with one or more of these colors indicating Class 1E wiring.

ii. Cases when a non-Class 1E circuit is reassigned as a Class 1E circuit or vice verse.

iii. Any unusual wiring problems such as control switches and selector switches which are in circuits operated from a power source different from the indication, or switches containing power feeds different from the indicating lights.

d. For those cases where the criteria are found to be impractical or unduly restrictive, relaxation of the requirements may be considered and exceptions to specific requirements may be approved. Nuclear Engineering must review deviations and exceptions to determine whether they are acceptable. The exception shall be adequately justified and included in Attachment 1 of these design criteria.

2) Internal Wiring Color Code

Wiring inside Class 1E cabinets listed in section 1.0 shall be identified by use of color coding as described in Table B. Under special circumstances where the entire cabinet is of one separation group, the cabinet may be designated as that channel, and internal color codes do not need to be applied. The internal wiring drawings for Class 1E cabinets shall be marked to show wire color codes at devices or terminal boards. Gray wire will not show an identification color code.

3) Separation Distances and Barriers

a. Components and Wiring

Class 1E redundant components and wiring should be separated to the maximum practical distance in the cabinets in which they are located. The minimum separation distance between redundant Class 1E components and wiring, and between Class 1E to Non-Class 1E components and wiring shall be 6 inches (Ref. Table D). Exceptions to this requirement are control board dual indicators, non-class 1E low energy circuits, terminations on devices and Engineered Safeguards Actuation and Channel Cabinets. (Refer to subsection 4.B.3.b below and Appendix 3). Separation by distance is the preferred method to be considered for a given design.

For inside Class 1E cabinets, it is acceptable to have Non-Class 1E wiring not separated from Class 1E wiring or associated wiring by the minimum separation distance of 6 inches or by a barrier as long as Non-Class 1E wiring or cable is not routed with redundant Class 1E wiring and/or its associated circuits.

Components shall be located to maintain this minimum separation requirement. In the case where a device is in a group or surrounded by redundant wiring or devices it may not be possible to maintain this distance. If the minimum air space separation distance cannot be maintained, a barrier shall be installed between the components or wiring requiring separation. Barriers for use within Class 1E cabinets are:

i. A single sheet of 16 gauge (minimum) metal separated by at least one inch air space between the nearest Class 1E component or wiring. Where one inch of air space between Class 1E components cannot be achieved, a fire retardant material equivalent to one inch of free air space shall be attached to the metal sheet which: (1) extends at least one inch beyond the edge of the larger device or wire bundle; or (2) where the difference in device depths is six inches or greater extends at least one inch beyond the edge of the small device (Refer to Figures 1, 2 and 3). For new construction or modifications, a barrier with fire retardant material attached is recommended. Non-Class 1E components or wiring may be adjacent to the barrier (Refer to Figure 4A or 4B).

ii. Two sheets of 16 gauge metal (minimum) separated by a minimum of one inch air space between the metal pieces which: (1) extends at least one inch beyond the edge of the larger device or (2) where the difference in device depths is six inches or greater extends at least one inch beyond the smaller device. Refer to Figures 1, 2 and 5.

iii. Rigid or flexible metallic conduit shall be considered a barrier. When conduit is used as a barrier, the minimum separation distance between conduits shall be as defined in Table D.

iv. Crossover of redundant Class 1E circuits shall be enclosed in conduit for a length of six inches on either side of the crossover point or a barrier shall be installed. Crossover situations will be avoided wherever possible.

Specifically designed cabinets/components with more than one redundant Class 1E channel entering shall have barriers to effectively create separate channels (e.g., reactor trip switch, RC pump power monitor).

b. Generic Deviations

i. Control Board Indicators - Devices such as electronic indicators which have a power source separation requirement different from the associated signal shall have the field cables terminated on their respective terminal boards according to the separation criteria outlined herein. The power side shall be jumpered to terminals adjacent to the signal circuit terminals. The multi-conductor cable to the device shall be terminated at that point. (Reference Figure 6).

According to the design criteria 4.B.3.a, redundant Class 1E or Non-1E circuit routed with Class 1E of redundant divisions shall not be run in a common multiconductor cable. However, based on analysis performed in Appendix 1 of this document, the use of multiconductor cables with different separation groups for Bailey RY indicators is acceptable.

ii. Non-Class 1E Low Energy Circuits - Incoming field cable entering cabinets shall satisfy the criteria of Section 4.B.4. The only exceptions to these criteria which will be allowed will be annunciator/events recorder and RECALL circuits. Due to the very low energy levels in these circuits, it is not probable that faults will be transmitted back into two different trains. Consequently, the following rules shall apply exclusively to these circuits, which are all identified either by having a "K" in the third letter of the circuit number (e.g. AHK-296) or by having "EMR" as the letter prefix of the circuit number. [Refer to Appendix 2 for Circuit Number 3rd Letter Code].

- EMR and "K" circuits running in non-Class 1E trays entering safety related cabinets through non-Class 1E openings will be allowed to run internally to the cabinet with either Class 1E train A or train B wiring but not both.

- EMR and "K" circuits running in Class 1E trays entering the control board through Class 1E floor openings will be allowed to run with non-Class 1E circuits internal to the control room.

- "K" circuits below and adjacent to holes 29 through 35 and 135 for the events recorder will be allowed to run through holes 29 through 35 and 135 without requiring separation.

For detail analysis refer to Appendix 1 of this document.

iii. Terminations on Devices - For circuits that require separation and which terminate on the same device, the separation of the wiring may be less than 6 inches providing the following practices are followed:

a. On small devices such as grouped indicating lights, selector switches, dual indicators or relays, the wires to be separated should be brought to the terminals from different directions to achieve the maximum possible separation.

b. The minimum wiring separation shall not be less than the distance between the terminals.

c. Where possible an extra stage should be added to the switch or a barrier inserted between stages.

d. Thermocouple wires run directly to the device and do not terminate on intermediate terminal blocks.

c. Mounting on Barriers

Components and wiring shall not be physically mounted on barriers.

d. Barrier Materials

The use of asbestos materials for installation of new separation barriers is not allowed. Existing installations need not be replaced. However, new installation or individual replacements of existing barriers must utilize a non-combustible, asbestos free, mineral fiber material. The following are considered as suitable fire retardant materials.

i. Babcock and Wilcox - M-Board

ii. Johns Manville - Marinite

iii. Other equivalent materials as specifically approved by Nuclear Engineering.

iv CR-3 approved wraps/sleeves as separation barriers (to be identified later).

To insure that a barrier design using fire retardant material will be constructable, the thickness of the material shall be considered in the design. For barrier details, see drawings E-201-182 thru -184.

Teflon sleeving is not an acceptable material for safeguard wiring separation. Circuits identified by Ⓐ on 210-series internal wiring drawings indicates teflon sleeving installed. The cases with teflon installed prior to April 1974 were reviewed and determined to satisfy the criteria without reliance on additional qualities added by teflon sleeving. Teflon sleeving shall not be used to maintain separation if these circuits are rerouted or relocated.

4) Incoming Field Cables

a. Cable Entrance/Terminations

Separate cable entrances, wireways and terminal points shall be provided for:

- redundant Class 1E and associated circuits
- Non-Class 1E circuits.

Incoming cables from the field arrive at the Class 1E cabinets either by tray systems or in conduit. The control room on elevation 145'-0" has floor openings through which cable can enter the relay racks or Main Control Board. For floor opening assignments of incoming cables to this elevation, refer to 201-156, 201-310 and 224-103 series drawings. The EFIC and relay rooms on elevation 124'-0" also use floor openings for cable access to Class 1E cabinets. Where floor openings are used, the opening shall be considered equivalent to a conduit or channel opening.

Barriered floor openings are to be used to maintain separation through the floor into the control boards, panels or relay racks.

i. <u>Class 1E and Associated Circuits</u>

(1) Class 1E cables entering the control board or relay rack from a tray or through a conduit of a specific engineered safeguard train (A, B or AB) or reactor protection channel (I, II, III or IV) shall enter through an opening dedicated to that channel and maintain the same internal separation. Non-Class 1E cables run in Class 1E trays (associated circuits) shall be bundled with the Class 1E cables of that channel. The cables shall retain their respective separation group identification at the cabinet opening and at the terminal points. Separation internal to the control board or relay rack (including the opening) shall comply with 4.B.3.

(2) Class 1E cables of a particular channel or associated circuits shall terminate only on terminal boards or components associated with that train or channel and shall be separated from the terminal boards of redundant trains/channels and Non-Class 1E channels as noted in 4.B.3.

Where this separation becomes impractical, a barrier shall be installed on the terminal board or 6 inch distance shall be maintained between terminals used for circuits of redundant trains/channels and Non-Class 1E channels.

ii. <u>Non-Class 1E Circuits</u>

Non-Class 1E cables shall enter Class 1E cabinets via non-Class 1E raceways physically separated from any engineered safeguard train or reactor protection channel and shall be terminated on Non-Class 1E terminal boards physically separated or barriered from terminal boards containing Class 1E circuits. Exceptions to this are the non-class 1E low energy circuits (Refer to Subsection 4.B.3.b(ii), Generic Deviation).

5) Isolation

Electrical isolation methods shall be used to maintain the independence of redundant circuits such that required safety functions can be accomplished. This electrical isolation shall be achieved through the use of Class 1E isolation devices applied to the interconnection of:

- Class 1E and Non-Class 1E
- Associated circuits and Non-Class 1E circuits, or
- Class 1E logic circuits of redundant channels. (Reference Figures 7, 8, and 9.)

Any device used for isolation shall be qualified for its intended function and shall be considered a part of the Class 1E system.

a. Devices

Isolation devices must be demonstrated by a product class test that -

- the maximum credible voltage or current transient applied to the device's Non-Class 1E side will not degrade the operation of the circuit connected to the device's Class 1E or associated side below an acceptable level, and
- shorts, grounds or open circuits occurring in the Non-Class 1E side will not degrade the circuit connected to the Class 1E or associated side below an acceptable level.

The following devices when properly applied and qualified can be used for isolation:

i. Amplifiers

ii. Control Switches

iii. Fiber Optic Couplers

iv. Photo-optical Couplers

v. Relays

vi. Transducers

vii. Power Packs

viii. Current Transformers

ix. Circuit Breakers

b. Fuses

Fuses may be used as an isolation device to isolate Class 1E circuits from Non-Class 1E circuits if the requirements in subsection 4.B.5.a and the following additional requirements are met:

i. Each fuse shall be tested (i.e. resistance measurement to verify overcurrent protection as designed).

ii. Fuses shall provide the design overcurrent protection capability for the life of the fuse.

iii. The fuse time-overcurrent trip characteristics for all current faults shall cause the fuse to open prior to the initiation of opening of any upstream interrupting device.

iv. The power sources shall be capable of supplying the necessary current under fault conditions to ensure the proper coordination without loss of function of Class 1E loads.

Note:

Fuses shall not be used to isolate redundant channels, i.e. Channel A & Channel B.

c. Terminal Wiring

The separation of the wiring at the input and output terminals of an isolation device may be less than six inches provided that it is not less than the distance between the input and output terminals.

5. CABLE TRAY LOADING

A. 6900 Volt Power Circuits Cable Tray

1) No other type of cable other than 8KV cable shall be routed in the same tray with 6900 volt power circuits cable.

2) There shall be only one layer of cable in tray.

B. 4160 Volt Power Cable Tray

1) No other type of cable other than 5KV cable shall be routed in the same tray with 4160 volt power circuits cable.

2) There shall be only one layer of cable in a tray.

C. 480 Volt, 120 Volt AC and 125 Volt DC Power Circuits Cable Tray

1) No other type of cable other than 600V or 1KV cable shall be mixed in the same tray carrying 480 volt, 120 volt AC and 125 volt dc power circuit cables.

2) Tray loadings of 50% maximum physical fill is the design objective. However, in certain areas where physical limitations govern, the tray fill may exceed 50%. In all cases, however, thermal loading shall be considered based on the derating factors for 40°C and 50°C ambient temperatures. (Refer to "Electrical design Criteria - Cable Tray and Conduit Fill and Weight Limitations" for specific guidance - Reference 3.D and Electrical Design Criteria - Cable Ampacity Sizing - Reference 3.0).

D. 120 Volt AC and 125 Volt DC Control Cable Tray

In general, control cable tray loading of 50% maximum physical fill is the design objective. However, in certain areas where physical limitations govern, the cable fill may exceed 50%. In all cases, however, thermal loading shall be considered. (Refer to "Electrical Design Criteria - Cable Tray and Conduit Fill and Weight Limitations" for Specific Guidance - Reference 3.D.)

NOTE: 480 volt, 120 volt AC and 125 volt DC power cables sized No. 8 AWG and smaller may be placed within control cable trays.

E. Instrument Cable Tray

1) In general, instrument cable tray loading of 50% maximum physical fill is the design objective. However, in certain areas where physical limitations govern, the cable fill may exceed 50%. (Refer to "Electrical design Criteria - Cable Tray and Conduit Fill and Weight Limitations" for specific guidance - Reference 3.D.)

2) There shall not be other types of cables mixed with instrumentation cabling except alarm, telephone, low level paging circuits and low energy inputs to computer.

6. CABLE AND WIRE APPLICATIONS

A. The application and routing of power, control and instrumentation cables shall be such as to minimize their vulnerability to damage from any source. All cables shall be selected using conservative margins with respect to their current carrying capabilities, insulation properties and mechanical construction.

Cable ampacity with respect to various installation conditions such as routing and environment temperature shall be determined in accordance with the Electrical Design Criteria - Cable Ampacity Sizing (Reference 3.O).

Power cable insulation shall be rated 90°C. The cable jacket may be made of neoprene or Hypalon. The cable may also have an overall interlocked armor for additional mechanical protection or for non-flame retarding purposes. Interlocked armor is acceptable as a barrier for separation purposes. However, interlocked armor cable shall not be used in the Reactor Building in order to minimize the quantity of zinc so as to avoid problems with chemical spray.

Instrumentation cables shall be twisted and shielded as appropriate to minimize the effects of induced voltage and magnetic interference.

B. Wire and cables that are classified as Class 1E shall be routed and installed to maintain the integrity of their redundant trains or channels in accordance with the requirements of Section 4.A and 4.B of this criteria.

Wire and cables shall be permanently marked (color coded) in accordance with Sections 4.A.5 and 4.B.2.

C. Fire barriers shall be used where cable trays and cable runs enter or leave Class 1 areas, enter or leave the control and auxiliary buildings and where vertical trays pass through floor openings. (Refer to drawing E-214-061 for details.)

D. Power and control cable trays shall be ladder type. Where there are horizontal trays passing under grating or hatches, the top tray shall have a solid cover which is spaced (if required due to heating of the cables) above the tray for ventilation. Covers shall be installed for protection where a tray has a vertical rise near a walkway or goes through a floor (Refer to E-214 series drawings).

TABLE A
ALLOWABLE RACEWAY/CABLE GROUPING AND COLOR CODE

GROUP NO. (COLOR CODE)															
INSTRUMENTATION					CONTROL						POWER				
1 (RED)	2 (GREEN)	3 (YELLOW)	4 (BLUE)	5 (WHITE)	6 (RED)	7 (GREEN)	8 (YELLOW)	9 (BLUE)	10 (VIOLET)	11 (WHITE)	12 (RED)	13 (GREEN)	14 (YELLOW)	15 (BLUE)	16 (WHITE)
RPS I	RPS II	RPS III	RPS IV	—	—	—	—	—	—		—	—	—	—	—
ES A	ES B	ES AB	—	—	—	—	—	—	—		—	—	—	—	—
EFIC A	EFIC B	EFIC C	EFIC D		EFIC A	EFIC B	—	EFIC D	EFIC C		—	—	—	—	—
Assoc. Ch. A	Assoc. Ch. B	Assoc. Ch. AB	—	—	Assoc. Ch. A	Assoc. Ch. B	Assoc. Ch. AB	—	—		A... [illegible]	Assoc. Ch. B	Assoc. Ch. AB	—	—
Other Safety Related Ch. A	Other Safety Rela' ' Ch. B	—	—	—	Other Safety Related Ch. A	Other Safety Related Ch. B	Other Safety Related Ch. AB	—	—		Other Safety Related Ch. A	Other Safety Related Ch. B	Other Safety Related Ch. AB	—	—
—	—	—	—	Non-Safety Related	—	—	—	—	—	Non-Safety Related	—	—	—	—	Non-Safety Related
—	—	—	—	—	—	—	—	—	—	—	Vital Bus Ch. A	Vital Bus Ch. B	Vital Bus Ch. III	Vital Bus Ch. IV	—

TABLE B

COLOR CODES FOR INTERNAL CONTROL BOARD AND RELAY RACK WIRING

1. Red (R) wire for engineered safeguards train "A", reactor protection channel I, or EFIC Channel "A".

2. Green (G) wire for engineered safeguards train "B", reactor protection channel II, or EFIC Channel "B".

3. Yellow (Y) wire for engineered safeguards train "AB", reactor protection channel III or EFIC Channel "C" analog.

4. Blue (BL) wire for reactor protection channel IV, or EFIC Channel "D".

5. Brown (B) wire for non-safety related circuits running in safeguards train "A" tray and isolated from all other circuits.

6. Orange (O) wire for non-safety related circuits running in safeguard train "B" tray and separated from all other circuits.

7. Black (BK) wire for non-safety related control circuits running in safeguard train "AB" tray and separated from all other circuits.

8. Gray wire for non-safety related circuits arriving at the control board or rack in a non-safety related tray.

9. Violet (V) wire for EFIC Channel "C" control.

10. Black and white small gauge wires (#22AWG) appear on miniature devices for low voltage circuits entirely within the control board. These wires are not safeguard related; therefore, no separation is required.

11. If manufacturer's supplied multiconductor, multicolored cables are used, the color coded wire will be referred to in the manufacturer's connection drawings and the colors have no safeguard implication.

12. Striped color coded wire for EFIC logic is used as follows:

    Red with green stripe EFIC "A" to EFIC "B" Logic
    Red with yellow stripe EFIC "A" to EFIC "C" Logic
    Red with blue stripe EFIC "A" to EFIC "D" Logic
    Green with red stripe EFIC "B" to EFIC "A" Logic
    Green with yellow stripe EFIC "B" to EFIC "C" Logic
    Green with blue stripe EFIC "B" to EFIC "D" Logic
    Yellow with red stripe EFIC "C" to EFIC "A" Logic
    Yellow with green stripe EFIC "C" to EFIC "B" Logic
    Yellow with blue stripe EFIC "C" to EFIC "D" Logic
    Blue with red stripe EFIC "D" to EFIC "A" Logic
    Blue with green strip EFIC "D" to EFIC "B" Logic
    Blue with yellow stripe EFIC "D" to EFIC "C" Logic

13. Bare/uninsulated wires are ground wires.

TABLE C
REDUNDANT RACEWAYS SEPARATION CRITERIA FOR 1E EXTERNAL RACEWAYS AND WIRING

	Edge to Edge Spacing[4]	Low Energy		Control		LV Power Circuits with cable size ≤ 500 MCM		LV Power Circuits with cable size > 500 MCM and All Medium Voltage Power Circuits	
		Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard
Conduit to Conduit	Horizontal Vertical	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	Note 1 Note 1	Note 1 Note 1
Conduit to Tray/ Cable	Horizontal Vertical	0 inches 0 inches	0 inches 0 inches	Note 2 1 inch	Note 2 1 inch	1 inch 1 inch	1 inch 1 inch	1 inch 1 inch	1 inch 1 inch
Cable to Cable/Tray	Horizontal Vertical	1 inch 3 inch	1 inch 3 inch	1 inch 3 inch	1 inch 3 inch	1 inch 3 inch	6 inch 12 inch	1 inch 3inch	3 feet 5 feet
Tray to Tray	Horizontal Vertical	1 foot 3 feet	3 feet Barriers	1 foot 3 feet	3 feet Barriers	1 foot 3 feet	3 feet Barriers	1 foot 3 feet	3 feet Barriers
Reactor Building Penetrations	Horizontal Vertical	N/A N/A	5 feet[3] 3 feet[3]	N/A N/A	5 feet[3] 3 feet[3]	N/A N/A	5 feet[3] 7 feet[3]	N/A N/A	5 feet[3] 3 feet[3]

NOTES:

[1] An air gap (minimum 1/16") to minimize heat transfer between the conduits. Conduits may have 0 inch separation at condulet bodies only.

[2] An air gap (minimum 1/16") to minimize heat transfer between the tray/cable to conduit.

[3] Measured between centers.

[4] All spacings shown are edge to edge of the raceway/cable and do not include attachment hardware.

[5] If the two circuits are of a different voltage level, the more stringent separation criteria shall apply. Circuit spacing should also take into account installation and electrical noise concerns (Refer to Section 4.A.2.c.)

(REF. SECT. 4.A.2.i)

TABLE D
SEPARATION CRITERIA FOR INTERNAL 1E TO 1E AND 1E TO NON-1E PANEL COMPONENTS AND WIRING

	Edge to Edge Spacing[3]	Low Energy	Control
Component to Component or Comp. To Wire/Cable or Cable to Cable or Wire to Wire or Wire to Cable	Horizontal Vertical	6 inch 6 inch	6 inch 6 inch
Conduit to Conduit	Horizontal Vertical	0 inch 0 inch	0 inch 0 inch
Conduit to Cable/Wireway/ Wire	Horizontal Vertical	0 inch 0 inch	Note 1, 2 1 inch, Note 2

NOTES:

[1] An air gap (minimum 1/16") or an insulating barrier to prevent thermal conductivity between the conduits.

[2] If wireways are enclosed, the wireway is considered an enclosed raceway and is equivalent to a conduit (enclosed raceway).

[3] All spacings shown are edge to edge of the raceway/cable and do not include attachment hardware.

(REF. SECT. 4.B.3.a)

TABLE E
RACEWAYS SEPARATION CRITERIA FOR 1E TO NON-1E EXTERNAL RACEWAYS AND WIRING

	Edge to Edge Spacing[4]	Low Energy		Control		LV Power Circuits with cable size ≤ 500 MCM		LV Power Circuits with cable size >500 MCM and All Medium Voltage Power Circuits	
		Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard
Conduit to Conduit	Horizontal Vertical	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	Note 1 Note 1	Note 1 Note 1
Conduit to Tray/ Cable	Horizontal Vertical	0 inches 0 inches	0 inches 0 inches	Note 2 1 inch	Note 2 1 inch	1 inch 1 inch	1 inch 1 inch	1 inch 1 inch	1 inch 1 inch
Cable to Cable/Tray	Horizontal Vertical	1 inch 3 inch	1 inch 3 inch	1 inch 3 inch	1 inch 3 inch	1 inch 3 inch	6 inch 12 inch	1 inch 3inch	3 feet 5 feet
Tray to Tray	Horizontal Vertical	1 inch 3 inch	1 inch 3 inch	1 inch 3 inch	1 inch 3 inch	1 inch 3 inch	6 inch 12 inch	1 inch 3 inch	3 feet 5 feet
Reactor Building Penetrations	Horizontal Vertical	N/A N/A	5 feet[3] 3 feet[3]	N/A N/A	5 feet[3] 3 feet[3]	N/A N/A	5 feet[3] 3 feet[3]	N/A N/A	5 feet[3] 3 feet[3]

NOTES:

1 An air gap (minimum 1/16") to minimize heat transfer between the conduits. Conduits may have 0 inch separation at condulet bodies only.

2 An air gap (minimum 1/16") to minimize heat transfer between the tray/cable to conduit.

3 Measured between centers.

4 All spacings shown are edge to edge of the raceway/cable and do not include attachment hardware.

5 If the two circuits are of a different voltage level, the more stringent separation criteria shall apply. Circuit spacing should also take into account installation and electrical noise concerns (Refer to Section 4.A.2.c.)

(REF. SECT. 4.A.2.a.ii)

J:\PROJECTS\CA3\EEPRS\TABLEF.WPF

TABLE F
RECOMMENDED SEPARATION DISTANCES BETWEEN EXTERNAL RACEWAYS OF DIFFERENT VOLTAGE LEVEL AND CABLE TYPE

	Horizontal	Vertical
Tray to Tray	6" (Note 2)	9" (Note 1)
Tray to Conduit	1"	1"
Conduit to Conduit	1"	1"

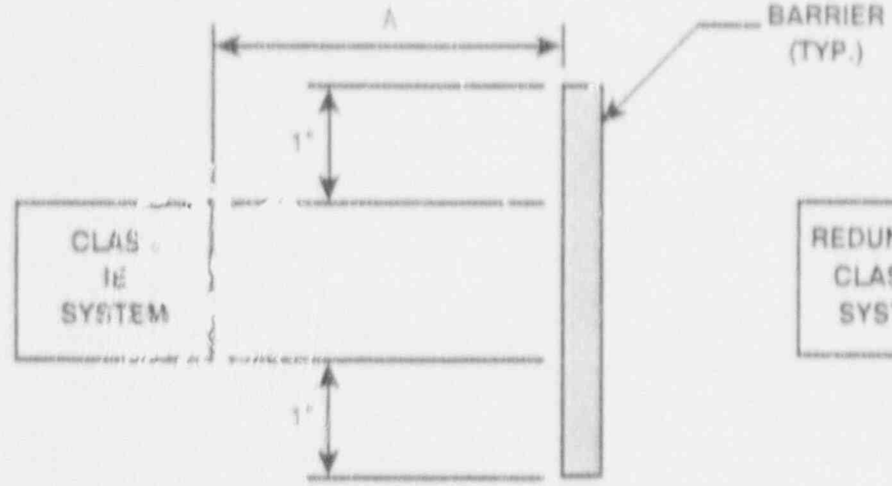
NOTES:

1 The distance between the bottom of the upper tray and top of the lower tray.

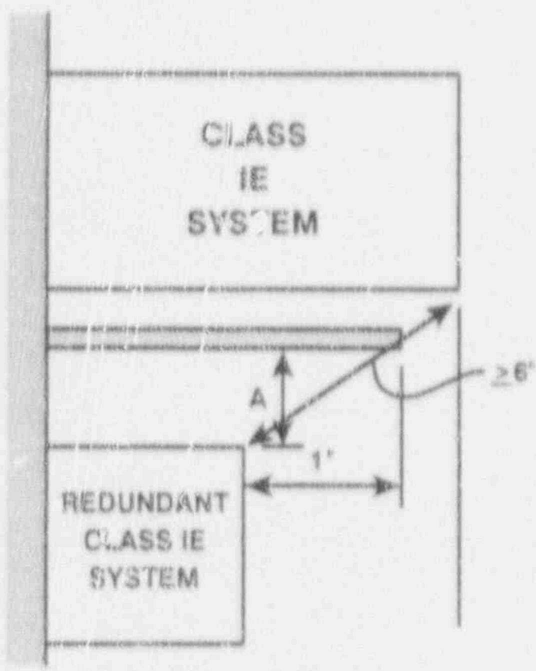
2 The distance between the adjacent sides.

3 The recommended separation distances in above table are to minimize noise in analog circuits run in close proximity with power circuits.

(REF. SECT. 4.A.2.a.iii)



(REF. SECT. 4.B.3.a.I)
FIGURE 1

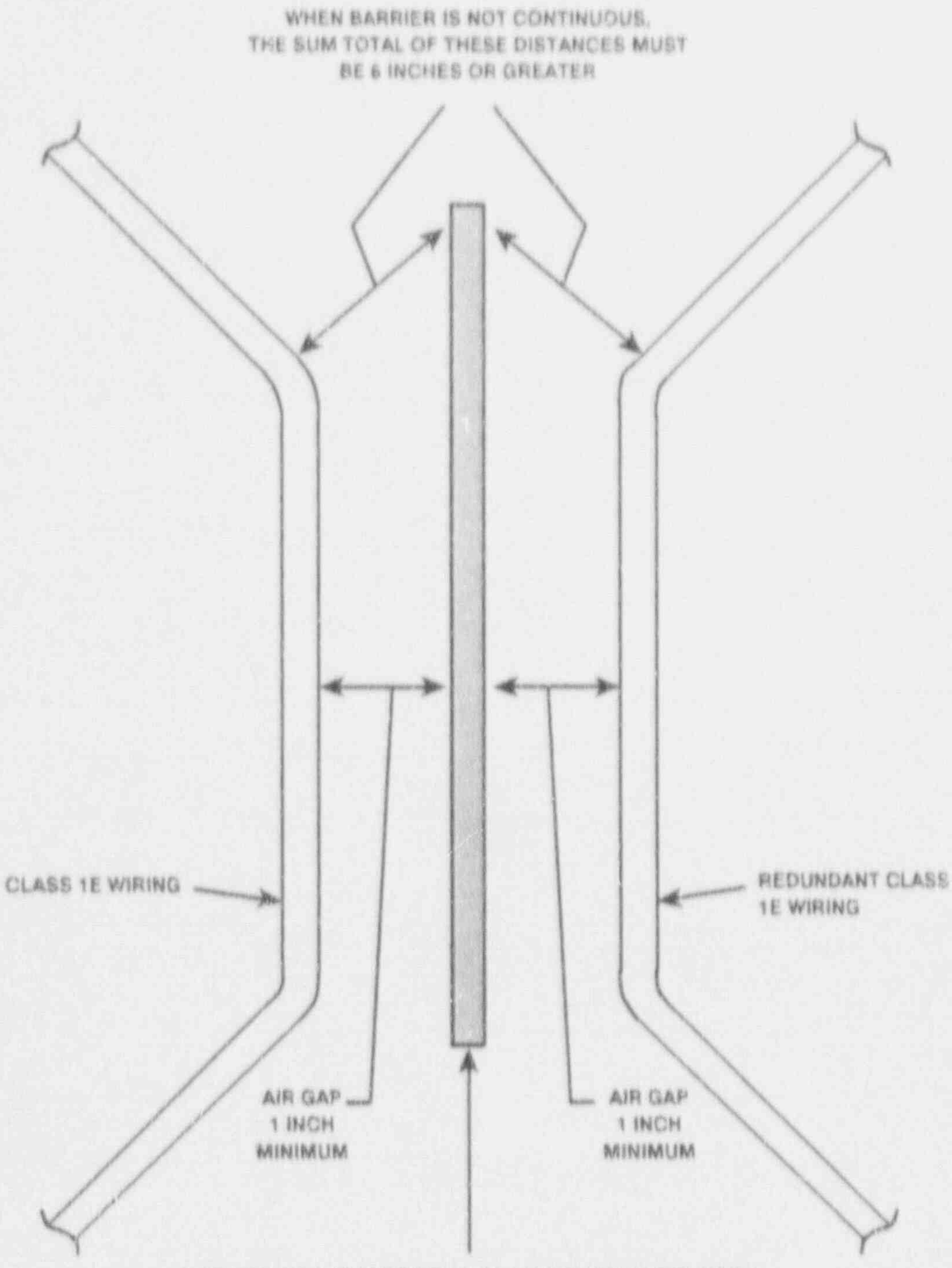


(REF. SECT. 4.B.3.a.I)
FIGURE 2

NOTE:

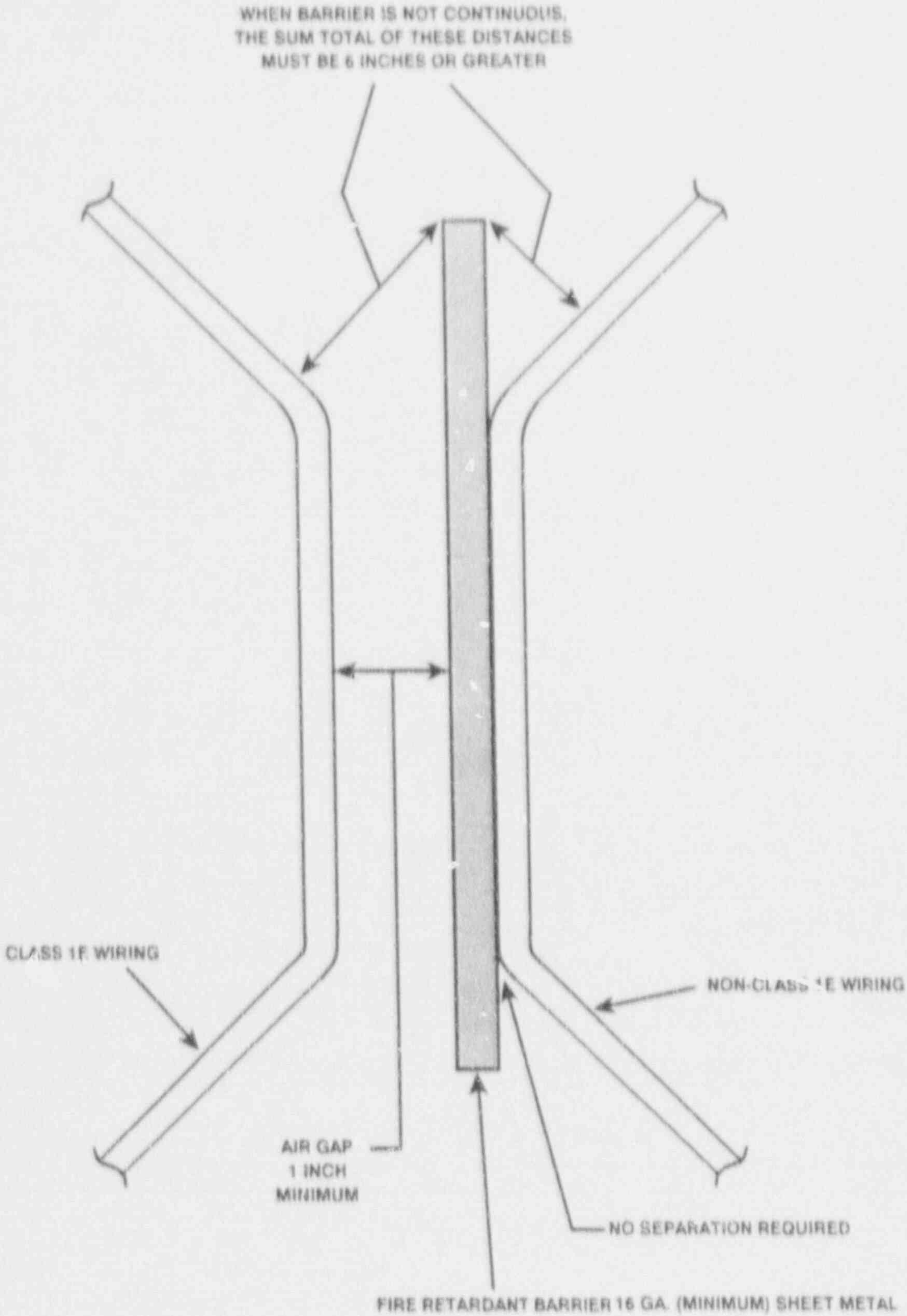
1. There is no minimum dimension for "A" where thermal insulation material is used in the barrier.

2. In the case where a component is in a group or surrounded by components or wire of a different separation channel, an enclosed box can be used to maintain the required separation.



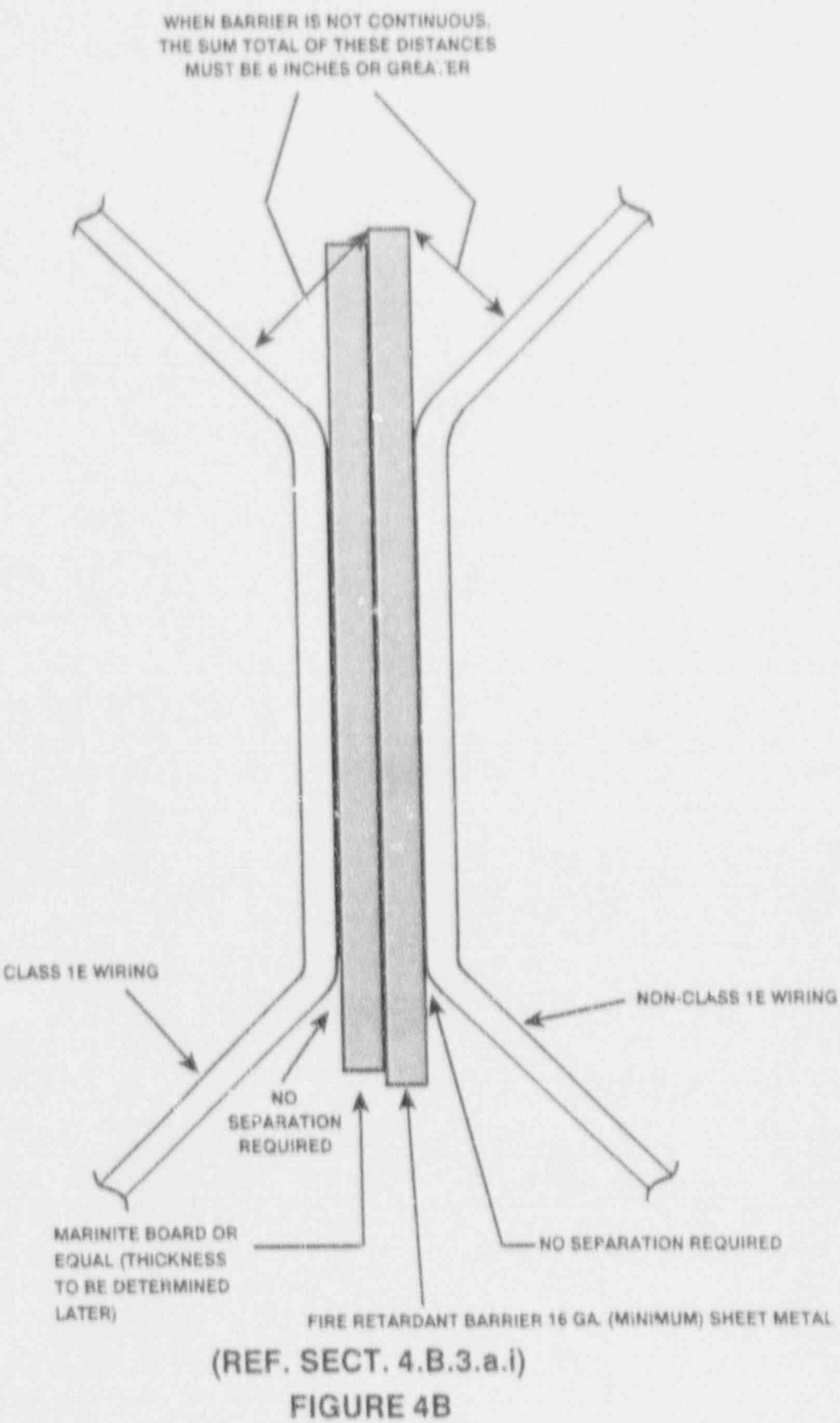
(REF. SECT 4.B.3.a.i)

FIGURE 3



(REF. SECT. 4.B.3.a.i)

FIGURE 4A



(REF. SECT. 4.B.3.a.i)

FIGURE 4B

CAUTION: DO NOT USE THIS CONFIGURATION FOR NEW INSTALLATIONS SINCE ASBESTOS MATERIAL IS NO LONGER ALLOWED TO USE.

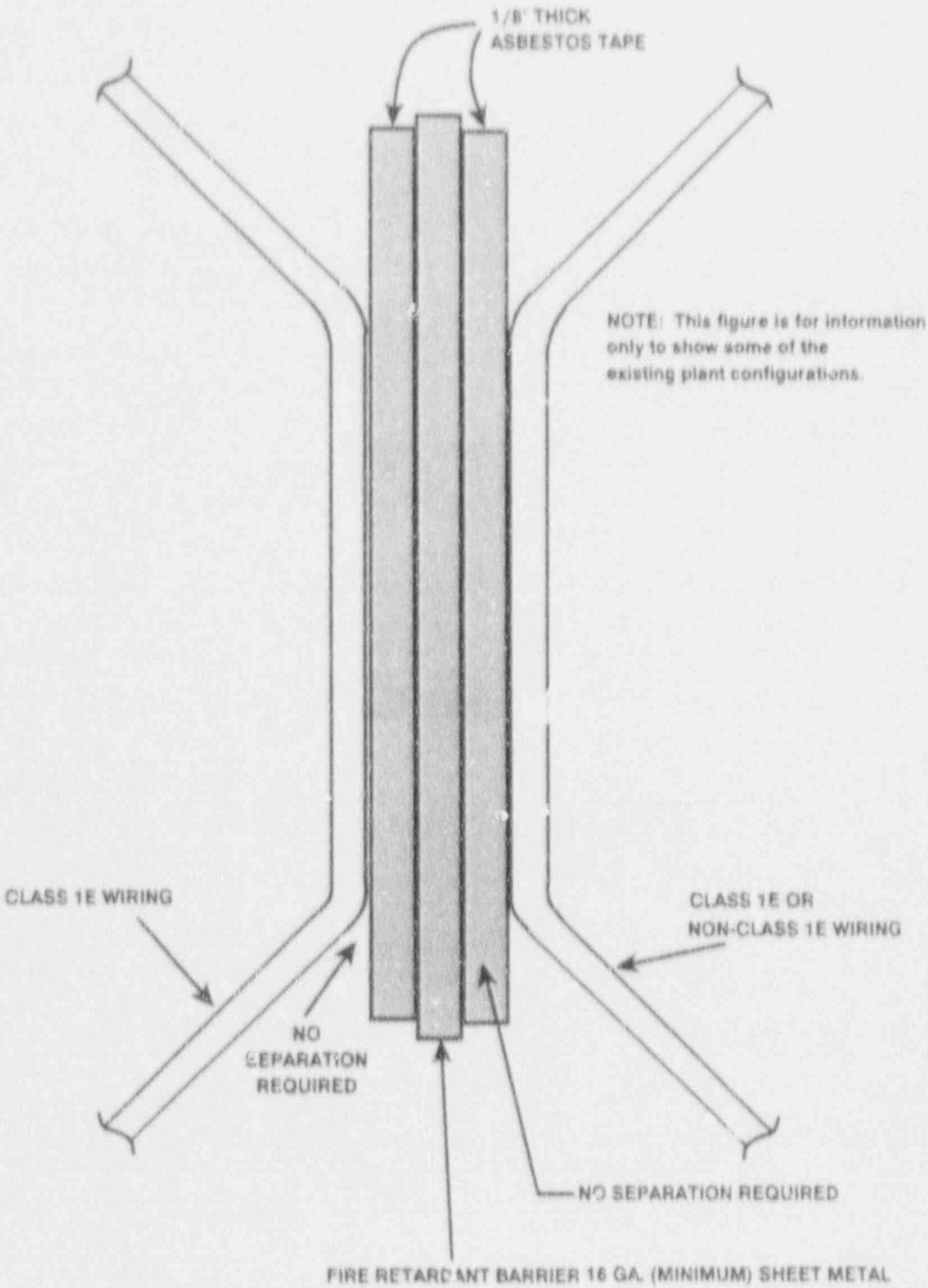
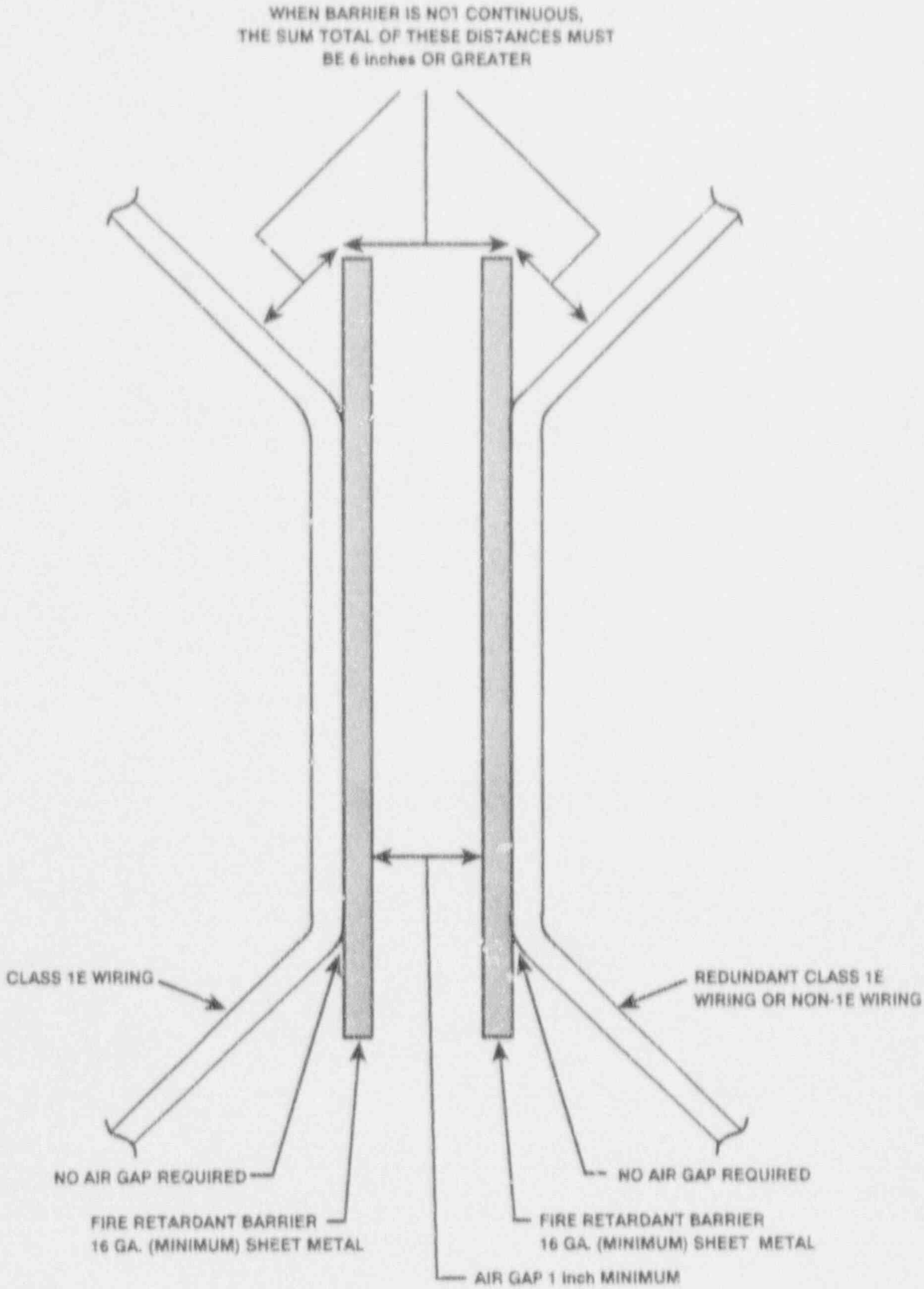
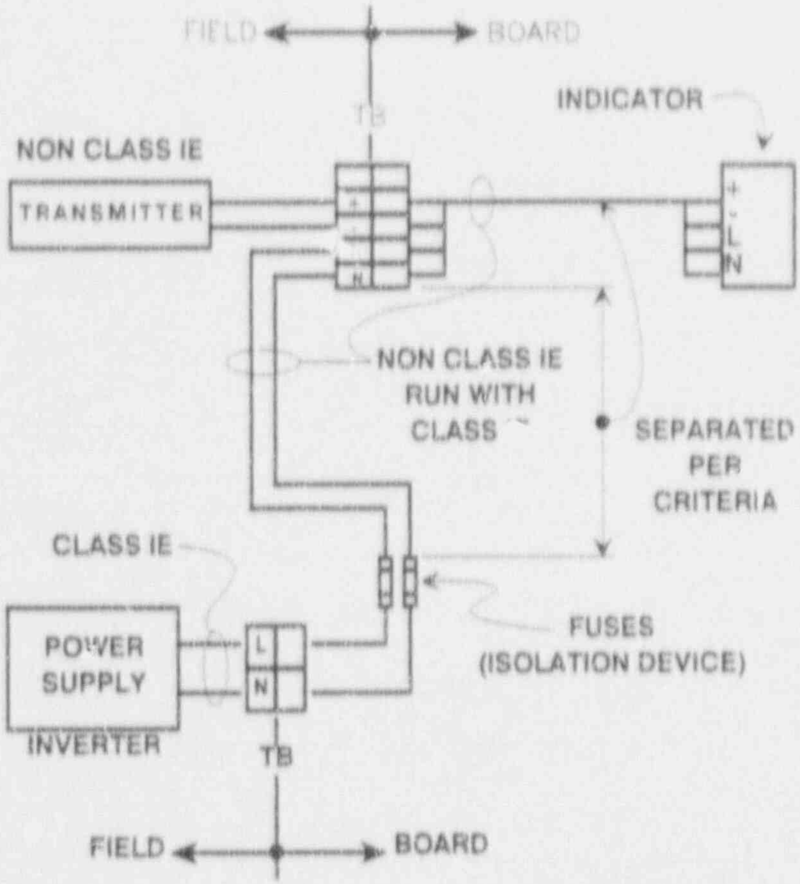


FIGURE 4C



(REF. SECT. 4.B.3.a.i)

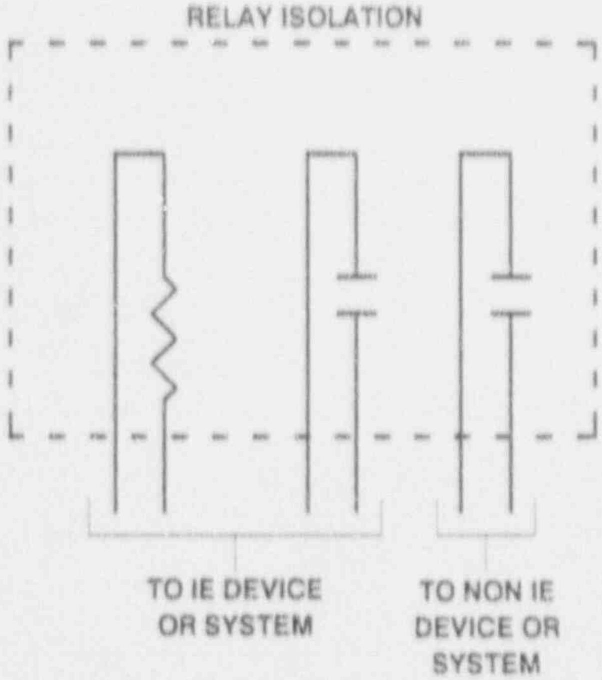
FIGURE 5



MAIN CONTROL BOARD INDICATOR WIRING

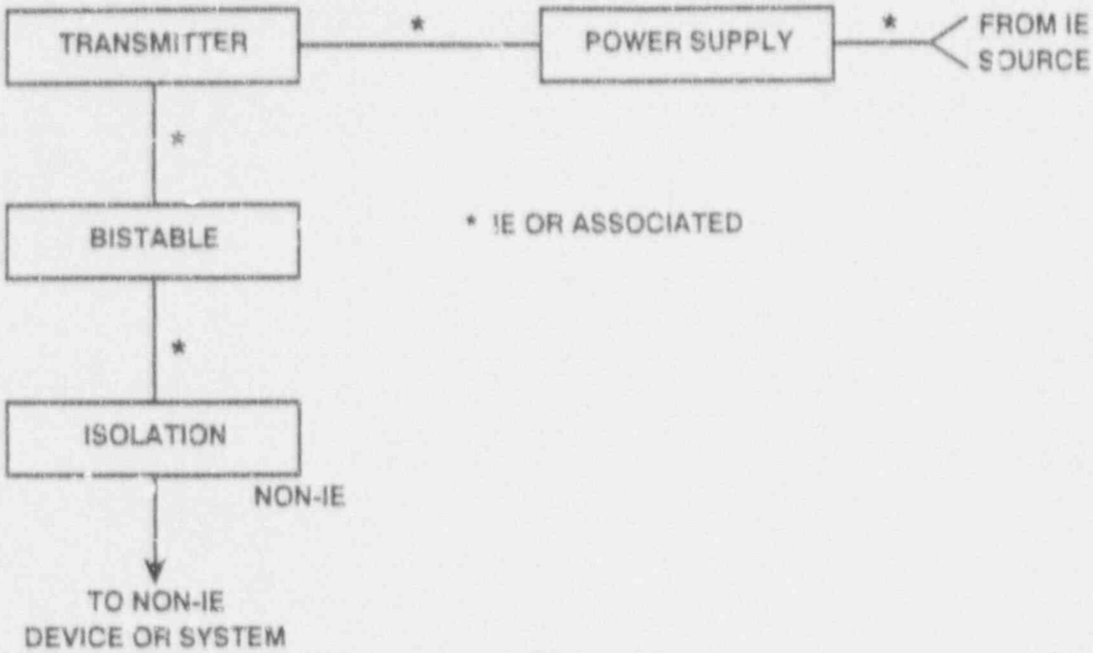
(REF. SECT. 4.B.3.b.i)

FIGURE 6



(REF. SECT. 4.B.5)

FIGURE 7



(REF. SECT. 4.B.5)

FIGURE 8

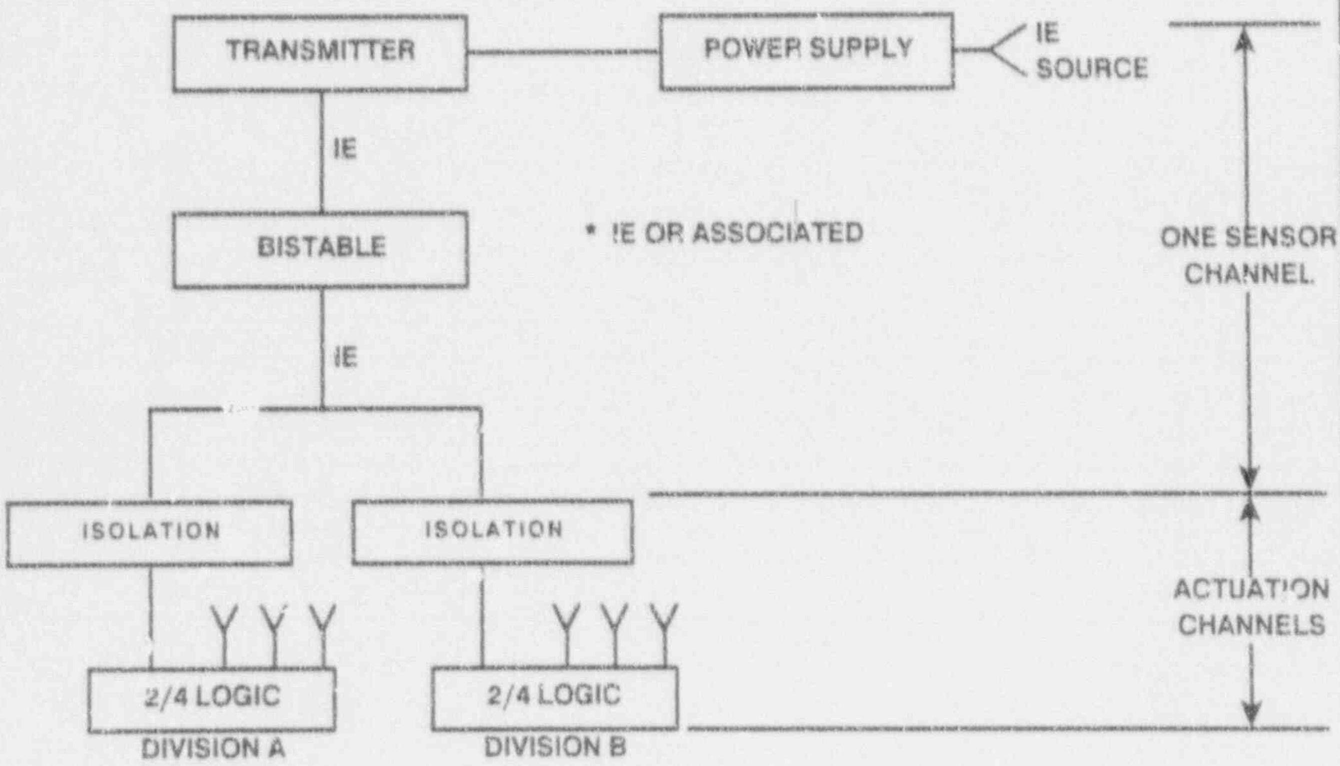


FIGURE 9 (REF. SECT. 4.B.5)

APPENDIX 1

BASIS FOR REDUNDANT AND 1E TO NON-1E CIRCUIT SEPARATION CRITERIA

1.0 BACKGROUND

This appendix to the Separation Design Criteria provides the basis for separation distances found in Tables C, D and E to the Separation Design Criteria. This appendix addresses both the separation distances for 1E raceways and cable external to panels and 1E internal panel components and wiring.

For external panel raceway and cables, this justification is limited to the Non-Hazardous (cable spreading room) area and the Limited Hazard area (outside cable spreading room but not Hazardous Areas) where the only energy available to damage electrical circuits is that energy associated with failure or faults internal to electrical equipment or cables within the area. Separation for external sources of energy (e.g. exposure fires, pipe breaks, missiles, etc. in a Hazardous Area) is not included in this Appendix (Reference IEEE-384).

FSAR Section 7.1.3.1.5 addresses the separation criteria internal to the control board and racks. FSAR section 8.2.2.12 includes separation requirements for external raceways in accordance with Draft 1, dated October 20, 1971, Section 8.0 of the proposed guide for the Design and Installation of Cable Systems in Power Generating Stations. These are the commitments before CR-3 was issued an operating license. The new design criteria still meets these requirements and commitments.

2.0 DEFINITIONS OF CABLE VOLTAGE LEVELS

2.1 LOW ENERGY CIRCUITS

Low energy circuits are those that satisfy the definitions found in Section 2.0 of the Design Criteria.

2.2 CONTROL CIRCUITS

Control circuits are those that satisfy the definitions found in Section 2.0 of the Design Criteria. For CR3, these are the 120V AC and 125V DC control circuits.

2.3 LOW VOLTAGE POWER CIRCUITS

Low voltage power circuits are those that satisfy the definitions found in Section 2.0 of the Design Criteria. For CR3, these are the 480V AC, 250V DC, 125V DC and 120V AC power cables.

2.4 MEDIUM VOLTAGE POWER CIRCUITS

Medium voltage power circuits are those that satisfy the definitions found in Section 2.0 of the Design Criteria. For CR3, these are the 6900 and 4160V power circuits. (The 6900V power circuits are all non-1E.)

3.0 SEPARATION DISTANCES FOR REDUNDANT 1E EXTERNAL RACEWAYS AND CABLES

This section provides the justification for the separation distances shown in Table C for redundant 1E raceways and cables external to panels.

3.1 1E CONDUIT TO CONDUIT SPACING

3.1.1 Low Energy Circuits

Should a low energy circuit fail, there will be insufficient fault current to heat the cable to a temperature which will damage or ignite the cable. Therefore cables in a redundant conduit that touch the conduit with the faulted cables will not experience degradation from heat transfer such that they will fail to perform their safety function.

A conduit to conduit spacing of 0 inches is acceptable for circuits defined as low energy based on the above justification.

3.1.2 Control Circuits and Low Voltage Power Cables Less Than or Equal to 500 MCM

The concern relative to conduit spacing is that the heat due to failure of a cable in one conduit is not transferred to cables in another conduit such that its cables are degraded to a condition that they are unable to perform their safety function.

The results of industry testing to determine distances needed to meet cable separation have been compiled in an IEEE paper entitled "Cable Separation - What Do Industry Testing Programs Show?" (Paper No. 90 WM 254-3 EC presented at the IEEE/PES 1990 Winter Meeting).

This paper was a factor used in reducing separation distance criteria as proposed for the 1991 revision of IEEE 384, Standard Criteria for Independence of Class 1E Equipment and Circuits.

The paper discusses the test methods and results of specific cable and raceway configurations, one being conduit to conduit. The test configurations used both rigid and flex conduit, aluminum sheathed cable, metal clad cable and armored cable and found no observable difference between them. Also the Fire Hazards Analysis, Section 3.3 states that interlocked armor cable is not included as a combustible since it is considered equivalent to a flex conduit. The test approach was to determine the cable type and size and current combination that produced the maximum amount of heat released to the environment as a result of fault current. This combination produced the worst-possible internally generated electrical fault, and any successful test with this combination would envelope all other sizes and fault current combinations. The tests showed no failures up to 500 MCM cable with a 0 inch separation between conduits.

A conduit spacing of 0 inches for control and low voltage power cables less than or equal to 500 MCM is acceptable based on the results of the industry testing performed to date.

3.1.3 **Low Voltage Power Cables Greater Than 500 MCM and All Medium Voltage Cables**

The concern relative to conduit spacing is that the heat due to failure of a cable in one conduit is not transferred to cables in a redundant conduit such that its cables are degraded to a condition that they are unable to perform their safety function.

The industry test results described in the paper noted previously in paragraph 3.1.2 showed that a 750 MCM low voltage cable in a conduit did cause a failure in another conduit when there was 0 inch separation. However, a second test with a 750 MCM cable with a spacing of 1 inch did not cause the cables in the other conduit to fail. Therefore, a conduit spacing somewhere between 0 inches and 1 inch will be acceptable. The results of the other cable tests noted below was used to determine what may be an acceptable distance.

The remainder of the cables in conduit in the test (from No. 12 AWG to 500 MCM) did not cause a cable failure in the other conduit when the separation was 1/4 inch or less. Therefore any air gap is acceptable separation so as to break the conductive heat transfer from the faulted cable. Based on the results of the No. 12 AWG to

500MCM cables coupled with the tests performed on 750MCM cables, an air gap to break conductive heat transfer from the faulted cable is acceptable for low voltage power cables greater than 500MCM.

No specific tests were run for medium voltage cable in conduit. For the CR3 1E electrical auxiliary distribution system, the 4160V (medium voltage) and 480V (low voltage) systems are resistance grounded. For the large majority of faults which are line to ground, the fault current will be limited to [illegible] amps. This is well below the current passed through the tested 750MCM cable. The 3 phase fault currents of the two systems are of a similar magnitude (30,000 amps for the 480V system and 35,000 amps for the 4160V system. In addition the proposed IEEE 384 revision, Table 1 lumps medium voltage power cables with large low voltage power cables for separation distances in a Limited Hazard Area.

Therefore as for the low voltage cables an air gap is acceptable separation for the medium voltage cables so as to break the conductive heat transfer from the faulted cable.

Condulet bodies only are allowed to have 0 inch separation given the following:

A. The conduits to which the condulets are connected will act like radiators thus cooling off the conduit and the condulet itself.

B. The condulet has a larger surface area subject to cooling and thus should be at a lower temperature than the conduits in the industry tests.

C. The possibility of the cable failing (igniting) in the condulet vs. some other point in the conduit run is remote.

Therefore, based on the preceding discussions, a visible air gap or an insulating barrier to prevent thermal conduction between the conduits for low voltage power cables greater than 500 MCM and for medium voltage power cables is acceptable based on the results of the industry testing performed to date. Conduit runs may touch only at a condulet.

3.2 1E CONDUIT TO TRAY/CABLE

3.2.1 Low Energy Circuits

A conduit to tray/cable spacing of 0 inches is acceptable for circuits defined as low energy based on the justification provided for conduit to conduit spacing for low energy circuits in Section 3.1.1.

3.2.2 Control Circuits

The test results in the IEEE paper noted in Section 3.1.2 of this Appendix are for power cables. The test results for the power cables are overly conservative for determining control circuit separation requirements. Control cables do not have the high fault energy available as do power cables since they have smaller power sources (less kVA and higher impedance), smaller conductor size (higher circuit impedance) and overcurrent protection generally limited to 15 Amp fuses or breakers.

The test results in the IEEE paper state that for the conduit to cable tray configuration, the one test performed with a 0 inch horizontal separation was successful. The test results for the conduit to cable in free air configuration showed all tests were successful for horizontal separation distances between 0 and 1 inch.

The test results in the IEEE paper noted in Section 3.1.2 of this Appendix state that for the conduit to cable tray configuration, six tests performed with a vertical separation between 0 and 1 inch were successful. The test results for the conduit to cable in free air configuration showed all tests were successful for a vertical separation distance of 0 inches.

Given the fact that control circuits have more fault current available than low energy circuits, a separation distance greater than 0 inches would be appropriate. However control circuits have less fault current available than low or medium voltage power cables and therefore a separation distance less than 1 inch would be appropriate (see the following Section 3.2.3 for low and medium voltage power cable separation distances).

To break conductive heat transfer between the faulted cable in a conduit and the tray/cable, a visible air gap or an insulating barrier to prevent the conduit having 0 inch separation with the tray/cable should be used for horizontal spacing.

To break conductive heat transfer between the faulted cable in a conduit and the tray/cable, and to minimize heat transfer to a conduit if cables are run beneath a conduit, a conservative separation distance of 1 inch should be used.

A horizontal spacing being a visible air gap or a barrier to prevent the conduit having 0 inch separation with the tray/cable and a vertical spacing of 1 inch is acceptable based on industry testing to date and the above justification.

3.2.3 **Low Voltage and Medium Voltage Power Cables**

As noted in the previous Section 3.2.2, the test results in the IEEE paper state that for the conduit to cable tray configuration, the one test performed with a 0 inch horizontal separation was successful. The test results for the conduit to cable in free air configuration showed all tests were successful for horizontal separation distances between 0 and 1 inch. The paper recommends a 1 inch horizontal separation for conduit to trays in a non-hazard area and 1 inch horizontal separation in all areas for conduit to cable in free air.

Also as noted in the previous section 3.2.2, the test results in the IEEE paper noted in Section 3.1.2 of this Appendix state that for the conduit to cable tray configuration, six tests performed with a vertical separation between 0 and 1 inch were successful. The test results for the conduit to cable in free air configuration showed all tests were successful for a vertical separation distance of 0 inches. However for certain test cases with 0 inch separation, the tested cable's jacket was damaged. For one test the jacket was severely damaged.

Another IEEE paper addresses tests done on faulted power cables in conduits (Reference T). The paper states that if the conduit becomes a ground return path for the fault current, the conduit may heat up to the point that a combustible material touching the conduit could ignite. Therefore a cable having 0 inch separation with a conduit that has a faulted power cable may be damaged to the point of becoming inoperable. To assure the cable remains functional, there should be separation between the cable and the conduit. No specific value was provided in this paper. It is recommended that 1 inch be used in accordance with the recommendation provided in the IEEE paper noted in Section 3.1.2 of this Appendix.

No specific tests were run for medium voltage cables. Given the high energy (fault currents) available for the tested low voltage power cables, the test results for medium voltage cables are expected to be similar to those for the low voltage power cables. This is based on the test method used to determine the worst case cable/current combination as previously defined in 3.1.2 of this Appendix.

A conduit spacing of 1 inch in both the horizontal and vertical directions between a conduit and a tray/cable is acceptable for low voltage and medium voltage power cables based on the results of the industry testing performed to date.

3.3 CABLE TO CABLE/TRAY

3.3.1 **All Voltage Level Circuits**

The separation requirements for cable to cable/tray spacing as shown in Table C are taken from the proposed 1991 revision to IEEE 384-1981. This revision is partially based on the IEEE paper noted previously in Section 3.1.2 of this Appendix.

The values are conservative relative to the test data in the referenced paper but are adopted in full.

3.3.2 **Non-Class 1E Low Energy Circuits Analysis**

Deviation from the physical separation or electrical isolation requirements is permitted for the "EMR" and "K" Non-Class 1E low level instrumentation signals and control circuits provided that (a) the Non-Class 1E circuits are not routed with associated circuits of a redundant division and (b) the Class 1E circuits are analyzed to demonstrate that they are not degraded below an acceptable level.

1. Annunciator and instrumentation circuits are low energy circuits. The annunciator circuits operate from a 125V dc high impedance (approximately 60 Kohm) source. The instrumentation systems operate on 1-5V dc or ±1-10V dc signals in high impedance circuits or 4-20 ma signals in low impedance circuits.

   All low voltage power and control cables have fire retardant insulation rated at 600V. Instrumentation cables have either 600V or 300V insulation and have grounded shields. Raceways are of fire retardant material. Instrument trays contain only instrumentation cables or telephone and low level paging circuits. Only voltages of these levels are present in control boards and relay racks.

   Since only low energy can be derived from instrumentation circuits, it is not probable that these Non-Class 1E circuits will provide a mechanism for failure of redundant Class 1E circuits inside Class 1E devices or enclosures. These Non-Class 1E circuits can be exempted from separation requirements only within the same channel/division with which the circuits are connected for their inputs.

2. Low energy Non-Class 1E circuits which are not separated from Class 1E circuits at the input device can be shown not to provide a credible mechanism of failure of the Class 1E system. The general approach is to demonstrate the low probability of occurrence of a failure mechanism. To summarize this failure mode the following conditions must occur at the same time.

   a. The low energy Non-Class 1E circuit is shorted to the highest voltage circuit conductors (125V dc/120V ac).

   b. The highest voltage circuit conductors are not short circuited or grounded.

   c. The highest voltage circuit protective device (breaker or fuse) fails to perform its intended function.

   d. The low energy Non-Class 1E cable is also shorted to the redundant Class 1E circuit.

   e. The fault current is greater than the rating of the cable insulation.

   In order for the redundant Class 1E protection system to fail several independent low probability events must happen simultaneously which is considered extremely unlikely.

3.4 TRAY TO TRAY

3.4.1 The separation requirements for tray to tray as shown in Table C are based on those presently shown in the FSAR Chapter 8. These in turn were based on an interpretation of the first draft to the proposed IEEE standard for the design and installation of wire and cable systems in power generating stations (now IEEE 422).

3.5 REACTOR BUILDING PENETRATIONS

3.5.1 The physical separation of the penetration cartridges within the particular area is determined by the reactor building tendon spacing. The 12 inch diameter penetration sleeves are on a minimum vertical spacing between centers of 3'-0". Minimum horizontal spacing of redundant safeguards penetrations is 5'-0" outside containment.

4.0 SEPARATION DISTANCES FOR REDUNDANT 1E COMPONENTS AND WIRING INTERNAL TO PANELS

This section provides the justification for the separation distances shown in Table D for redundant 1E components and wiring internal to panels.

4.1 1E CONDUIT TO CONDUIT SPACING

4.1.1 Low Energy and Control Circuits

A conduit to conduit spacing of 0 inches is acceptable for circuits defined as low energy and control. This is based on the justification previously provided in Section 3.1.1 and 3.1.2 for conduit to conduit spacing of 1E redundant circuits external to panels.

4.2 1E CONDUIT TO CABLE/WIREWAY/WIRE

4.2.1 Low Energy Circuits

A conduit to cable/wireway/wire spacing of 0 inches is acceptable for circuits defined as low energy. This is based on the justification previously provided in Section 3.2.1 for conduit to cable/wireway/wire spacing of 1E redundant circuits external to panels.

4.2.2 Control Circuits

A conduit to cable/wireway/wire vertical spacing of 1 inch and a horizontal spacing which is a visible air gap or an insulating barrier to prevent thermal conduction between the conduit and the cable/wireway/wire are acceptable for control circuits. This is based on the justification previously provided in Section 3.2.2 for conduit to cable/wireway/wire spacing for 1E redundant circuits external to panels.

If the wireway is enclosed, it is considered an enclosed raceway and is equivalent to a conduit. Therefore the conduit to conduit spacing criteria can be used. This is based on the definition of enclosed raceways as provided in the 1991 proposed revision to IEEE 384-1981.

4.3 CABLE TO CABLE, WIRE TO WIRE OR WIRE TO CABLE

4.3.1 The separation requirements of 6 inches in all directions are those presently shown in the FSAR Chapter 7. These were based on industry practice and IEEE Draft Standards at the time of plant design.

5.0 SEPARATION DISTA[illegible] FOR 1E (INCLUDING NON-1E CIRCUITS THAT ARE ROUTED WITH C[illegible]RCUITS) TO NON-1E EXTERNAL RACEWAYS AND CABLES

This section p[illegible]fication for the separation distances shown in Table E[illegible] raceways and cables external to panels.

5.1 CONDUIT TO CONDUIT

5.1.1 The separation requirements are the same as for the redundant 1E conduit to conduit circuits. The justification is therefore the same as previously provided in Section 3.1 of this Appendix.

5.2 CONDUIT TO TRAY/CABLE

5.2.1 The separation requirements are the same as for the redundant 1E conduit to tray/cable circuits. The justification is therefore the same as previously provided in Section 3.2 of this Appendix.

5.3 CABLE TO CABLE/TRAY

5.3.1 The separation requirements are the same as for the redundant 1E cable to cable/tray configuration. The justification is therefore the same as previously provided in Section 3.3 of this Appendix.

5.4 TRAY TO TRAY

5.4.1 The separation requirements for tray to tray are taken from the proposed 1991 revision to IEEE 384-1981. This revision is partially based on the IEEE paper noted previously in Section 3.1.2 of this Appendix.

5.5 REACTOR BUILDING PENETRATIONS

5.5.1 The separation requirements are the same as for the redundant 1E reactor building penetrations. The justification is therefore the same as previously provided in Section 3.5 of this Appendix.

6.0 SEPARATION DISTANCES FOR 1E (INCLUDING NON-1E CIRCUITS THAT ARE ROUTED WITH CLASS 1E CIRCUITS) TO NON-1E COMPONENTS AND WIRING INTERNAL TO PANELS

This section provides the justification for the separation distances shown in Table D for 1E to non-1E components and wiring internal to panels.

6.1 CONDUIT TO CONDUIT

6.1.1 The separation requirements are the same as for the redundant 1E conduit to conduit configuration. The justification is therefore the same as previously provided in Section 4.1 of this Appendix.

6.2 CONDUIT TO CABLE/WIREWAY/WIRE

6.2.1 The separation requirements are the same as for the redundant 1E conduit to cable/wireway/wire configuration. The justification is therefore the same as previously provided in Section 4.2 of this Appendix.

6.3 CABLE TO CABLE, WIRE TO WIRE, WIRE TO CABLE, COMPONENT TO COMPONENT OR COMPONENT TO WIRE/CABLE

6.3.1 The separation requirements are the same as for the redundant 1E cable to cable, wire to wire or wire to cable configuration. The justification is therefore the same as previously provided in Section 4.3 of this Appendix.

7.0 CONTROL BOARD INDICATORS - MULTICONDUCTOR CABLES CONTAINING MORE THAN ONE REQUIRED SEPARATION CIRCUIT

7.1 CIRCUIT ANALYSIS

The power sources to the Bailey RY meters on the Main Control Board are supplied from the Class 1E inverters. The Bailey indicators require both an input signal (-10 to +10 V) and a 120 VAC power source.

Each indicator has an internal transformer which reduces the input voltage to the working level required by the indicator.

The only credible fault that can be postulated is 480V to the input side of the inverters. For this fault the inverter transformer output will saturate and limit the voltage to the indicator to 120 VAC. The routing for this circuit is through seismic tray from seismic racks; hence no other fault can be imposed between the inverters and the control board.

The input signals are routed in instrument tray or conduit that contain only low level circuits (Section 3.3.2 of this Appendix) and use 600 V insulation. This insulation level would prevent the maximum voltage which can be postulated from generating any "flash-over" from one cable to an adjacent cable.

Additionally, the power supply wires are fused. Therefore, any potential fault within the indicator or input signal is isolated from the 1E inverter source. Since there are no credible events that can impose excessive voltage or current levels on the analog or power supply cable and the cable insulation is adequate to prevent "flash-over", the use of multiconductor cables with different separation groups for Bailey RY indicators is acceptable.

8.0 BARRIERS

It was established on April 20, 1972 in a meeting between GAI and FPC that a suitable separation barrier would be 16 gauge metal and 1/8 inch asbestos. This was incorporated into the Engineered Safeguards Criteria (ESC) which was issued May 18, 1974.

In Feb. 1974, Mr. Bower, inspector for the AEC, inspected the control boards and specified changes to the ESC to satisfy his inspection (ref. Mar. 7, 1974 letter FPC to GAI). Pending those revisions, the control boards and report were to be accepted via a return visit by Mr. Bower in four weeks.

Figures 3, 4A, 4C and 5 included in this revision to the ESC reflect the as-built conditions as specified by the ESC issued May 18, 1974.

In 1986 the control boards received a major upgrade and the use of asbestos was discontinued. A suitable barrier was defined as 16 gauge metal with the asbestos replaced with 1/4 inch thick maranite. (ref: Figures 4B). Further engineering evaluations are presently being made to substantiate the asbestos replacement with marinite.

APPENDIX 2

CIRCUIT NUMBER 3RD LETTER CODE

A	Computer
B	Video
C	Motor Control Centers (Pwr & Cont)
E	D.C. Circuits
F	A.C. Circuits (A.C. Dist. Pnls)
G	Turbine-Generator-Exciter
H	Reactor Protection (Circuits which trip the Reactor; low level Circuits which initiate safeguards logic)
K	Events Recording
L	480 V Switchgear
M	6900 V & 4160 V Switchgear
P	Communications
R	Reactor Plant
S	Secondary Plant
T	Transformers
U	230 KV
V	500 KV
W	Fiber Optics

APPENDIX 3

ENGINEERED SAFEGUARDS ACTUATION SYSTEM (ESAS) ELECTRICAL SEPARATION CONSIDERATIONS

SEE ATTACHED ANALYSIS

POWER AND INDUSTRIAL SYSTEMS DIVISION – READING

REVIEW AND APPROVAL RECORD

1. PROJECT: CRYSTAL RIVER UNIT 3

ENGINEERING DOCUMENT (TITLE): ENGINEERED SAFEGUARDS ACTUATION SYSTEM ELECTRICAL SEPARATION CONSIDERATIONS

RESPONSIBLE SECTION: CONTROL SYSTEMS/0423

IDENTIFIER: RP-5515-096-1.00-CS

W.O.: 04-5515-096

CLASSIFICATION:
☐ SAFETY-RELATED
☒ NON-SAFETY RELATED

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3. ORIGINATOR/DATE	[signature] 10/19/90				
4. INTERFACE REVIEWERS/DATE	N/A				
5. REVIEWER/DATE	[signature] 10/19/90				
6. QAD APPROVAL/DATE	N/A				
7. APPROVAL/DATE	[signature] 10/22/90				

Gilbert/Commonwealth

GAI-20 4-84

FOR INTERNAL USE AND RECORD

ENGINEERED SAFEGUARDS ACTUATION SYSTEM

ELECTRICAL SEPARATION CONSIDERATIONS

Engineered Safeguards Actuation System

Electrical Separation Considerations

1.0 INTRODUCTION

The Engineered Safeguard Actuation System (ESAS) provides the signals required to actuate two redundant trains of safety related plant auxiliaries. The ESAS monitors both reactor coolant pressure and reactor building pressure to provide actuation should a preset value be reached.

Reactor coolant pressure is monitored by pressure transmitters which provide analog signals auctionered by bistables to provide a digital signal when a preset level is reached. Reactor building pressure is monitored by pressure switches which provides digital signals when the pressure exceeds preset values.

For redundancy, reliability and testability, each of the plant parameters monitored for ESAS actuation use multiple instrumentation channels arranged in a logic based on an enhanced two-out-of-three voting redundancy. The enhanced portion of the two-out-of-three logic is applicable only to the digital portion of the ESAS. It provides the features of a two-out-of-three-taken-twice logic. An actuation matrix made of two-out-of-three logic is provided for each actuated component. This approach, while providing significant margin against the consequences of postulated single failure, increases the complexity of the application of separation criteria.

The reactor coolant pressure is monitored by three transmitters and the reactor building pressure is monitored by six pressure switches. The integration of three reactor coolant analog instrument channels into two ESAS actuation trains (each composed of a two out of three logic) creates separation and channel identification difficulties. The source of these difficulties can often be traced to situations where redundant channels are combined for logic purposes. This situation is recognized in IEEE 279 "Criteria for Nuclear Power Plant Protection Systems" which states that "A channel loses its identity where single action signals are combined.".

The purpose of this document is to identify the features included in the design of ESAS needed to assure that the separation requirements are met. This document also includes considerations relative to power supply requirements and impact of the single failure requirement.

The considerations provided in this document are applicable only to the internal and intercabinet wiring of the ESAS cabinets.

The ESAS separation and isolation features also provide significant excess margins toward meeting the consequences of postulated single failures. These margins are not totally taken credit for in the Plant Technical Specifications and could be used to justify potential LCO.

2.0 ESAS ACTUATION CHANNELIZATION REQUIREMENTS

The channelization requirements of the ESAS are defined in part by the number of channels required to meet the single failure criteria and by the way these channels are interfaced to generate the output signals required to actuate both train of equipment.

A. Number of channels

The ESAS monitors both reactor coolant pressure and reactor building pressure to provide actuation of redundant safety related plant auxiliaries at a preset value.

The actuation logic selected is based on a two-out-of-three logic to provide reliability, testability and capability to meet the single failure criteria in accordance with the design requirements of IEEE 279.

A two-out-of-three logic scheme requires that the selected parameters be monitored by a minimum of three sensors. When only three sensors are used (as for the reactor coolant pressure), the scheme does not have any excess margin toward meeting the single failure criteria. This is because if one sensor fails in an unsafe mode, the remaining sensors must actuate properly to provide a two-out-of-three output. Therefore each of the input signal to a two out of three logic must be kept independent.

IEEE 279 requires that sensors be testable during normal plant operation. Testing can be performed by either perturbing the monitored process parameter or by comparing the output of redundant sensors against each other.

Since any sensor monitoring the reactor coolant pressure must be located inside the reactor building and is not readily accessible for testing during normal plant operation, pressure transmitters are used. The transmitters provide the capability for cross checking the pressure readings from the control room and thus provide on line testing capabilities.

Because the amount of hardware required for a transmitter loop is significantly greater than for a measurement utilizing a pressure switch, only three transmitters are used to produce the two redundant two out of three logic.

Reactor building pressure can be monitored by sensors located outside the reactor building. The sensors selected are pressure switches with sensing lines which penetrate the reactor building wall.

Since accessibility to the pressure switches is possible during normal plant operation, testing can be done by perturbing the process variable. Also, because the amount of hardware needed to implement a measurement using pressure switches is limited, reliability can be increased by providing three sensors, in a two out of three configuration, for each of the two trains of actuation.

B. Channel to Actuation Interface

The on-line testing requirements of IEEE 279 states in part that "Capability shall be provided for testing and calibrating channels and the devices used to derive the final system output signal....". This requirement is further clarified to indicate that capability should be provided for testing during power operation. This last requirement brings the concern that testing could cause an inappropriate actuation of the final actuated device with potential negative impact on plant operation.

This concern is the major design consideration which decided the basic feature of the ESAS actuation scheme whereby the two out of three logic is performed as the last logic element prior to actuation of the final devices. This preserves the testing capability afforded by the two out of three voting redundancy. Figure 1 shows a simplified scheme of one channel of RC pressure and one channel of RB pressure for both A and B actuation.

Referring to figure 1, the reactor coolant pressure is measured by a pressure transmitter located in the reactor building. The pressure signal is monitored for HPI actuation by a bistable (test and buffer modules omitted for simplicity), the output of which is equipped with two relays wired in parallel. One relay is assigned to Train A actuation and the other is assigned to train B actuation. The bistable is located in channel test cabinet 1 and feeds train A and B digital signals to auxiliary relays located in channel cabinets 1A and 1B.

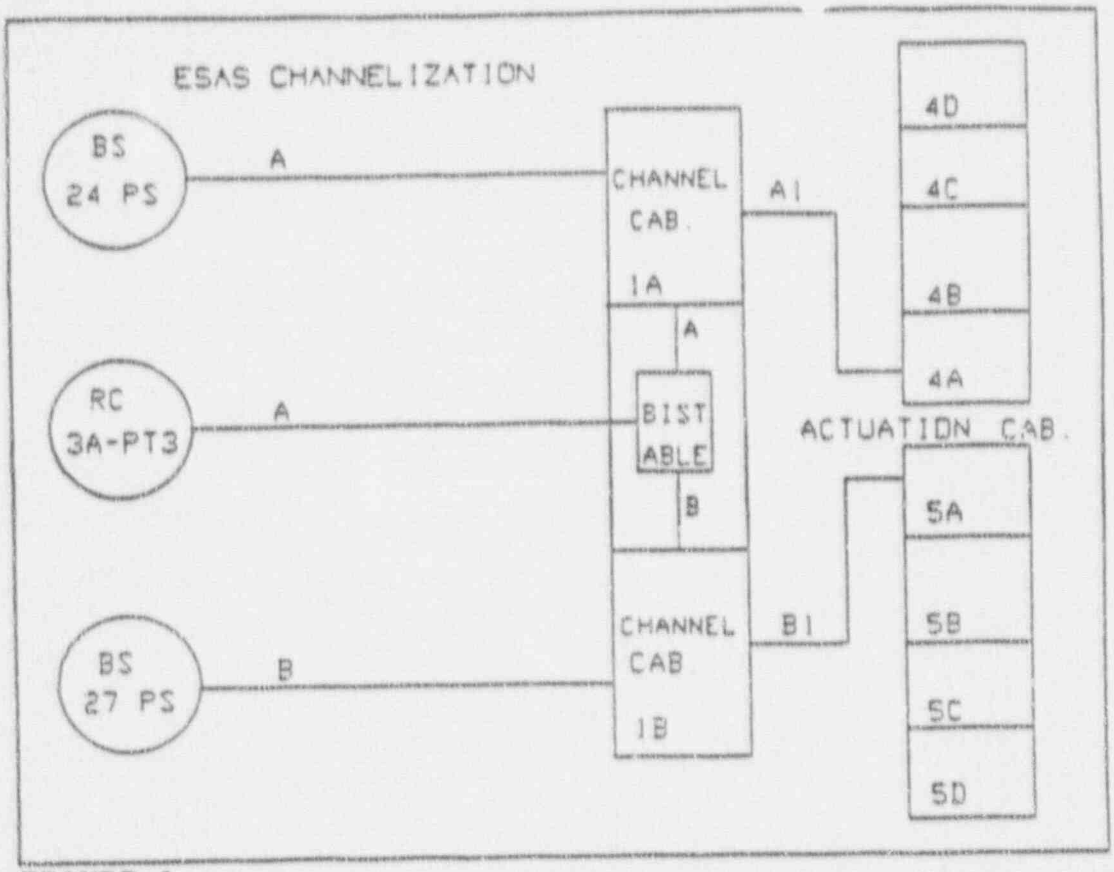


FIGURE 1

The reactor building pressure is monitored by pressure switches. One pressure switch is assigned to Train A, providing a signal to channel cabinet 1A and another is assigned to train B, providing a signal to channel cabinet 1B.

The digital signals from the pressure switches are functionally equivalent to the digital signals from the bistables. It is important to note that the analog signal from the transmitter to the bistable must be kept separated from the bistable's digital signals and the signals from the pressure switches. This is because the analog signal is actually an A or B signal as far as actuation is concerned.

The output of the channel cabinets 1A and 1B are directed to the redundant actuation cabinets 4 and 5. Each of the actuation cabinets is segregated into four compartments identified as A,B,C,D. Two out of three logic matrices, one for each plant auxiliary to be actuated, are made from relay contacts located in the A,B,C compartments of each actuation cabinet.

As represented in fig. 1, one reactor coolant pressure measurement and a set of two redundant pressure switches constitute, via the channel cabinets, one input to both the A and B actuation cabinet.

Since three separated inputs are required to form a two out of three matrix, a total of three reactor coolant pressure and three sets of two redundant reactor building pressure measurement is required to complete the actuation system.

3.0 SEPARATION CRITERIA

Electrical separation or isolation are design features which assure that 1E equipment performing redundant functions are kept independent. Independence of redundant equipment is required to meet the single failure criteria.

Electrical separation can be provided by physical distance of circuits or when it cannot be provided by electrical isolation. The level of electrical isolation required is determined by the maximum credible fault which can be postulated. Since power plant wiring is segregated by voltage levels (eg. 480 volts and 4160 volts), the highest fault voltage level credible for control circuits is 480 volts. This correspond to the since the level of voltage which exists in motor control centers and that could be imposed onto the 120 volt control wiring in that MCC.

To assure adequate electrical separation, the assigned separation grouping must be identifiable. Color coding is used for that purpose.

Assigning color c ''ng to define separation groups for actuation systems like the ESAS is a compre mise between the need to accurately identify the separation grouping of the different electrical components performing redundant functions and the practical aspect associated with implementing a color coding which truly represent the complexity of the two-out-of-three-taken-twice logic. A color code truly adapted to the channelization of the ESAS would require three colors for the analog input signals plus six colors for the pressure switches signals and two additional colors for the actuation signals for a total of 11 colors. Such color code could not be practically implemented.

As a result, only three basic colors have been used for the ESAS. These colors are red, green and yellow. This selection is consistent with separation requirements on the following basis:

A. Input signals

The input signals (analog) from the reactor coolant pressure transmitters to the ESAS must be kept separated from the digital signals of the reactor building pressure switches since each analog signal actually generates a channel A and channel B digital output.

Separation of analog transmitter signals and pressure switch digital signals is accomplish by running the analog signals in separated instrument trays or conduit. Channel A and B are run in instrument tray while channel C is run in conduit. The input signal from the reactor building pressure switches are run in individual conduits. The signals from the pressure switches are considered to be control voltage.

Therefore, the analog input signals (transmitters) are kept separate from the digital input signals (pressure switches) because of the voltage level associated with these circuits. This allows to use the same color coding and channel assignation for the analog signals (ie A,B,C) and for the digital signals (ie,A,B,C) when in fact these are kept separate by their routing.

B. Signals from the bistables to the channel cabinets

The digital signals from the bistables to the channel cabinets consist of two signals, one assigned to train A and the other to Train B actuation. However, the three digital signals (one per bistable) assigned to the Train A actuation must be kept separate from each other since the two-out-of-three voting is performed in the actuation cabinet. The same reasoning requires that the signals assigned to Train B actuation be kept separate from each other. This requirement would imply the need for six different channels. This was implemented running the signals from the bistables to the channel cabinets internally within the test cabinets or in individual conduits. Therefore, they are kept separate from the redundant channels.

C. Signals from the pressure switches to the relay cabinets

Similar to the digital signals from the bistables, the signals from the pressure switches must be kept separate from each other. This requirements require in effect 6 channels and has been implemented by routing the wiring for each pressure switches wiring in individual conduits. Three of the conduits are labelled A and the other three conduit labelled B.

D. Signals from the channel cabinets to the actuation cabinets

The signals from the channel cabinets to the actuation cabinets are an extension of the input signals and must be kept separate from each other.

The signals from the separate relay cabinets are run in conduit directly to the corresponding compartments of the actuation cabinets and; therefore are kept separate from each other.

D. Wiring associated with the two out of three matrices

The two-out-of-three matrices are formed in a separate compartment at the back of the actuation cabinets. Wiring from the output relays located in the separate compartments located in the front of the actuation cabinets is routed through openings located at the bottom of the compartments. This wiring is terminated on terminals located in the back compartment where field wiring also terminates.

This arrangement maintains the separation of the three channels while combining them to form a two-out-of-three logic.

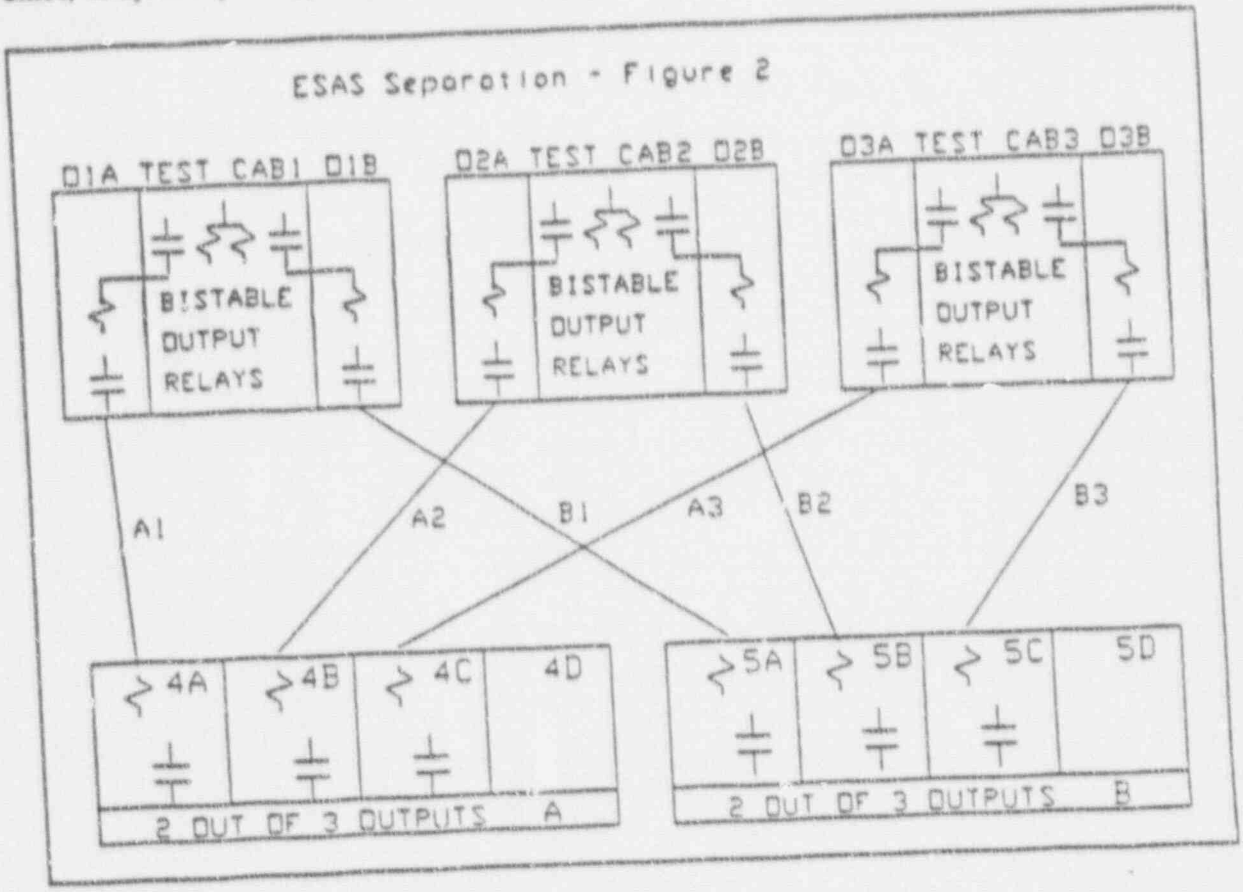
4.0 ESAS POWER SUPPLY REQUIREMENTS

The ESAS system is a basic two-out-of-three de-energize to actuate system. The power to the system is derived from the inverters which are backed-up by redundant 250 Volt batteries. A single failure of a 250 volt battery will result in the loss of the two associated inserters. This results in the potential for a simultaneous two-out-of-three actuation of both train of the ESAS.

A major requirement of the ESAS is to provide a timely loading of the emergency diesel generators during a loss of off-site power. In the event of postulated battery failure in one train coincident with a loss of off-site power, a timely loading of the diesel generator associated with the redundant train must be provided. To perform this requirement, the power supply to the ESAS timers is distributed over the 4 inserters. This assures that power is available to reset the timers associated with the redundant diesel generator and provide timely loading. Distributing the timers among the 4 inserters creates an appearance of inadequate separation but is acceptable when postulated single failures are analyzed.

5.0 DISCUSSION OF SELECTED SEPARATION FEATURES AND DESIGN IMPLEMENTATION

The ESAS is configured in such a manner that significant separation features exist, they are portrayed on figure 2.



The following provides an overview of some of the major features which assures that the ESAS complies with the single failure criteria:

A Separation between actuation trains

Train A and Train B outputs from the ESAS are formed separately in actuation cabinets 4 and 5, respectively. A significant amount of separation exists between the actuation trains since the actuation cabinets are physically separated enclosures.

B. Separation within the actuation cabinets

Actuation cabinets 4 and 5 are designed to provide separate enclosures for each of the three channels required to form the two-out-of-three matrices. The general color coding used for the wiring inside cabinet 4 is red and green in cabinet 5. Some of the matrices are used to actuate "A/B" components (i.e., such as the third Reactor Building Cooling Unit). The color coding for these components is yellow. It was perceived at the original design stage that changing wire color from yellow to red or green across terminal blocks would create potential confusions therefore some of the contacts of output relays were wired with yellow wiring to assure a color match between the field wiring landing at the back of the actuation cabinets and the matrices wiring.

Following the TMI-2 accident, major wiring modifications were required inside the actuation cabinets to implement required changes associated with diverse Reactor Building Isolation. As a result and for practicality, the separation between red colored wiring in cabinet 4 (green in cabinet 5) and yellow wiring could not be maintained. It is important to note that the segregation of yellow and red wiring inside actuation cabinet 4 and yellow and green inside actuation cabinet 5 was not required to meet a separation requirements but to assure that a match in color coding would exist between cabinet wiring and field wiring.

The yellow field wiring can actually loop from one actuation cabinet to the other. This is acceptable since the maximum fault voltage is within the rating of the insulation of the components selected and the theory of the "hot wire" is not applicable when only safety related wiring is under consideration. The actuation cabinets are designed such that a localized fire will not propagate from one compartment to another.

The color of wires inside the different compartments of an actuation cabinet is kept as either red or green for practicality. Non-safety wires used for indicating lights and alarms are run with the safety related wires and color coded brown (A) or orange (B) to identify their channel associations.

Since the maximum voltage inside the compartment is only 480 volts (see section B), separation between wiring associated with the coil and the contacts of the relays located in the actuation cabinets is not required.

C. Separation between actuation cabinets and channel cabinets

The channel cabinets act as buffer between the bistable output relays and the actuation cabinets. The channel cabinets are designated as 1A, 2A and 3A for A train and 1B, 2B and 3B for B train. The field wiring between the compartments of the actuation cabinets and the channels cabinets is kept separate from each other even that they are color coded red or green. The separation is assured by independent conduits shown on figure 2 as A1,A2,A3 and B1, B2,B3.

This separation and isolation capabilities of the channel cabinets is required because a fault voltage of 480 volts cannot be accommodated by the bistable output relays. Without this isolation, a 480 volt fault originating in a compartment of cabinet 4 (e.g., 4A) could be transmitted to a compartment of cabinet 5 (e.g.,5A) and would not be in accordance with the design requirement for the ESAS that a fault in one train may not reduce the reliability of the B train.

D. Separation of the channel cabinets

The channel cabinets are separate compartments of an enclosure which also contain the test cabinets. Each channel cabinet is physically and electrically separated from its counterpart (i.e., 1A from 1B) and from channel cabinets associated with the other redundant channels (i.e., 2A & 2B, 3A & 3B).

E. Isolation between the channel cabinet and the bistables.

As indicated, the channel cabinets act as buffers between the bistables and the actuation cabinets by providing coil to contact isolation with an isolation capability of 600 volts (e.g., insulation rating of the wires). They also assure that a fault voltage no greater than 120 volts A.C. can be imposed on the bistable output contact and its wiring. 120 volts A.C. voltage is within the rating of the bistable contacts and associated wiring. This is required because the bistable is the common link between Train A and Train B actuation.

D. Signal segregation at the bistable level.

At the bistable level, the output relays are assigned to Train A actuation and Train B actuation. No separation between Train A and Train B can be provided inside the test cabinet.

6.0 EXCESS MARGINS IN MEETING THE SINGLE FAILURE REQUIREMENT

The ESAS has separation and isolation features which provide significant excess margin in meeting the single failure criteria. The excess margin exist mostly because the system logic is essentially a two-out-of-three taken twice.

The following is a discussion of some of these features:

A. Outputs of the ES

Except for low energy applications such as alarm and indicating lights, matrices are not used in non safety applications. Therefore, for a fault voltage in excess of the normal 120 volt control voltage to be seen at the ESAS actuation cabinets, a single failure of 1E component must be postulated outside the ESAS cabinets. An example of such a failure could be the failure of a control transformer in a Motor Control Center. Since these circuits are fused below the rating of the wire used, no "hot wire" can be postulated. On this basis, no further failure needs to be postulated in the ESAS cabinets. Thus assuring the availability of the other outputs on the same train as the fault and the complete other redundant train is assured.

B. Actuation cabinets

Should a localized fire be postulated in a compartment of an actuation cabinet as an extreme interpretation of the single failure criteria, all equipment and wiring located in the affected compartment can be postulated to fail. This includes the postulation of short circuits which impose the highest voltage available in the compartment on all wires connected within the compartment.

Should a localized fire occur in the back of an actuation cabinet, the loss of a complete train of actuation may be postulated since this is where the output connections are located. This failure would not impact the redundant train because of the physical separation of the redundant cabinet.

A localized fire in any other compartment (i.e., the front compartments) will result in the loss of the equipment in that compartment only. This does not preclude the system to still be capable to meet the single failure. This excess margin is significant and is not reflected in the technical specification.

C. Channel cabinets

A localized fire in a channel cabinet does not prevent the ESAS from meeting the single failure criteria. Only the reliability of the affected train is reduced to a one-out-of-two or two-out-of-two logic. Note: Reduction to one-out-of-two or two-out-of-two is dependent on the failure mode postulated (open circuit versus short circuit).
This excess margin is not reflected in the technical specifications. However, it can be used to justify potential LCO.

D. Test cabinets.

A localized fire in a test cabinet will prevent the system to meet the single failure criteria for actuation on low Reactor Pressure. Actuation on High Reactor Building Pressure is not affected. This excess margin is not reflected in the technical specification.

7.0 REFERENCES

IEEE 279 Proposed Standard dated August 30, 1968 "Proposed IEEE Criteria for Nuclear Power Plant Protection Systems".

8.0 DEFINITIONS

Channel: An arrangement of components and modules as required to generate a single protective action signal when required by a plant condition. (IEEE 279).

Train: A train is one of the redundant set of "actuated equipment"

Actuated Equipment: The assembly of prime movers and driven equipment used to accomplish a protective action (IEEE603).

Attachment 1
Separation Criteria Exceptions

No.	Case or Exception	Equipment I.D	Dwg. Nos.	Analysis No.
1	1. RCM81 IS AN ASSOCIATED (BROWN) CABLE TERMINATING ON TB4-7. ECN-3421 TERMINATED A GRAY WIRE ON TB4-7 WHICH IS INTERNALLY JUMPERED TO A NON-1E TERMINAL BLOCK. ADJACENT TERMINATIONS TO TB4-7 ARE ALSO BROWN. 2. RCM19 IS AN ASSOCIATED (ORANGE) CABLE TERMINATING ON TB16-25. ECN-3421 TERMINATED A GRAY WIRE ON TB16-25 WHICH IS INTERNALLY JUMPERED TO A NON-1E TERMINAL BLOCK. ADJACENT TERMINATIONS TO TB16-25 ARE ALSO ORANGE (REFERENCE CASE 39, ESSE-CB & RR).	MCB ICSAR	210-383 210-384	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated August 18, 1976.
2	ACF62 IS AN ASSOCIATED (BROWN) CABLE TERMINATING ON A NON-1E TERMINAL BLOCK AT TB8-29 AND TB8-30. ALL INTERNAL WIRING FOR THESE POINTS IS NON-1E (REFERENCE CASE 38, ESSE-CB & RR).	RR3;	210-601 210-600	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated March 1, 1976.

Attachment 1
Separation Criteria Exceptions

No.	Case or Exception	Equipment I.D	Dwg. Nos.	Analysis No.
3	CONTROL SWITCHES (DEVICES AB3 AND AC3 ON EC-210-501) HAVE ASSOCIATED WIRING OF REDUNDANT CHANNELS (ORANGE AND BROWN) TERMINATED LESS THAN 6" APART. THE EXTERNAL WIRING FOR THE SWITCHES IS PART OF ALARM CIRCUITS CIK21, CIK22, CIK23, AND CIK24. THESE EXTERNAL CIRCUITS ARE ASSOCIATED WITH SAFEGUARD CHANNEL "A" ONLY (REFERENCE CASE 37, ESSE-CB & RR).	MCB HV SECTION	210-501	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated February 5, 1976.
4	ORANGE AND GRAY WIRES ARE TERMINATED ON TB46-23. THE GRAY WIRE IS INTERNALLY JUMPERED TO TB45-3. A YELLOW WIRE IS ALSO TERMINATED AT TB45-3. THE EXTERNAL SIDE OF TB45-3 IS PART OF 28V INDICATING LIGHT CIRCUIT MUF253 (REFERENCE CASE 36, ESSE-CB & RR).	MCB ESB	210-144	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated February 5, 1976.
5	AK, AM, AP, AND AR ARE SPARE RELAYS IN RR3. SINGLE GRAY WIRES TERMINATED ON THE RELAYS ARE INTERNALLY JUMPERED TO A NON-1E TERMINAL BLOCK AT POINTS TB16-21, 24, 27, AND 30. ALL OTHER RELAY TERMINATIONS HAVE ORANGE WIRES (REFERENCE CASE 35, ESSE-CB & RR).	RR3	EC-210-597 EC-210-600	Ref G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated February 2, 1976.

Attachment 1
Separation Criteria Exceptions

No.	Case or Exception	Equipment I.D	Dwg. Nos.	Analysis No.
6	ITEM CZ ON EC-210-157 CONTAINS A FUSE WHICH HAS ORANGE AND BROWN WIRES TERMINATED AT THE SAME POINT (REFERENCE CASE 34, ESSE-CB & RR).	MCB ES SECTION AB	210-157	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated September 24,1975.
7	JC11 IS AN INDICATING LIGHT WITH ORANGE WIRE TERMINATIONS. THE ORANGE WIRES ARE LESS THAN 6" APART FROM GRAY WIRES ON OTHER INDICATING LIGHTS (REFERENCE CASE 33, ESSE-CB & RR).	MCB ICS	210-089	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated September 10, 1975.
8	ED3 IS AN INDICATING LIGHT WITH ORANGE WIRE TERMINATIONS. THE ORANGE WIRES ARE LESS THAN 6" APART FROM BROWN AND GRAY WIRES ON OTHER INDICATING LIGHTS (REFERENCE CASE 32, ESSE-CB & RR).	MCB ICS	210-081	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated September 10, 1975.
9	GRAY WIRING IS TERMINATED WITH ASSOCIATED WIRING (ORANGE) ON TB23-43 AND TB23-44. IN ADDITION, THE PHYSICAL SEPARATION BETWEEN THE ORANGE AND GRAY WIRES IS LESS THAN 6" (REFERENCE CASE 28, ESSE-CB & RR).	MCB ICS	210-094	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated July 11, 1975.

Attachment 1
Separation Criteria Exceptions

No.	Case or Exception	Equipment I.D	Dwg. Nos.	Analysis No.
10	Teflon sleeving installed on MCB wiring to provide safeguard wiring separation. (Reference Case 4, Calc E91-001, Table C and Teflon Sleeving Inspection Report dated April-May, 1990)	MCB	210-007, -021, -046, -050, -111, -300, -341, -370, -379 - ALL 210-SERIES DWGS COVERED BY NOTES ON DWGS.	Teflon Sleeving Inspection Report For April-May 1990.
11	Device AL is a lockout relay with green and gray wires terminated less than 6 inches apart. (Reference Case 3, Calc E91-001, Table C)	SSTR	EC-210-328	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated April 15, 1975 Analyzing Similar Existing Exception.
12	Wire color changes from safeguards "A" to "B" across a fuse in Engineered Safeguard Channel Cabinet 3A. (Reference Case 1, Calc E91-001, Table C)	ES CAB A	EC-210-473	I-89-0047
13	Orange and gray wires are terminated less than 6 inches apart on TB10. (Reference Case 1, ESSE-CB & RR)	RR2	EC-210-401	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated February 19, 1975.
14	Devices AL and EL contain terminal blocks which have orange and gray wires terminated on adjacent points. (Reference Case 2, ESSE-CB & RR)	MCB HVC SECTION	EC-210-492	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated February 19, 1975.
15	Device BN6 is a control switch with orange and gray wires terminated across the same contact. (Reference Case 3, ESSE-CB & RR)	MCB HVC SECTION	EC-210-495	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated February 19, 1975.

Attachment 1
Separation Criteria Exceptions

No.	Case or Exception	Equipment I.D	Dwg. Nos.	Analysis No.
16	1. Device AQ is an auxiliary relay with orange and gray wires terminated less than 6 inches apart. 2. Device BG is an auxiliary relay with orange and gray wires terminated less than 6 inches apart. In addition, the orange and gray wires are terminated across the same contact. (Reference Case 6, ESSE-CB & RR)	RRHV	EC-210-520	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated February 19, 1975.
17	1. AHF748 AND AHF751 ARE ASSOCIATED CIRCUITS OF REDUNDANT CHANNELS. THESE CIRCUITS TERMINATE ON TB3-1, -2, -26 THRU 30. NO BARRIER EXISTS BETWEEN THE BROWN AND ORANGE TERMINATIONS. 2. ITEM CV IS A DUAL PANEL METER WITH INPUTS SUPPLIED BY CIRCUITS AHF748 AND AHF751, RESPECTIVELY. THE CONDUCTORS OF BOTH CIRCUITS ARE ROUTED IN ONE VENDOR CABLE TO THE PANEL METER. PHYSICAL SPACING IS LESS THAN 6" AND THE CONDUCTORS ARE NOT ELECTRICALLY ISOLATED. (REF. CASE 5A, ESSE-CB & RR)	MCB HV SECTION	EC-210-514 EC-210-515	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated June 11, 1975.
18	ITEM R ON THE SUBSTATION MISCELLANEOUS WIRING BOARD IS A LOCKOUT RELAY WITH RED, GREEN AND GRAY WIRE TERMINATIONS LESS THAN 6" APART. (REFERENCE CASE 11, ESSE-CB & RR)	MCB MISC/SSTR	EC-210-332	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated April 15, 1975.

Attachment 1
Separation Criteria Exceptions

No.	Case or Exception	Equipment I.D	Dwg. Nos.	Analysis No.
19	1. VBF27 IS A NON-1E CIRCUIT TERMINATING ON TBA1-1,2,3,4. ADJACENT TERMINATIONS AT TBA1-5,6 ARE FOR SAFEGUARD CIRCUIT VBF30 (RPS CHANNEL III). 2. VBF28 IS A NON-1E CIRCUIT TERMINATING ON TBB1-1,2,3,4. ADJACENT TERMINATIONS AT TBB1-5,6 ARE FOR SAFEGUARD CIRCUIT VBF29 (RPS CHANNEL IV). (REFERENCE CASE 10, ESSE-CB & RR)	MCB TPC CAB. A & B	EC-210-576 EC-210-580	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated April 4, 1975.
20	Device AP1 is a control switch with brown and yellow wires terminated less than 6 inches apart (Reference Case 4, ESSE-CB and RR).	MCB HV SECTION	EC-210-502	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated February 19, 1975.
21	Circuit AHC-951 is a Channel "B" safeguard power feed. This cable supplies 480V power to Emergency Diesel Generator Room Air Handling Fan Motor AHF-22C. AHC-951 is a #4AWG cable routed in the control tray system (Reference FCN 3 to MAR-89-10-07-01).		209-005 AH-030	Refer to MAR 89-10-07-01, FCN 3.

No.	Case or Exception	Equipment I.D	Dwg. Nos.	Analysis No.
22	Devices L, M and N are isolation relays in Remote Shutdown Relay Cabinet A. Redundant devices L, M, and N are in the Remote Shutdown Relay Cabinet B. The Cabinet A relays are Channel "A" (red) powered and the Cabinet "B" relays are Channel "B" (green) powered. Violet wires terminated on the "A" relays are less than 6" apart from red wires. Blue wires terminated on the "B" relays are less than 6" apart from green wires. (Reference Wiring Analysis ND89-1, Item 2). Also relays P & Q in Relay Cabinet	RS RELAY CAB. A & B	EC-210-726 EC-210-736	Wiring Analysis ND89-1.
23	The physical spacing between green and gray wires terminated on fuses RQ and RR is less than 6". Teflon sleeving is not used to provide wiring separation, as is done in similar situations (Reference Case 7, ESSE-CB and RR).			Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated March 3, 1975.
24	The Remote Shutdown Auxiliary Cabinets contain Class 1E and non-1E circuits routed in the same wire bundle. The non-1E circuits terminate on non-1E terminal block TB3. (Reference Wiring Analysis ND89-1, Item 1)	RS AUX. CAB. A & B	EC-210-747, -750, -746, -749	Wiring Analysis ND89-1.

memorandum Gilbert/Commonwealth

August 18, 1976

to R. E. Miller - GIII 3NW

from J. B. Haneiko

subject Engineered Safeguard Separation Exception
Control Boards & Relay Racks - Case 39
ECN 3421
Crystal River Unit No. 3

The condition described in your memo of August 16, 1976, has been reviewed and found acceptable as shown. No single failure will prevent the operation of redundant E.S. equipment or negate the operation of more than one E.S. power supply.

John B. Haneiko
Project Instrument Engineer

JBH:drc
cc: E. R. Hottenstein (2)
R. P. Cronk

memorandum Gilbert/Commonwealth

to: R. E. MILLER - 3E

March 1, 1976

from: J. B. Haneiko

subject: ENGINEERED SAFEGUARD SEPARATIONS EXCEPTIONS
CONTROL BOARDS & RELAY RACKS - CASE 38
ECN 2924A
CRYSTAL RIVER UNIT NO. 3

In response to your memo of February 26, 1976, the following exception to the E. S. separation criteria has been reviewed.

CASE 38: EC-210-601, TB8-29-30

DESCRIPTION: Non E. S. circuit routed in red tray terminates on non E. S. terminal board (gray). Although there is no color violation within the control board, this is essentially the same case as a brown and gray wire not having the required 6" separation.

CONCLUSION: The case as you describe it is acceptable by definition, since it is not a violation of the E. S. control board criteria. Nowhere in the criteria does it state that gray cannot mix with brown or orange. Furthermore, you have stated that this gray wire does not mix with orange or green anywhere in RR3. Therefore, no possible violation exists.

Please note that the 38 cases reviewed to date do not all constitute violations. Several, such as cases 37 and 38, do not violate the basic criteria but were written up since possible confusion could otherwise result. The "ESX" notation should still be put on the drawing at the appropriate place. The "ESX" on drawings indicates (a) there is no violation although it may appear to be one, or (b) there is a violation and it has been reviewed and found to be acceptable.

John B. Haneiko
John B. Haneiko

JBH:ems
xc: E. R. Hottenstein (2)
J. B. Haneiko (2)

Attachment 1
Separation Criteria Exceptions

No.	Case or Exception	Equipment I.D	Dwg. Nos.	Analysis No.
25	Device D contains two terminal blocks. Yellow and gray wires are terminated on adjacent points. (Reference Case 4, ESSE-CB & RR)	MCB HV SECTION	EC-210-502	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated February 19, 1975
26	Various separation violations exist between associated wiring and non-1E wiring (Reference GAI Memorandum from V. H. Willems dated March 20, 1973).	VARIOUS	VARIOUS	Ref. G/C Inc. Memorandum by V.H. Willems Dated March 20, 1973.
27	Various separation violations exist between associated wiring and non-1E wiring (Reference GAI Memorandum from V. H. Willems dated March 20, 1973).	VARIOUS	VARIOUS	Ref. G/C Inc. Memorandum by V.H. Willems Dated March 20, 1973.
28	DEVICES JY AND JZ ARE CONTROL SWITCHES IN THE PRIMARY AND SECONDARY AUXILIARY SECTION OF THE MCB. THE ORANGE, BROWN, AND GRAY WIRES TERMINATED ON THE SWITCHES ARE LESS THAN 6" APART (REFERENCE CASES 29 & 30, ESSE-CB & RR).	MCB PSA	210-104	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated July 11, 1975.
29	Device AG is a lockout relay with red and gray wires terminated less than 6 inches apart. (Reference Case 2, Calc E91-001, Table C)	SSTR	EC-210-328	Ref. G/C Inc. Memorandum J.B. Haneiko/R.E. Miller Dated April 15, 1975 Analyzing Similar Existing Exception.

memorandum Gilbert Associates, Inc.

to: R. E. Miller

from: J. B. Haneiko

subject: Engineered Safeguard Separation Exceptions
Control Boards and Relay Racks - Case 37
GAI Field Change 76-668
Crystal River Unit No. 3

February 5, 1976

The following apparent exception to the standard CR3 separation procedure was reviewed.

Case 37: EC-210-501, devices AB3 and AC3

Description: Orange and brown wires exist on the same control switch on the HV section of the main control board. This does not show up as a violation on the appropriate elementaries (B-208-077, sheets CI-18 and CI-19) since they are part of two alarm circuits.

Conclusion: There is no E.S. violation of any sort in this case. The power source involved is the events recorder source. The circuits involved, CIK-21, 22, 23 and 24, are all alarm circuits and therefore are not even covered by the separation criteria. However, this memo is presented as justification for the apparent violation on HV section of the control board, since the wires are not identified there as being part of an alarm circuit.

John B. Haneiko

JBH:vjk

xc: E. R. Hottenstein (2)
J. B. Haneiko (2)

memorandum Gilbert/Commonwealth

to: R. E. MILLER - 3E

February 5, 1976

from: J. B. Haneiko

subject: ENGINEERED SAFEGUARD SEPARATION EXCEPTIONS
CONTROL BOARDS AND RELAY RACKS - CASE 36
GAI FIELD CHANGE 75-662
CRYSTAL RIVER UNIT NO. 3

An exception to the standard CR3 separation procedure was reviewed in relation to the field change on MUV 54.

CASE 36: B-208-028, sheet ES-AB07
B-208-041, sheet MU-55
EC-210-144, TB 46-23

DESCRIPTION: Orange and gray wire exist on the same terminal because they must be tied together. The normal power feed is from VBDP-3, BKR. #7 (120 VAC) through a transformer to 28 volts. However, it may also be fed from VBDP-4, BKR. #7 since this is an AB bus.

CONCLUSION: These are 28 volt indicating light circuits, and do not affect any safety related equipment. Identical exceptions were previously reviewed in case 34 and case 4. See memo for case 4 dated February 19, 1975 for further discussion.

Please note that fuse "BZ" also added on this field change on drawing EC-210-157 does not require an "ESX" notation on the drawing although the wire color changes from orange to gray through the fuse. This case is not an exception to the standard separation criteria report since an even more stringent case is covered on page 1 of the report under section 3A: "The AB actuation must be kept separate from the A & B channels and trains except at the point of origin where reasonable isolation is required." Drawing ES-AB07 is a point of origin where the A and B power sources may both be used, and consequently apparent violations will appear on this drawing by definition. No further reviews of apparent exceptions to the separation criteria will be required on drawing B-208-028, sheet ES-AB07.

John B. Haneiko
JOHN B. HANEIKO

JBH:ems
xc: E. R. Hottenstein (2)
J. B. Haneiko

memorandum Gilbert/Commonwealth

February 2, 1976

to: R. E. MILLER - 3E

from: J. B. Haneiko

subject: ENGINEERED SAFEGUARD SEPARATION EXCEPTIONS
CONTROL BOARDS AND RELAY RACKS - CASE 35
GAI FIELD CHANGE 76-667
CRYSTAL RIVER UNIT NO. 3

An exception to the standard CR3 separation procedure was discussed with T. V. Garbini today relating to GAI FCN 76-667. The items affected are as follows:

CASE 35: B-208-039, sheets MS-18 and MS-19
EC-210-597, items AK, AM, AP, AR
EC-210-600, TB16-19 through TB 16-30

DESCRIPTION:

Orange and gray wire exist on the same relay and opposite each other on the same terminal board. The power feed is 125VDC from DPDP-8B, an engineered safeguards power source.

CONCLUSION:

These exceptions to the CR3 separation criteria are acceptable since no single failure, such as a random ground, open circuit or short circuit, will negate the operation of more than one E. S. power supply. In fact, no single electrical failure will negate the proper operation of the main steam isolation valves, which are the pieces of equipment directly relating to these exceptions.

John B. Haneiko
JOHN B. HANEIKO

JBH:ems
xc: E. R. Hottenstein (2)
J. B. Haneiko (2)

GAI 35 1/75

memorandum Gilbert Associates, Inc.

September 24, 1975

to: R. E. MILLER - 3E

from: J. B. Haneiko

subject: ENGINEERED SAFEGUARD SEPARATION EXCEPTIONS
CONTROL BOARDS AND RELAY RACKS - CASE 34
CRYSTAL RIVER UNIT NO. 3

Another exception to the standard CR3 separation procedures was discussed with T. V. Garbini today relating to ECN 2428 and its "A" revision. The items affected are as follows:

CASE 34: B-208-028, sheet ES-AB07 (Item CZ)
EC-210-157

This exception has been reviewed and it does not compromise the safe functioning of any safety-related equipment. The same explanation given for E. S. exception case 4(reference 2/19/75 memo to you) applies here also. In addition, low voltage signal levels(28 volts) are involved. ECN 2428 will therefore be approved as it is.

John B. Haneiko
JOHN B. HANEIKO

JBH:ems
cc: E. R. Hottenstein (2)
J. B. Haneiko (2)

memorandum Gilbert Associates, Inc.

Gilbert Commonwealth Companies

September 10, 1975

to: R. E. MILLER - 3E

from: J. B. Haneiko

subject: ENGINEERED SAFEGUARD SEPARATION EXCEPTIONS
CONTROL BOARDS AND RELAY RACKS - CASE 32
GAI FIELD CHANGE 75-642
CRYSTAL RIVER UNIT NO. 3

Two exceptions to the standard CR3 separation procedure were discussed with T. V. Garbini today relating to the following drawings:

CASE 32: EC-210-081, item ED3 (ICS)
B-208-047, sheet RC-05

CASE 33: EC-210-089, item JC11 (ICS)
B-208-032, sheet FW-38

Both cases involve an orange wire less than the required physical distance from brown and gray wires. Both of these cases have been reviewed and are acceptable from a separation standpoint. These are low voltage circuits (24 volts) fed from a non-safety related power source (ACDP-51, breaker 25). No system fault in these indicating lights would violate the integrity of any E. S. power source.

JOHN B. HANEIKO

JBH:ems
cc: E. R. Hottenstein (2)

GAI-35-1274

MEMORANDUM

GILBERT ASSOCIATES, INC.

TO: R. E. Miller

FROM: J. B. Haneiko

July 11, 1975

SUBJECT: Engineered Safeguard Separation Exceptions
Control Boards and Relay Racks - Cases 12 Through 30
GAI Field Change 74-550 (Feedwater Backfit)
Crystal River Unit No. 3

The following E.S. exceptions resulted from preparation of GAI field change 74-550, and results of the review together with all affected drawings are listed below. H. M. Snyder reviewed the exceptions with me on July 9 and 10.

	Elementary	Circuit No.	
Case 12	FW-11	FWC151	EC-210-620, 623, 625 Relay Rack items AA, Z, L, M
Case 13	FW-12	FWC153	EC-210-622, 627, 629 Relay Rack items N, AB, AC, P
Case 14	FW-13	FWC155	EC-210-620, 623, 625 RR items AA, M, Z, L
Case 15	FW-14	FWC157	EC-210-622, 627, 629 RR items AB, AC, P, N
Case 16	FW-19	FWC159	EC-210-620, 622, 625, 627, 629 RR items AA, AB, M, N, Z, L, AC, P
Case 17	FW-22	FWC161	EC-210-620, 625, 629 RR items AA, M, Z, L
Case 18	FW-23	FWC163	EC-210-622, 625, 627 RR items AB, AC, N, P
Case 19	FW-28	FWE141	EC-210-620, 623, 625 RR items AA, M, Z, L
Case 20	FW-29	FWE143	EC-210-622, 627, 629 RR items AB, AC, N, P
Case 21	FW-30	FWE145	EC-210-620, 623, 625 RR items AA, M, Z, L
Case 22	FW-31	FWE147	EC-210-622, 627, 629 RR items P, N, AC, AB
Case 23	FW-49	FWE149	EC-210-620, 625, 629 RR items AA, M, Z, L
Case 24	FW-50	FWE151	EC-210-622, 623, 625 RR items AB, N, AC, P

R. E. Miller July 11, 1975

	Elementary	Circuit No.	
Case 25	FW-19	-	EC-210-589 RR item AS
Case 26	FW-22	-	EC-210-397 RR items AJ, AK
Case 27	FW-23	-	EC-210-397 RR items AJ, AK
Case 28	-	-	EC-210-084 (Terminal block jumpers)
Case 29	FW-47	-	EC-210-106 RR items JY, JZ
Case 30	FW-48	-	EC-210-106 RR items JY, JZ

Cases 25, 29, and 30 involve separation violations between separate relay contacts whose wiring originates in an ES "A" cable tray versus wiring from an ES "B" tray. There is electrical separation (isolation) between the orange and brown wires, but not 6" physical separation. This has been reviewed and is acceptable. All other cases (12-24 and 26-28) are wiring violations between nonsafeguard wires in non E.S. tray and nonsafeguard wires in E.S. tray (one channel only). Each of these has also been reviewed on a case by case basis, utilizing all affected drawings which are listed above. No violations of E.S. system integrity exist, utilizing review methods discussed in previous E.S. exception memorandums.

John B. Haneiko
John B. Haneiko

JBH:in

cc: E. R. Hottenstein (2)
R. P. Cronk
J. B. Haneiko (2)

MEMORANDUM

GILBERT ASSOCIATES, INC.
April 15, 1975

TO: R. E. MILLER - 3-E

FROM: J. B. Haneiko

SUBJECT: ENGINEERED SAFEGUARD SEPARATION EXCEPTIONS CONTROL BOARDS & RELAY RACKS - CASE 11
CRYSTAL RIVER UNIT NO. 3

In response to your memo of April 15, 1975 regarding another exception to the E. S. separation criteria, the following justification is offered:

Case 11: Reference GAI Dwgs. EC-210-332, EC-229-107, and B-208-040, sheets MT-09 and MT-10. Lockout relay 86BU/PL4(item R on MISC/SSTR board) is the item in question, and the question resulted because of GAI field change 75-555. The conclusion of my review is that the condition described(red and green wires on relay item "R") is acceptable, because it reflects the design intent and does not impair safety.

This relay must interlock into both the 4160 volt E. S. "A" bus and the 4160 volt E. S. "B" bus, because both busses are fed from the 230 kv substation and both must be tripped if a fault occurs at the substation. This is a similar situation to that existing for the CR3 startup transformer. Such a trip does not negate operation of E. S. equipment because of the backup provided by the diesel generators.

A short circuit on relay 86BU/PL4 could cause a false trip of the 4160V E. S. busses. An open circuit could prevent a trip, but then there is still backup relay protection to initiate it. A spurious ground anywhere in this circuitry would be protected by the overcurrent relays. All of these conditions are acceptable from a safety standpoint, and so the E. S. exception described is acceptable as it is.

John B. Haneiko
JOHN B. HANEIKO

JBH:ems
cc: E. R. Hottenstein (2)
R. P. Cronk
M. A. Gerhard
M. E. Ober
J. B. Haneiko (2)

MEMORANDUM

GILBERT ASSOCIATES, INC.

February 19, 1975

TO: R. E. MILLER - [illegible] E

FROM: J. B. Haneiko

SUBJECT: ENGINEERED SAFEGUARD SEPARATION EXCEPTIONS
GAI FIELD CHANGE 74-513
CRYSTAL RIVER UNIT NO. 3

Exceptions to standard CR3 separation procedures were discussed with T. Garbini on February 18 relating to the following elementary and wiring drawings:

	Elementary	Wiring Drawing
Case 1	AH-131	EC-210-401
Case 2	AH-20	EC-210-492
Case 3	AH-48	EC-210-495
Case 4	AH-90	EC-210-502
Case 5	AH-131	EC-210-514
Case 6	AH-15	EC-210-520

All six (6) exceptions to normal separation criteria are acceptable as they are without barriers, since they do not compromise the safe functioning of any safety related equipment or power sources. Case 4 is unique in that it is a non-safeguard device receiving power from an ES(AB) power source, but this is not a concern because of the manual transfer feature of this bus. A fault which occurs when the manual transfer switch is fed from the "A" bus will not be transferred to the "B" bus. It was verified with the electrical engineering department that the formerly named AEC had accepted the scheme of non-safety devices powered from this safety grade bus without circuit isolation at this low voltage level.

JOHN B. HANEIKO

JBH:ems
cc: E. R. Hottenstein (2)
R. F. Cronk
J. B. Haneiko (2)

GAI-35 8/54

MEMORANDUM

GILBERT ASSOCIATES, INC.

TO: Mr. R. E. Miller - LA-3W

FROM: J. B. Haneiko

SUBJECT: Engineered Safeguard Separation Exceptions
Control Boards & Relay Racks - Case 5A
Crystal River Unit No. 3

June 11, 1975

In response to your memorandum of May 28, 1975, regarding the change to previously reviewed exception #5, this revised exception will be designated as case 5A. Conclusions are as follows:

Case 5A: The drawings affected are the same as those discussed for case 5 (See February 19, 1975 memo). The exception for case 5A is not significantly different from case 5 and is therefore also acceptable from a safety standpoint.

John B. Haneiko

John B. Haneiko

JBH:pam

cc: E. R. Hottenstein (2)

memorandum Gilbert Associates, Inc.

April 4, 1975

to: R. E. MILLER - 3E

from: J. B. Haneiko

subject: ENGINEERED SAFEGUARD SEPARATION EXCEPTIONS
CONTROL BOARDS & RELAY RACKS - CASE 10
CRYSTAL RIVER UNIT NO. 3

In response to your memo of March 31, 1975 regarding another exception to the E. S. separation criteria, the following justification is offered:

Case 10: Reference GAI Dwgs. EC-210-586 and EC-210-587. The circuit numbers involved with this separation exception are VBF27, VBF28, VBF29, and VBF30. The conclusion of my review is that the condition described in your memo is acceptable.

A single failure analysis was performed to see if any of the following conditions would endanger two (2) E. S. power sources simultaneously:

1) random short circuit
2) random open circuit
3) random system ground

It was determined that none of the system faults investigated would violate the integrity of more than one E. S. power source. The existing situation is therefore acceptable from a safety standpoint.

John B. Haneiko

JBH:ems
cc: E. R. Hottenstein (2)
R. P. Cronk
J. B. Haneiko (2)

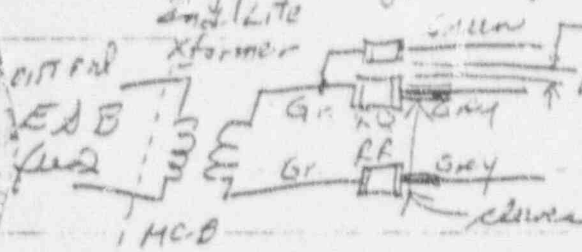
GA-35-1274

TO: J B Hranko

FROM: R E Miller

DATE: 3/3/1975 SUBJECT: E S Sep problem 75-564, **CASE #7**

this is typical of past procedure used by us:



We normally would fuse a feed to lights and sleeve the grey wires.

-- Per past practice we've added RQ, RR (which by us with...) we will not sleeve as we have in past. OK - or - not OK

SIGNED RCM DEPT.

DATE: MARCH 3 1975 | R.S. - We're going to issue today or tomorrow 3/3 3/4

This apparent violation is acceptable because the grey wires referenced are in fact green-associated wires & we have proved (per TJH) that there is no connection between these & some red-associated wires also run in non-E.S. grey for the same function. Identification of cable channels by color was not req by IEEE SIGNED 279-1968. John Hranicka - 0423

REPLIER: ANSWER LETTER, DETACH COPIES, KEEP WHITE AS YOUR FILE COPY AND RETURN PINK COPY TO SENDER

ATTACHMENT

MEMORANDUM

GILBERT ASSOCIATES, INC.

March 20, 1973

TO: MR. T. C. REITZ

FROM: V. H. Willems

SUBJECT: FLORIDA POWER CORPORATION
Crystal River 3
Exceptions to the Control Boards Separation Criteria

The exceptions to the separation criteria, as marked up on the attached elementaries, were reviewed for their acceptability.

A portion of the circuits indicated as possible exceptions have been identified as NON-ES circuits where parts of the circuits were run in E. S. trays and the balance in NON-ES trays. The NON-ES cables run in ES trays are color coded, brown, orange or black, in accordance with the separation criteria report, while the cable run in NON-ES trays are gray color resulting, at the terminals where they meet, in exception to the criteria.

The balance of the circuits indicated as exceptions are power feed to E. S. actuation relays cabinets and therefore E. S. circuits. Power to the E. S. cabinets is obtained from the 4 inverters. The cables associated with the inverters are color coded red, green, yellow and blue. While the wiring in the actuation cabinets is either red(A train) or green (B train).

The wiring associated with each inverter is kept separated from each other within each of the E. S. actuation cabinet therefore separation between redundant function is preserved.

The results of the review indicates that no failure of the circuits referenced above negates the separation of E. S. circuitry and are acceptable as they are.

V. H. Willems

V. H. WILLEMS

Attachment
VHW:cms
cc: W. J. Kerchner(w/o enc)
G. K. Henry (w/o enc)
R. E. Miller (w/o enc)

GAI-35

LIST OF ELEMENTARIES REVIEWED

ELEMENTARY	REVISION	ELEMENTARY	REVISION
FW-33	0	CF-09	3
MU-34	2	CD-02	6
MU-35	2	TB-21	1
MU-47	2	RC-25	1
MU-52	1	ES-A63	0
SW-07	0	ES-B22 *	0
SW-28	0	ES-B21 *	0
TD-01	3	ES-B37 *	0
DH-24	3	ES-B36 *	0
SW-08	0	ES-B46 *	0
MS-12	1	ES-B45 *	0
MU-44	2	ES-B63	0
MU-43	2	ES-A22 *	0
MD-01	3	ES-A21 *	0
SC-07	2	ES-A37 *	0
MU-33	2	ES-A46 *	0
CA-20	6	ES-A45 *	0
CF-07	2	ES-AB05	0
CI-23	1	ES-AB07	0
CD-07	6		
SW-06	0		

Elementaries with an asterisk (*) have E.S. circuits