VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

W. L. STEWART
VICE PRESIDENT
NUCLEAR OPERATIONS

December 1, 1983

Mr. Harold M. Denton, Director
Office of Nuclear Reactor Regulation
Attention: Mr. Darrell G. Eisenhut, Director
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Serial No. 668A
PSE/PEC:jp
Docket Nos.: 50-280
50-281
50-338
50-339
License Nos.: DPR-32
DPR-37
NPF- 4
NPF- 7

ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED ELECTRICAL EQUIPMENT
SURRY AND NORTH ANNA POWER STATIONS

Gentlemen:

As referenced in our letters dated May 20, 1983, Serial No. 085F for Surry Power Station and Serial No. 110D for North Anna Power Station, enclosed is Vepco's response to 10 CFR50.49(b)(2).

Enclosed are forty (40) copies of an initial report stating with reasonable assurance that no equipment falls into the 10CFR 50.49(b) (2) category at either Surry or North Anna Power Stations. This report was prepared by an independent consultant, Nuclear Power Services.

Any corrective actions required to qualify or replace equipment identified for compliance will be completed on a schedule consistent with the requirements of 10CFR 50.49, paragraph (g). In addition, all subsequent report findings will be made available to the NRC.

Very truly yours,

W. L. Stewart

Attachments

cc: Mr. James P. O'Reilly, w/attachments
Regional Administrator
Region II
101 Marietta Street, Suite 2900
Atlanta, Georgia 30303

Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing

Mr. James R. Miller, Chief
Operating Reactors Branch No. 3
Division of Licensing

Mr. D. J. Burke, w/attachments
NRC Resident Inspector
Surry Power Station

Mr. J. Don Neighbors, w/attachments
NRC Project Manager - Surry
Operating Reactors Branch No.
Mailstop 438
7920 Norfolk Avenue
USNRC
Bethesda, Maryland 20014

Mr. M. B. Shymlock, w/attachments
NRC Resident Inspector
North Anna Power Station

Mr. Leon B. Engle, w/attachments
NRC Project Manager - North Anna
Operating Reactors Branch No. 1
Mailstop 428
7920 Norfolk Avenue
USNRC
Bethesda, Maryland 20014

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION & SURRY POWER STATION COMPLIANCE WITH 10CFR50.49(b)(2)

Prepared by:

Nuclear Power Services
Secaucus, New Jersey 07094

Lawrence P. Gradin
Project Manager

Gobin Ganguly
Project Engineer

Richard Leone
Lead Engineer

Prepared On Behalf Of:
VIRGINIA ELECTRIC AND POWER COMPANY

Paul Conner
VEPCO Task Leader
Responsible for Project Coordination

Release Date: November 10, 1983

ABSTRACT

Nuclear Power Services,Inc. has completed an initial and independent evaluation of the Virginia Electric and Power Company's (VEPCO) North Anna and Surry Power Station's safety-related electrical systems in response to 10CFR50.49(b)(2). Nuclear Power Services' (NPS) findings, based on data so far studied, indicates with reasonable assurance that there is no "nonsafety electrical equipment whose failure under postulated environmental conditions could prevent satisfactory accomplishment of safety functions specified in subparagraphs (i) through (iii) of paragraph (b)(1) of this section by safety-related equipment". Included herein is a potential list of nonsafety electrical loads which are potentially located in harsh environments and which share a common safety system power source with safety-related equipment required for safe shutdown or accident mitigation. The review described in this report is continuing so as to provide complete assurance that each of the above power station's nonsafety electrical loads are in conformance with '(b)(2)'. Should any nonsafety loads be found, which falls in the category of '(b)(2)', a method to upgrade that particular nonsafety equipment will be applied or a design modification implemented, the "master safety-related equipment list" revised, and the US Nuclear Regulatory Commission notified.

This effort will be implemented and completed prior to the time limitation specified in 10CFR50.49(g), ie., "...by the end of the second refueling outage after March 31, 1982 or by March 31, 1985, whichever is earlier."

TABLE OF CONTENTS

TABLE OF CONTENTS
(con't)

TABLE OF CONTENTS
(con't)

TABLE OF CONTENTS

(con't)

TABLE OF CONTENTS
(con't)

LIST OF FIGURES

LIST OF FIGURES (con't)

LIST OF FIGURES (con't)

NORTH ANNA PLANT EXAMPLES OF TIME - CURRENT COORDINATION CURVES

SURRY PLANT EXAMPLES OF TIME - CURRENT COORDINATION CURVES

LIST OF TABLES

PART I

EXECUTIVE SUMMARY

PART I EXECUTIVE SUMMARY

I. PURPOSE

The purpose of this report is to describe the Virginia Electric and Power Company (VEPCO) program and methods of identifying the equipment covered by 10CFR50.49 (b)(2), (see Appendix A for selected excerpts). It addresses nonsafety-related electrical equipment which are not required to function following a design basis accident, but whose failure in the resulting harsh environment must be reviewed to assure it does not affect safe reactor shutdown or accident mitigation.

II. Summary and Conclusions

This report describes the methodology and criteria, including the utilization of a systematic design review approach, for determining a potential list of nonsafety-related electrical equipment for North Anna and Surry Power Stations which are considered as "important to safety" within the scope of 10CFR50.49. This "Area Approach" review considers potential failure modes of the nonsafety-related equipment resulting from the impact of an accident and their consequence, if any, on the safety-related electrical equipment. Finally, the report evaluates the design criteria utilized in electrical system design, whose implementation would preclude the potential failure of nonsafety-related electrical equipment affecting safety related equipment. Demonstration is provided based on an initial assessment that the actual design meets the intent of the established criteria.

The preparation of the potential list is based on a systematic approach described in "Specific Review Methodology"-Section VIII. The environmental impact on nonsafety-equipment due to an accident and the resulting effects, if any, on safety systems have been assessed.

Due to similarity of design between Unit-1 and Unit-2 of each station, only Unit-1 drawings were evaluated to establish the list of non-safety loads presented in Table 1 and 2. Unit-2 loads for each station that will be affected are considered to be the same as those listed for Unit-1.

The detail design evaluation of North Anna and Surry safety-related electrical distribution systems, as described in Section XII, further demonstrates that the potential impact on safety-related electrical power systems, due to the failure of nonsafety-related equipment sharing a common power source with the safety systems, are improbable due to implementation of an electrical system design based on good engineering practice.

Results of this review indicate that connection of nonsafety-related equipment to the safety-related equipment is controlled by properly selected protective devices that are coordinated to minimize the disturbances to safety-related systems. The review verified the design criteria utilized to implement design and installation, and concluded that the present design provides adequate assurance that design criteria in general has been met. However, VEPCO intends to continue its review to provide additional assurance that specific equipment and circuits are designed and installed in accordance with the established criteria.

In regard to the connection of nonsafety equipment to safety-related circuits, initial assessment indicates that these circuits were properly evaluated during the preparation of 'master list' equipment in response to IEB 79-01B and NUREG-0588 requirements. A continuing review will be initiated to verify that no such circuits exist and if there are any, a method to upgrade the associated nonsafety equipment will be established in conformance to 10CFR50.49(b) and proposed regulatory guide 1.89, Rev. 1. The results of further review will be made available to NRC in accordance with 10CFR50.49 -- paragraph (g) schedule requirements.

During this review, it was observed that certain electrical system, design documents such as FSAR, drawings and purchase specifications, have not yet been revised to reflect as-built conditions. The test of the report is therefore, based on actual installed condition. VEPCO is document update program is addressing the revision of design documents to reflect as-built conditions.

III. BRIEF SYNOPSIS OF SYSTEMATIC APPROACH

The following step-by-step methodology and considerations were applied:

1) Consideration of postulated events which could cause a failure of non-Class 1E equipment resulting in unacceptable influence on the Class 1E power system.
2) Identification of the allowable limits for the influences on the Class 1E power system.
3) Establishing a methodology to identify non-Class 1E electrical equipment whose environmentally induced failure could cause unacceptable influences on the Class 1E system.
4) Identification of the design features required to maintain conditions within allowable limits in the Class 1E power system.
5) Review electrical distribution system design descriptions and criteria for electrical protection systems, including identification of various operating modes of the Class 1E power system.
6) Analysis and evaluation of design to verify compliance with established criteria by independent initial review and sample audit of the actual design and installation to demonstrate, with reasonable assurance, that the above criteria is implemented.

IV. DEFINITION OF SAFETY-RELATED ELECTRIC EQUIPMENT

As defined in a footnote to 10CFR50.49 (b)(1), "safety-related electric equipment" is the same as "Class IE" equipment in IEEE 323-1974. Both terms are used in this report consistent with industry usage.

PART II

DETAILED DISCUSSION OF INVESTIGATION

PART II DETAILED DISCUSSION OF INVESTIGATION

V. BACKGROUND FOR REPORT SUBMITTAL

On January 21, 1983 the USNRC Office of Nuclear Regulatory Research issued (Federal Register/Vol. 48, No. 15) the final rule on "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants" 10CFR50.49 which required that each holder or applicant for a license to operate a nuclear power plant, shall establish a program for qualifying the electric equipment important to safety. Specific direction was given to VEPCO by the NRC for North Anna and Surry Power Stations to "discuss the methods used to identify the equipment covered by paragraph 10CFR50.49(b)(2) and to establish any qualification programs not previously described for such equipment". VEPCO responded by the required May 20, 1983 date[(4)(5)] as follows:

> In response to 10CFR50, paragraph 50.49(b)(2), VEPCO is developing criteria to address this equipment. It is anticipated that the equipment in this category, if any, and the methodology used to identify this equipment will be provided to you on or before November 16, 1983. Additionally, any corrective actions required to qualify or replace equipment identified for compliance will be completed on a schedule consistent with the requirements of 10CFR Part 50, paragraph 50.49(g).

VI. SCOPE

The scope of this report preparation includes the analysis of the consequent effects on non-class IE equipment caused by various design basis events within the scope of 10CFR50.49 which may degrade safety-related electrical equipment.

As indicated in the rule (10CFR50.49 (c)) the "requirements for (i) dynamic and seismic qualification of electrical equipment important to safety, (ii) protection of electric equipment important to safety

against other natural phenomena and external events and (iii) environmental qualification of electrical equipment important to safety located in a mild environment, are not included within the scope ......".

The electrical equipment of concern is defined to be any nonsafety-related electrical equipment whose failure under postulated harsh environmental conditions could prevent accomplishment of safety function specified for safety-related equipment in 10CFR50.49 (b)(1).

The following nonsafety-related equipment, subject to a harsh environment, fall within the scope of 10CFR50.49 (b)(2):

1. Nonsafety-related equipment sharing a common power supply with the safety-related equipment required for shutdown or mitigation of the postulated accident, which is not electrically protected from the circuits of concern by coordinated breakers, fuses or protective devices.

2. Nonsafety-related equipment connected to circuits of safety-related equipment whose spurious or inadvertent operation may adversely affect achieving the necessary safety function.

VII GENERIC REVIEW PROCESS

VEPCO's independent design verification process to ensure that the design, installation and evaluation presented in this report are, in fact verified, is in process.

The design verification review and audit have begun with an independent consultant's review of project criteria and unique project implementation methods. The next phase will be the design verification of selected design provisions to validate the adequacy, accuracy, and completeness of the engineering methods used. The design verification process will include the resolution of the following questions:

- o Does design meet the criteria?
- o Is the design documentation adequate?
- o Have design inputs been correctly selected?
- o Have appropriate standards been specified?
- o Is the plant systems maintainable?
- o Does design comply with the related regulatory requirement intent for North Anna and Surry Power Stations?
- o Is the technical analysis adequate?
- o Is the design change control process adequate to retain qualification?

The design verification process as presently conceived is illustrated in Figure 1.

The next phase of the process will be a field verification of a selected installation as an audit of the effectiveness of the existing QA/QC program.

The last and final stage is the modification of this initial report to be reviewed by management which will include corrective action recommendations and presentation of the report to the regulatory agency. The summary of the whole (Design Verification Review and Audit) Methodology is illustrated in Figure 2.

VIII SPECIFIC REVIEW METHODOLOGY

The methodology to determine the electrical equipment which is not required to perform a safety function following a Design Basis Accident, but whose failure due to the harsh environment resulting from the postulated accident may prevent the accomplishment of required safety functions, is based on a systematic "Area Approach" to locate all electrical equipment which are subjected to a harsh environment resulting from DBA and determining the interaction between this equipment and electrical equipment providing safety functions.

INDEPENDENT DESIGN VERIFICATION PROCESS

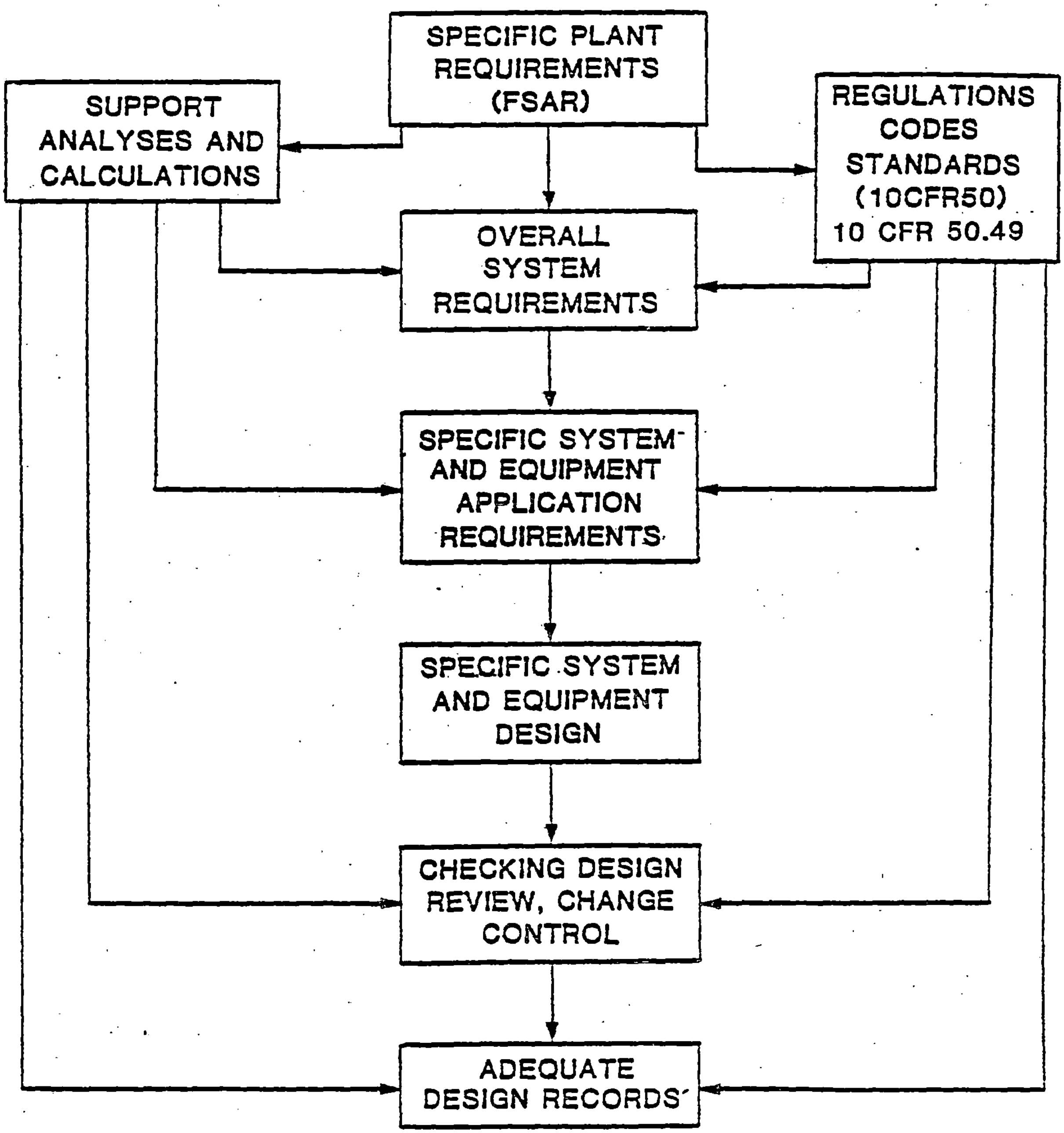
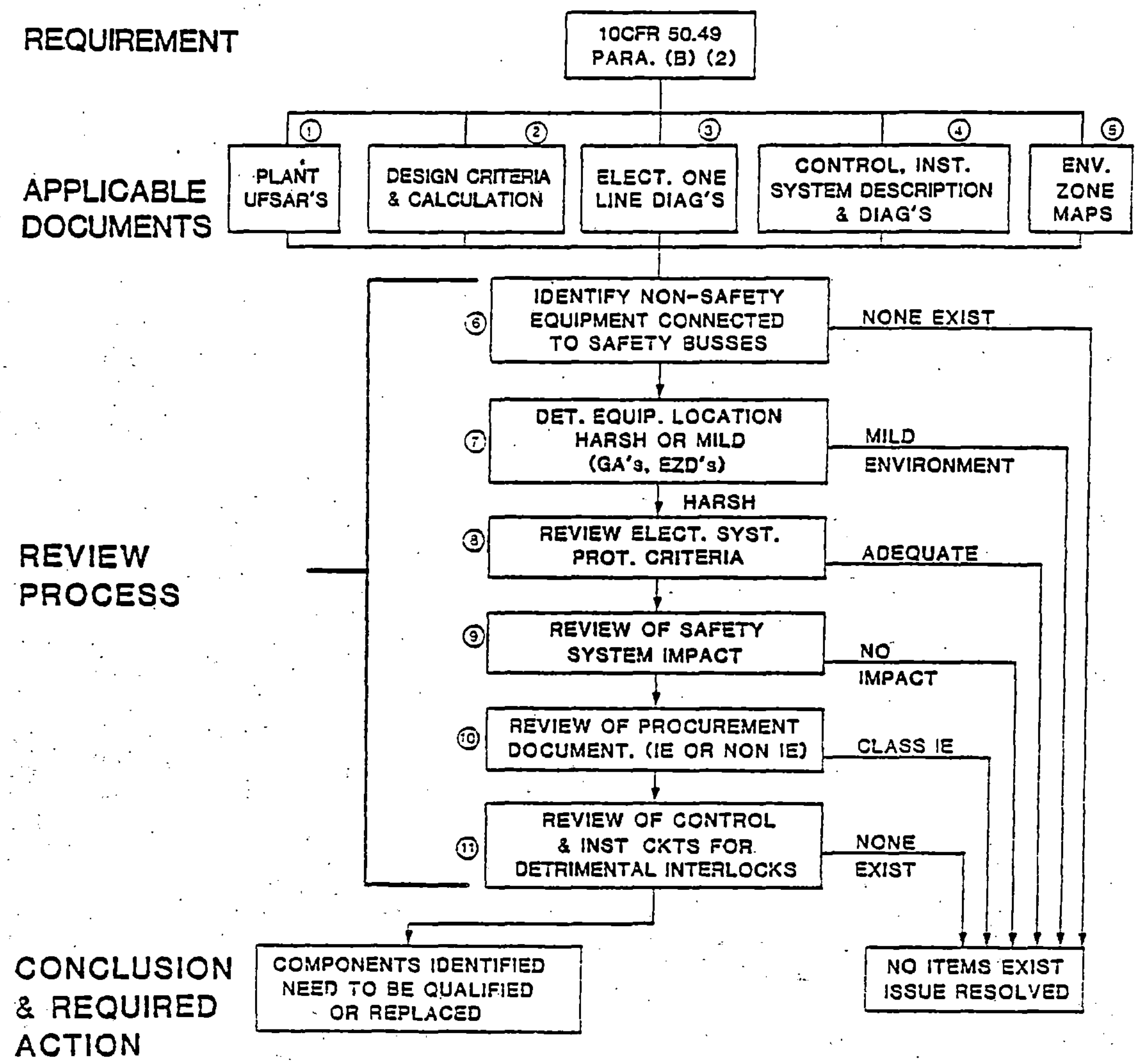


FIGURE 1

METHODOLOGY



LEGEND:

GA's – General Arrangement Dwgs.
EZD's – Environmental Zone Descriptions

FIGURE 2

The electrical equipment, which are required to perform a safety function or post-accident monitoring within the scope of the rule and can be affected from an environmentally induced failure, have been previously identified and submitted to the NRC in a comprehensive master list of equipment with VEPCO's IE Bulletin-79-01B (90 day response) or in NUREG-0588 (North Anna Power Station - Unit 2) submittals.

Therefore, the methodology described herein is strictly related to electrical equipment not required to perform safety functions following an accident.

The basic steps in this "Area Approach" based methodology are as follows:

a) Review of plant (North Anna and Surry Power Stations) one line diagrams, FSAR's and plant manuals.

b) Identify nonsafety related loads connected to safety related electrical busses, i.e., common power supply.

c) Determine if the nonsafety-related loads are subjected to the harsh environment resulting from DBA - including HELB outside the containment. This determination is based on review of plant general arrangement drawings and environmental zone description maps.

d) Determine if the environmentally induced failures in the equipment described in paragraph b) and c) above will not prevent proper performance of the required safety functions by safety-related equipment.

e) Review of electrical protection system and plant design criteria to determine if the components identified in paragraph c) above (if any) are adequately protected in the event of any electrical fault or an accident from damaging safety circuits (i.e., isolated promptly from the class 1E circuits).

f) Review of component procurement documents to verify if the components identified in paragraph c) above, can withstand the environmental impact resulting from an accident.

g) Review of control and interlocks associated with the specific component, and determine if special control features or administrative procedures are utilized to prevent the specific nonsafety-related equipment from affecting the safety components.

IX GENERAL DESIGN PRACTICE TO DETERMINE SIGNIFICANCE OF IMPACTS OF NONSAFETY LOADS ON SAFETY-RELATED SYSTEMS

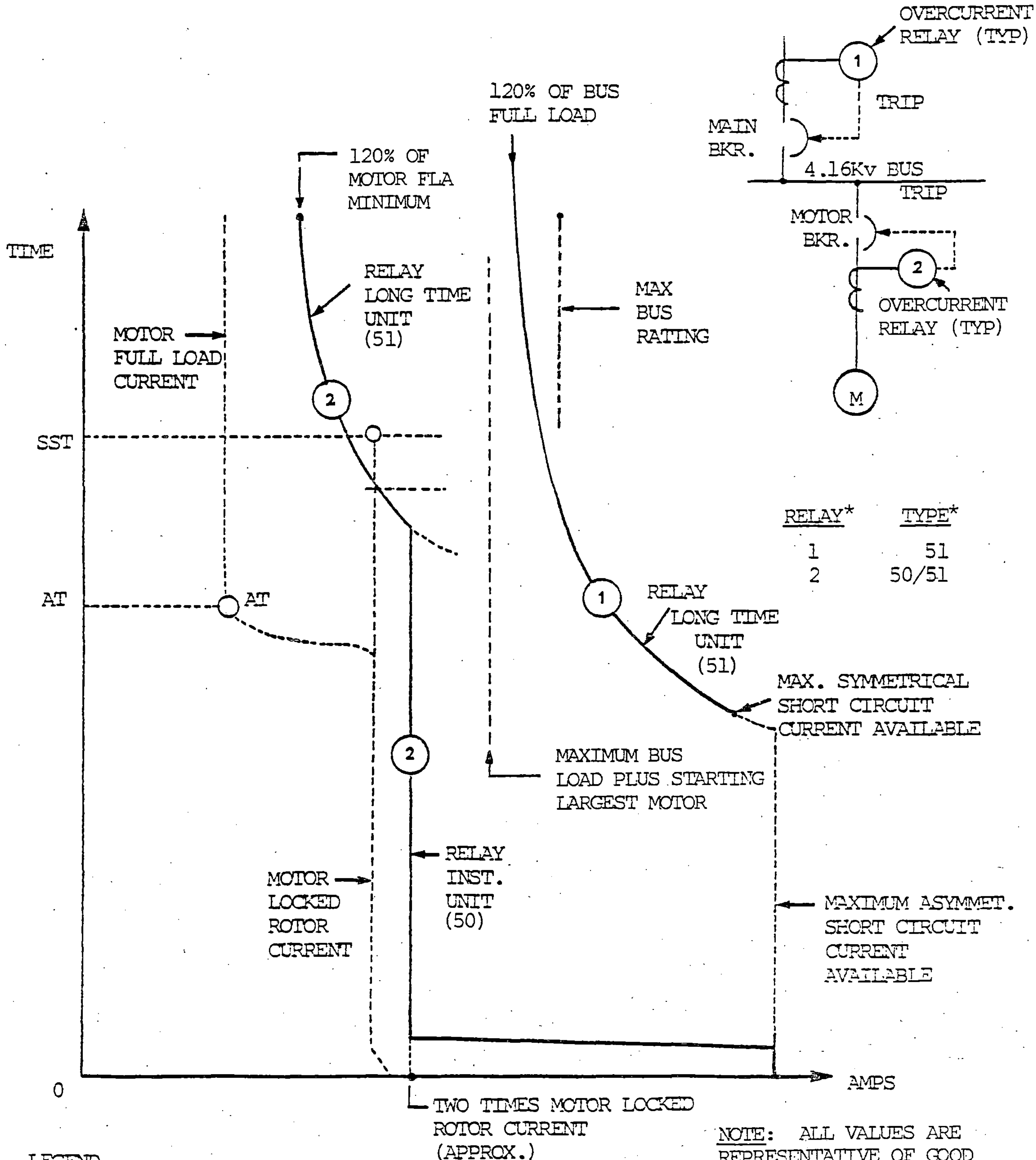
Postulated events within the scope of 10CFR50.49 may result in a failure of non-Class 1E equipment (loads) so as to effect the Class 1E power system. The most probable damaging failure can be an electrical fault, (phase to ground or phase to phase). In order to maintain the consequence of this failure within allowable limits, the fault currents may be inherently limited to levels below the pickup values of overcurrent relays protecting the main Class 1E supply circuit breakers and/or because proper selective coordination has been applied. This eliminates the potential trip of the main Class 1E supply circuit breakers and consequential loss of power to Class 1E loads.

X GENERAL AUXILIARY SYSTEM PROTECTION AND COORDINATION CRITERIA

A. Design Objectives and General Characteristics of Proper Power Systems Design, Protection and Control

Some design objectives and general characteristics of acceptable power system design and protection are:

1) The electrical protective device (circuit breaker, overload element or fuse) for all nonsafety circuit faults will cause the protective device to interrupt the fault current prior to initiation of a trip of any upstream protective device (e.g., main circuit breaker, fuse, etc.) which would otherwise cause loss of power to a safety related load.The electrical power source will supply sufficient fault current and fault duration so as to ensure proper coordination between the protective devices. The criteria for coordination for various voltage levels is shown on Figures 3 through 5.
2) The electrical protective device to the nonsafety-related load is automatically tripped by an accident derived signal generated in the same division as that to which the device is applied, provided that the time delay involved in generating the accident signal and tripping the protective device does not result in unacceptable degradation of safety function.
3) The electrical protective device described in (1) and (2) above is procured, designed and installed to the same criteria for protective devices directly feeding safety-related loads.
4) Input current limiters to the nonsafety-related load are provided that will limit the input current to an acceptable value, under faulted output conditions due to potential harsh environments.



<u>NOTE</u>: ALL VALUES ARE REPRESENTATIVE OF GOOD PROTECTIVE DEVICE COORDINATION CRITERIA.

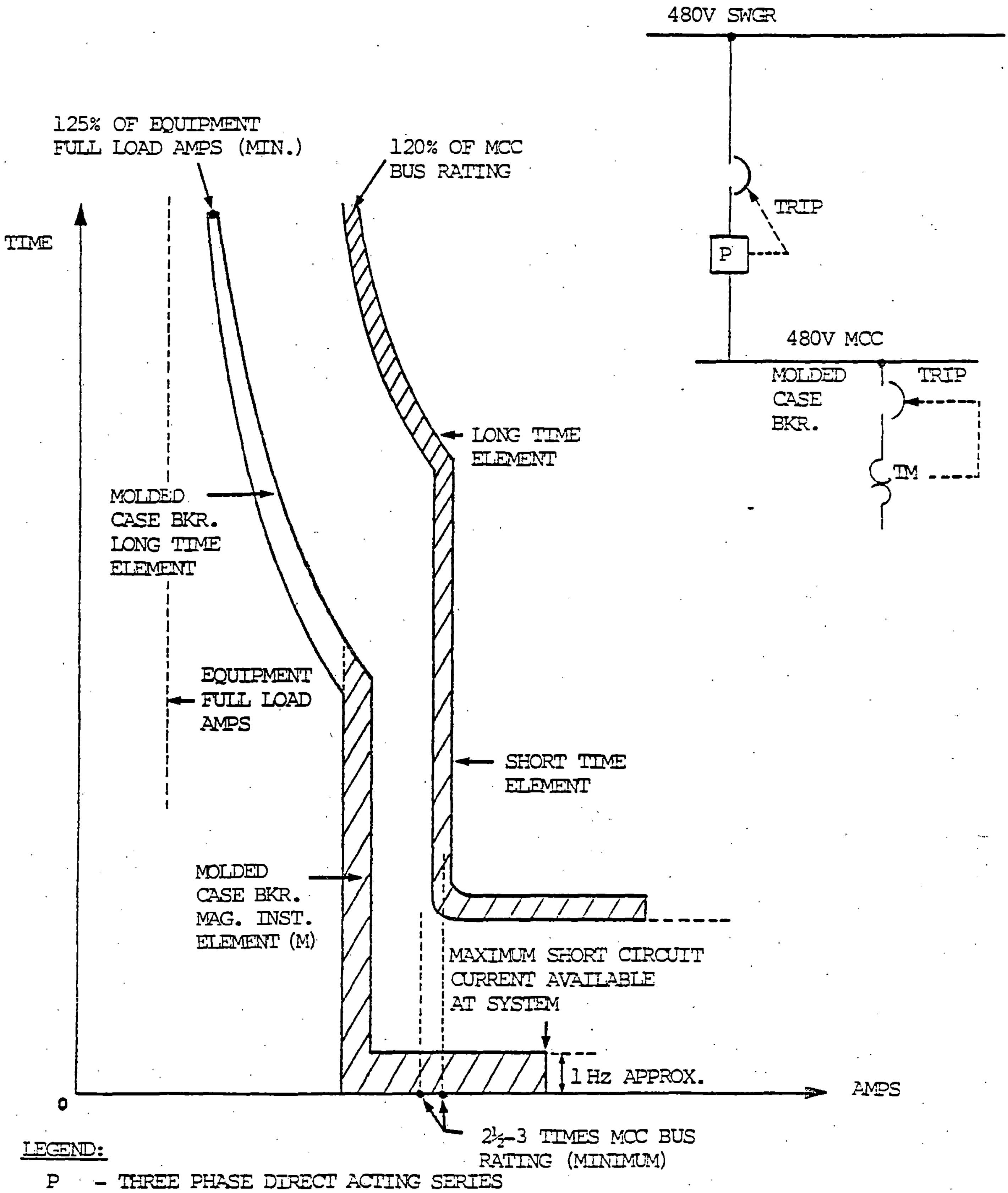
<u>LEGEND</u>

M -MOTOR
SST -MOTOR SAFE STALL TIME
FLA -MOTOR FULL LOAD CURRENT
AT -MOTOR ACCELERATING TIME TO FULL SPEED

*51 - TIME-OVERCURRENT INVERSE CHARACTERISTIC RELAYS
*50/51 - TIME - OVERCURRENT INVERSE CHARACTERISTIC RELAYS WITH INSTANTANEOUS ELEMENT.

4.16KV BUS & 4.0KV MOTOR
OVERCURRENT PROTECTION CRITERIA

FIGURE 3



LEGEND:

P - THREE PHASE DIRECT ACTING SERIES TRIP DEVICE
- ± 10% TOLLERANCE

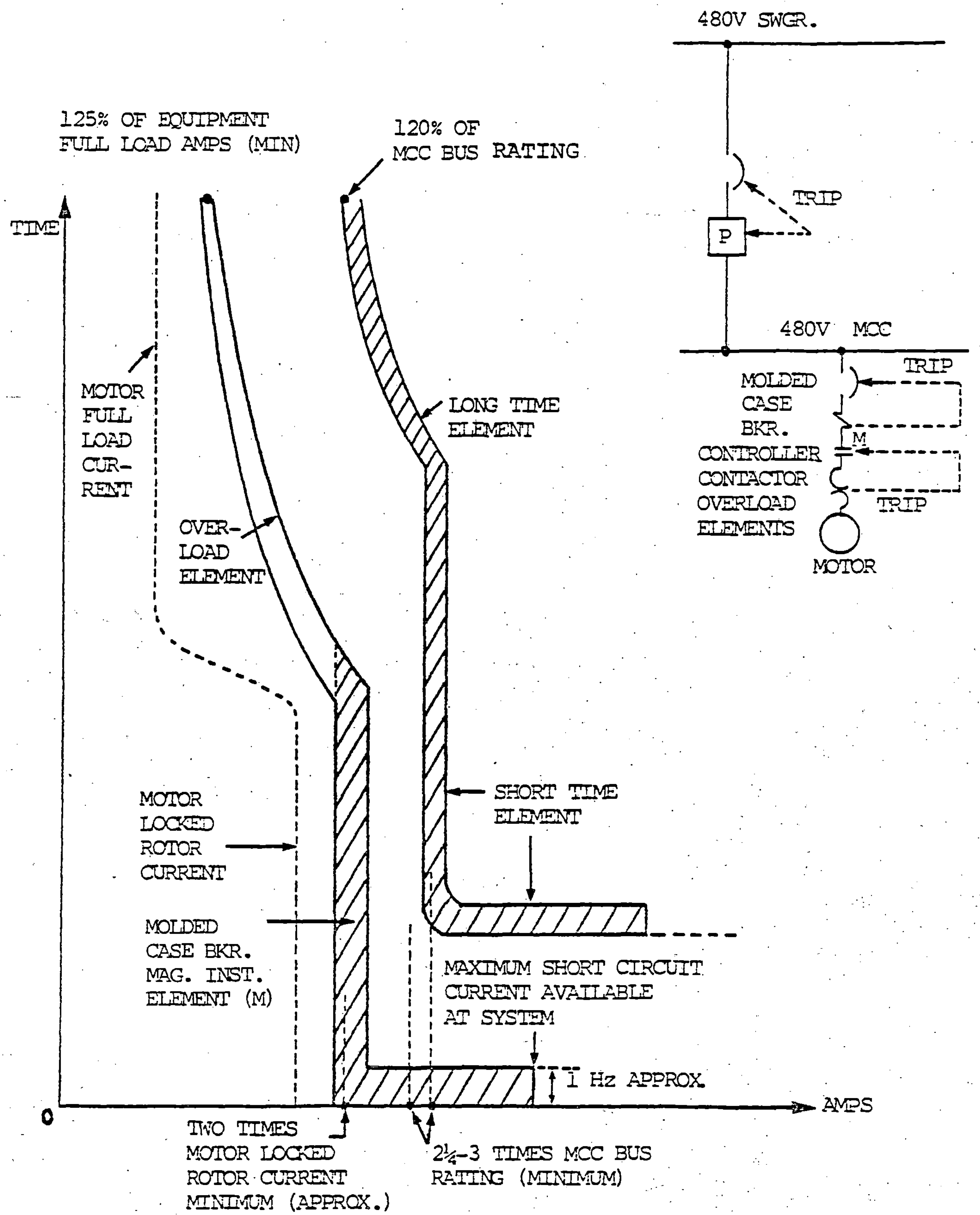
TM - THERMAL (LONG TIME) - MAGNETIC (INSTANTANEOUS) ELEMENT

NOTE

ALL VALUES ARE REPRESENTATIVE OF GOOD PROTECTIVE DEVICE COORDINATION CRITERIA.

480V MCC FEEDERS OVERCURRENT PROTECTION CRITERIA

FIGURE 4



LEGEND

P —THREE PHASE DIRECT ACTING SERIES TRIP DEVICE
—± 10% TOLERANCE

M —MAGNETIC (INSTANTANEOUS) ELEMENT

NOTE

ALL VALUES ARE REPRESENTATIVE OF GOOD PROTECTIVE DEVICE COORDINATION CRITERIA.

480V MCC COMBINATION MOTOR CONTROLLERS-
MOTOR OVERCURRENT PROTECTION CRITERIA

FIGURE
5

5) Placement of the protective device or input current limiters to the nonsafety-related load in the plant surveillance maintenance program for a level of surveillance/maintenance equivalent to that used for devices feeding safety-related loads.

6) Place nonsafety-related loads on safety busses in areas not subject to the potentially degrading influence of a harsh environment.

7) Provide sufficient impedance between each main Class 1E supply circuit breaker and the non-Class 1E connection point to prevent unacceptable degradation of the Class 1E power supply in the event of maximum possible fault at the non-Class 1E boundary without unacceptably degrading bus voltage levels under all bus configurations.

8) Assuring that nonsafety-related devices or components, whose failure or malfunction may prevent safety related equipment to perform its required safety function, are environmentally qualified against the harsh environment they are subjected to.

B. AC and DC Distribution System Protection and Coordination Criteria

The classical approach to design of Class 1E power systems in nuclear power plants has always been to minimize the potential of failure in these systems. Various methods within the realm of applicable regulatory and industry standards such as protection and control systems, redundancy, independence and separation, as well as assurance of quality of equipment, are extensively utilized to achieve this goal. The primary function of the Class 1E electrical system is to reliably supply power to those loads required to safely shut down the reactor. However, consideration for providing additional margin for emergency condition, as well as protection of major equipment, personnel and the limitations of certain equipment design warrants that certain nonsafety

loads be also connected to the safety system. Examples of these loads are the turbine-generator turning gear motor, emergency A.C. lighting, fire protection, d-c emergency bearing oil pump drives, pressurizer heater (backup) groups, security systems, and plant communications.

Thus, the objective of an electrical protection system is to provide a selective, coordinated electrical distribution protection scheme by proper application of protective relays and trip devices. The function of the protective system, for all postulated events, is to:

- o Detect the presence of abnormal system conditions.
- o Isolate only the faulted equipment.
- o Minimize damage to equipment and maintain service to the unaffected part of the system with minimum disturbance.
- o Prevent unacceptable influences in the Class 1E power system due to faults in the non-Class 1E power system.

To accomplish the above function, the protective devices are designed to provide selectivity, sensitivity, high speed and reliability. Selectivity is achieved by establishing protective zones for the system and selecting protective relays and devices which are capable of recognizing faults within their zone of separation. The protective relays and devices then operate to isolate the faulted equipment or the affected zone.

Sensitivity of protection is assured by analyzing the system for various operating and associated fault conditions and applying sensitive protective device settings which enable the protective device to operate correctly under these faulted conditions for all distribution system configurations. High speed protection is provided to minimize system disturbances and damage to equipment.

Reliability is achieved by utilizing inherently reliable protective devices and establishing an appropriate maintenance and testing program for all protective relays and devices.

Coordinated protection for the safety-related power distribution system is achieved by proper selection of the operating characteristics and setting of each relay and device. In case of a fault, a relay or device protecting the faulted equipment operates with high speed and isolates the faulted equipment.

The design of the Class 1E power distribution system, together with the arrangement of the feeder circuits, ensures that faults on the nonsafety-related circuits or equipment will not cause unacceptable influence on the safety-related A.C. and D.C. distribution systems. Faults on the nonsafety circuits will be isolated by fast operation of the affected feeder protective device resulting in acceptable transient disturbances. A line to ground fault (which is the most likely mode of failure) on a nonsafety-related circuit will have less effect on the safety-related system than a three phase or phase-to-phase fault since A.C. or D.C. distribution system consist of high impedance grounding or ungrounded system, respectively, which minimize or do not allow the flow of high ground fault current.

The unlikely three phase or phase-to-phase faults on a nonsafety--related circuit will be cleared by the selective instantaneous operation of the branch protective device.

XI DESIGN FEATURES

A. Description of Class IE A.C. Power Distribution System for North Anna and Surry Power Station.

The Class 1E A.C. power distribution system consists of two separate and physically independent subsystems. Each subsystem can receive A.C. power from either of three sources:

- o Preferred off-site A.C. power supply
- o Normal power supply through station service transformer (applicable only for North Anna Unit-1).
- o Standby A.C. power supply (diesel-generator)

Each A.C. power distribution subsystem supplies power to redundant Class 1E loads at 4.16KV, 480V and 120V voltage levels and some selected non-Class 1E loads. The potentially selected 10CFR50.49 (b)(2) non-Class 1E loads are tabulated in Tables 1 and 2.

B. Design Description of North Anna and Surry Power Station Safety-Related Electrical Power Distribution Systems

1) <u>North Anna Power Station Safety-Related Electrical Power Distribution System Description</u>

a) General Description

The A.C. power system for the North Anna Power Station consists of various auxiliary power systems which provide reliable power to all auxiliary electrical loads sufficient for start-up, operation and shutdown conditions. The systems are provided with sufficient power sources, switching capability, circuit protection and redundancy to accomplish this reliability.

The voltage ratings of the A.C. power distribution system are 4160V, 480V and 120/240V. Figure-6, the main one line diagram for the North Anna Power Station Unit -1, shows the connection of the offsite power source and main turbine generator to the safety-related (4160V) busses. Detail of connection is described in North Anna Power Station FSAR Section 8.3.1.1.

The safety-related onsite power distribution system consists of two (2) 4160V switchgear busses in two separate systems designated as 'H' and 'J'. The bus 'H' is associated with train-A and bus 'J' is associated with train-B. The 4160V busses are electri-

cally and physically separated. The 4160V busses are rated at 1200 Amp continuous serving emergency loads through air circuit breakers equipped to protect the loads from an overcurrent condition.

Each 4160V switchgear bus feeds two (2) 480V switchgear busses 1H and 1H1 (or 1J and 1J1). These busses are rated at 2000 Amp continuous with overcurrent devices to protect the loads.

The 480V switchgear busses in turn feed several 480V motor control centers and 240/120V power panels as well as large 480V motors. The arrangement of 480V switchgear and motor control centers and associated loads are shown in Figure - 7 through 12.

In addition to the A.C. distribution system described above, the power distribution system is provided with a Vital A.C. (120V) power system and a 125V D.C. distribution system.

The Vital A.C. system provides a highly reliable source of 120V A.C. for safety-related instruments and equipments. The Vital A.C. power system is shown on Figures - 13 to 17 and 19, and is subsequently described in detail.

The 125V D.C. power system provides a reliable source of power for instrumentation and control of safety and nonsafety-related equipment for safe operation and shutdown of the plant. The 125V D.C. system is shown in Figure - 18 and is described in subsequent paragraphs.

b) <u>4160V Auxiliary System</u>

The two 4160V emergency busses 'H' and 'J' supply power to equipment essential for safe shutdown of the plant. These two

busses normally receive power from reserve service transformers through transfer busses F and D, respectively, which are the preferred sources. 4160V emergency busses are fed from two (2) preferred source feeder breakers. Upon loss of preferred source power to either of the emergency busses, an automatic transfer is initiated from the reserve station service transformer to its normal station service supply transformer. This transfer is initiated and completed during the interval between its associated diesel generator start signal and its designed closing time to the emergency bus. If the transfer is not completed in this interval, the transfer is aborted and the diesel generator is connected to the emergency bus as designed.

A proposed modification to this arrangement will remove the automatic transfer of the emergency busses from their preferred offsite source to the respective normal station service busses prior to loading to the emergency diesel generator. Instead, upon loss of offsite power, all transfer will be to the emergency diesel generator. Manual transfer capability between all three sources will be retained.

Unit-2 presently does not have feeders from station service busses to emergency busses. A proposed modification will install these offsite power feeders. Upon loss of offsite power, all emergency bus transfers will be to the emergency diesel generators. Manual transfer capability between all three sources will be available.

The 4160V emergency busses are of indoor, three phase, metal-clad construction with drawout magnetic air circuit breakers. The circuit breakers operate from 125V D.C. control power which is supplied by the safety-related 125V D.C. system.

Each of the emergency busses is protected against bus faults and uncleared outgoing feeder faults. Three inverse time over-current relays, one in each phase, and one ground protective

relay are located at the main and at each feeder breaker. Each of the feeder relays will trip its feeder breaker from its bus.

The setting of the long time characteristic relay unit for bus feeder breakers permits starting of the largest motor in the system with the safety busses carrying the total connected load. The pickup current of the relay is selected high enough to avoid false operation due to overload. Outgoing feeders from busses 'H' and 'J' are protected against feeder short circuit by three overcurrent relays having instantaneous and overcurrent element attachments. Additionally, feeder circuit to 4160V/480V transformer are protected by three overcurrent relays having instantaneous and voltage restrained overcurrent elements. The setting of the phase inverse overcurrent elements feeding 480V switchgear busses allows the starting of the largest motor while its transformer is carrying maximum nameplate load minus that of the largest motor. The 4160V motor feeders are equipped with three (3) inverse time relays having long time and instantaneous characteristics. The long time unit provides protection against abnormal strarting current so as to prevent the motor from reaching its thermal limit. The instantaneous element provides protection against high locked rotor current (set at approximately twice the motor rotor locked rotor current) while being below the maximum short circuit current available. In addition, the above emergency 4160V busses are each provided with three (3) undervoltage relays. These relays sense loss or degraded voltage at the bus and initiate tripping of the main supply and feeder breakers. Thus loads are shed from the emergency bus so that the diesel generator can then be connected to the emergency bus.

c) <u>480V Auxiliary System</u>

The 480V auxiliary system receives power from the 4160V system through dry-type, three phase, indoor transformers.

The 480V safety-related system consists of four (4) load centers, nine (9) motor control centers (MCC's), the safety and nonsafety-related loads and interconnection cables.

Feeder circuit breakers are 480V A.C. 2000 Amp or 600 Amp frame size, metal-enclosed, drawout construction. Control power is fed from safety-related 125V D.C. batteries. Feeder circuit breakers are provided with direct acting magnetic trip devices having long time and short time elements. The setting of the long time and short time elements for the MCC feeders allows starting of the largest motor at its MCC while its bus is carrying maximum load. The motor feeders are provided with direct-acting magnetic trip elements having long time and instantaneous characteristics. The long time element is set to trip the breaker during abnormal starting conditions, i.e., if the acceleration time of the motor exceeds the safe stall time (thermal limit). The instantaneous element trips the breaker from approximately twice locked rotor current up to the maximum short circuit available.

The 480V MCC's are provided with molded case circuit breakers having a thermal magnetic characteristic, and having 22000 Amp interrupting rating for the main breaker and 14000 Amp symmetrical interrupting rating for branch circuit breakers.

Motor feeders are provided with combination circuit breakers and magnetic starters having thermal overload relays. The overload element opens the contactor on motor overload. The instantaneous element of the molded case circuit breakers are set to protect against short circuit and high locked rotor current (approximately set at twice the locked rotor current).

d) <u>120/240VAC Distribution System</u>

The 120/240VAC distribution panels are fed from emergency Motor Control Centers (MCC's) feeding nonsafety and safety loads. Each panel bus is provided with a main molded-case

circuit breaker with thermal and magnetic trip elements. The branch circuit breakers are also of the molded-case type with thermal and magnetic trip elements.

e) <u>120 A.C. Vital A.C. Power Distribution System</u>

The vital A.C. power system consists of four separate vital bus panels, each fed independently from an associated 125V D.C./ 120V A.C. single phase static inverter. Each inverter's output is rated at 118V A.C. ± 2%, 60 Hz ± ½ Hz.

The inverters are connected to the batteries that are continuously float charged by the battery chargers; therefore, the effective power sources for the inverters are the 480V A.C. emergency busses. Should the effective power source to any battery charger fail, the inverter is automatically fed from its associated station battery without disturbing the vital bus voltage or frequency.

Voltage regulating transformers fed from 480V A.C. emergency busses are provided to supply 118V A.C. ± 2% to vital bus panels in the event either panel's respective inverter fails or is undergoing maintenance. For this purpose, manual bypass switches are provided to transfer the load of vital bus panels from the inverters to the voltage regulating transformers.

Four vital bus panels 1-I, 1-II, 1-III, and 1-IV supply 120V A.C. power to the plant protection system channels I, II, III, and IV, respectively. In addition, the vital bus panels 1-I and 1-III supply 120V A.C. power to the safety system trains A and B, respectively. Each vital bus panelboard is provided with a two pole 225 Amp frame size main breaker having thermal and magnetic trip elements. The branch circuit breakers are single pole 100Amp frame size with instantaneous and thermal trip elements.

f) 125 VDC Direct Current Power Distribution System

The D.C. system is designed to provide a source of reliable continuous power for plant protection system control and instrumentation and other loads for safe plant start-up, operation, and shutdown under normal and emergency conditions.

The D.C. system consists of four 60 cell 125V batteries, each with its own battery charger (plus two spare chargers), D.C. load center and distribution switchboards.

The 4 banks of batteries designated I, II, III, and IV, and their associated load centers and distribution panels have been arranged to feed the respective loads in protection channels I, II, III and IV. Additionally, Battery I and III supply power to safety train A and train B, respectively. The four redundant D.C. load centers also feed certain essential nonsafety-related loads. Each battery consists of series-connected cells, ungrounded and designed for continuous duty.

Each battery charger has a nominal output load current of 225 Amp at 132V D.C. and a maximum output current of 250 Amp with an input of 480 $\pm$ 15% V.A.C., three phase.

The battery chargers have been sized to furnish electric energy for the largest combined demands of the various steady state loads while restoring the battery from the minimum charged state to the fully charged state, irrespective of the status of the plant during which these demands occur. Each charger is equipped with a D.C. voltmeter and ammeter, ground detection, and alternating current failure relays.

Each battery distribution switchboard is NEMA Class II metal clad, with a 2500 Amp, two-wire ungrounded main bus, and two-pole, manually operated air circuit breakers. Each switchboard is provided with a noninterrupting ground-testing system for

those loads being fed from breakers rated at 100 Amp or less. Each switchboard provides the interconnection of the respective battery charger and battery to their particular loads.

Because the D.C. System operates ungrounded, at least two grounds are necessary to trip a feeder circuit breaker. Ground fault annunciation provides an opportunity to correct a fault condition before a second fault occurs.

Two lamps are provided on each distribution switchboard and main control board for ground detection indicating.

The D.C. System status is continuously displayed in the main control room and a periodic visual check is made of the status and equipment. A condition of low supply voltage, low output current, low output voltage, or ground fault of a particular battery charger will activate an alarm on the main control room board annunciator.

During normal operation, the 125V D.C. load is fed from the battery chargers with the batteries floating on the system. On loss of normal power to the battery chargers, the D.C. load is automatically fed from the station batteries. Each battery is rated and designed to operate all required loads for 2 hours during which time standby generation power is expected to become available to supply required D.C. loads through the battery chargers.

2. SURRY POWER STATION

Safety-Related Electrical Power Distribution System Description

a) General Description

The A.C. power distribution system for the Surry Power Station consists of various auxiliary power systems which provide reliable power to all auxiliary electrical loads sufficient for all starting, operating and shutdown conditions. The systems are provided with sufficient power sources, switching capability, circuit protection and redundancy to accomplish this reliability.

The voltage ratings of the A.C. power system are 4160V, 480V and 120/240V. The main one line diagram, Figure 20, shows the connection of offsite power source and main turbine generator to the safety-related (4160V) busses. Detail of connection is described in Surry Power Station UFSAR Sections 8.4 and 8.5.

The safety-related onsite power distribution system consists of two (2) 4160V switchgear busses in two separate systems designated as 'H' and 'J'. The bus "1H" is associated with train-A and bus "1J" is associated with train-B. The 4160V busses are electrically and physically separated. The 4160V busses are rated 1200 Amp continuous serving emergency loads through air circuit breakers equipped to protect the loads from overcurrent.

Each 4160V switchgear busses feeds two (2) 480V switchgear busses 1H and 1H1 (or 1J and 1J1). These busses are rated at 1600 Amp continuous. Overcurrent devices are installed on both the main and feeder 480V A.C. switchgear breakers for fault and overload protection.

The 480V switchgear busses in turn feed several 480V motor control centers and 240/120V power panels as well as large 480V motors. The arrangement of 480V switchgear and motor control centers and associated loads are shown in Figures 21 to 26.

In addition to the A.C. distribution system described above, the power distribution system is provided with a Vital A.C. (120V) power system and a 125V D.C. distribution system.

The Vital A.C. system provides a highly reliable source of 120V A.C. for safety related instruments and equipments. The vital A.C. power system is shown on Figures 28 and 29 and is described in detail in a paragraph which follows.

The 125V D.C. power system provides a reliable source of power for instrumentation and control of safety and nonsafety-related equipment for safe operation and shutdown of the plant. The 125V D.C. system is shown in Figure 27 and is described in subsequent paragraphs.

b) <u>4160V Auxiliary System</u>

The two 4160V emergency busses "IH" and "IJ" supply power to equipment essential for safe shutdown of the plant. These two busses normally receive power from reserve station service transformers through transfer busses F and D respectively, which are the preferred sources. 4160V emergency busses are then fed through a feeder breaker in the emergency switchgear.

The 4160V emergency busses are of indoor, three phase, metal-clad construction with drawout magnetic air circuit breakers. The circuit breakers operate from 125V D.C. control power which is supplied by the safety-related 125V D.C. system.

Each of the emergency busses is protected against bus faults and uncleared outgoing feeder faults. Three inverse time overcurrent relays, one in each phase and one ground protective relay, are located at the main and at each feeder breaker. Each of the feeder relays will trip its feeder breaker in the event of fault on the feeder circuit.

The setting of the long time characteristic relay unit for bus feeder breaker permits starting of the largest motor in the system with the safety busses carrying the total connected load. The pickup current of the relay is selected high enough to avoid false operation due to setpoint drifting while maintaining bus overload protection. Outgoing feeders from busses "IH" and "IJ" are protected against feeder short circuits by three overcurrent relays having instantaneous and overcurrent element attachments. The setting of the inverse overcurrent elements feeding 480V switchgear busses allows the starting of the largest motor while its transformer is carrying maximum nameplate load minus that of the largest motor. The motor feeders are equipped with three (3) inverse time relays having long time and instantaneous characteristics. The long time unit provides protection against abnormal starting current so as to prevent the motor from reaching its thermal limit. The instantaneous element provides protection against high locked rotor current (approximately set at twice the motor rotor locked rotor current) while being below the maximum short circuit current available. In addition to the above, emergency 4160V busses are each provided with three (3) undervoltage relays. These relays sense loss or degraded voltage at the bus, initiate tripping of the main supply breaker and initiate loading of the diesel generator to the emergency bus.

c) <u>480V Auxiliary System</u>

The 480V auxiliary system receives power from the 4160V system through dry-type, three phase, indoor transformers.

The 480V safety-related system consists of four (4) power centers, eight (8) motor control centers (MCC's), the safety and nonsafety-related loads and interconnection cables.

Feeder circuit breakers are 1600 Amp or 600 Amp frame size. All breakers are of metal-enclosed, drawout construction. Control power is fed from safety-related 125V D.C. batteries. Feeder circuit breakers are provided with direct acting magnetic trip devices having

long time and short time elements. The setting of the long time and short time elements for the MCC feeders allows starting the largest motor at its MCC while its bus is carrying maximum load. The motor feeders are provided with direct-acting magnetic trip elements having long time and instantaneous characteristics. The long time element is set to trip the breaker during abnormal starting conditions, i.e., if the acceleration time of the motor exceeds the safe stall time (thermal limit). The instantaneous element trips the breaker from approximately twice locked rotor current up to the maximum short circuit available.

The 480V MCC's are provided with molded case circuit breakers having a thermal magnetic characteristic, and having 22000 Amp interrupting rating for the main breaker and 14000 Amp symmetrical interrupting rating for branch circuit breakers.

Motor feeders are provided with combination air circuit breakers and magnetic starters having thermal overload relays. The overload element opens the contactor on motor overload. The instantaneous element of the molded case circuit breakers are set to protect against short circuit and high locked rotor current (approximately set at twice the locked rotor current).

d) <u>120/240VAC Distribution System</u>

The 120/240V A.C. distribution panels are fed from emergency MCC's feeding nonsafety and safety loads. Each panel bus is provided with a main molded case circuit breaker with thermal and magnetic trip elements. The branch circuit breakers are also of the molded case type with thermal and magnetic trip elements.

e) <u>120 A.C. Vital A.C. Power Distribution System</u>

The vital A.C. power system consists of four separate vital bus panels - two of which (busses II and III) are independently fed from an associated 10KVA 125V D.C./120V A.C. single phase static inver-

ter. Each inverter's output is rated at 120V A.C. ± 6V, 60 Hz ± ½ Hz. The remaining two vital busses (I and IV) are supplied by independent 10KVA, sola voltage regulating transformers energized from separate 480 V A.C. emergency busses.

The inverters are connected to the batteries that are continuously float charged by the battery chargers; therefore, the effective power sources for the inverters are the 480V A.C. emergency busses. Should the effective power source to any battery charger fail, the inverter is automatically fed from its associated station battery without disturbing the vital bus voltage or frequency.

Voltage regulating transformers fed from 480V A.C. emergency busses are provided to supply 120V A.C. to vital bus panels in the event either panel's respective inverter fails or is undergoing maintenance. For this purpose, manual bypass switches are provided to transfer the load of vital bus panels from the inverters to the voltage regulating transformers. Similarity on loss of regulating transformer, inverters can supply power to loads on busses I or IV. The vital bus panels 1-I and 1-III supply 120V A.C. power to the safety system trains A while panels 1-II and 1-IV supply power to safety system train B, respectively. All four vital bus panels 1-I, 1-II, 1-III, and 1-IV supply 120V A.C. power to the protection system channels I, II, III, and IV, respectively. The main breaker for each vital bus panelboard is a two pole 225 Amp frame size breaker with thermal and magnetic trip elements. The branch circuit breakers are single pole 100Amp frame size with instantaneous and thermal trip setting.

The 120V, 60Hz output from each inverter and the sola regulating transformers is ungrounded. Instrumentation is provided to detect an accidental ground. A ground on one phase does not interrupt service and, with multiple channels, it is possible to correct the ground fault without tripping the reactor or sacrificing protection.

The vital bus battery chargers and inverters are assembled from high-quality components, conservatively designed for long life and continuous operation. By avoiding the use of electromechanical

devices, routine maintenance downtime is greatly reduced. There are no vacuum tubes or moving parts in the completely static vital bus supply system. Magnetic amplifiers, transistors, and silicon rectifiers are used to provide trouble-free operation.

f) 125 VDC Direct Current Power Distribution

The 125V DC batteries supply power for operation of turbine-generator emergency auxiliaries, switchgear, annunciators, vital bus inverters, and emergency lighting.

It is therefore a source of reliable continuous power for plant protection system control and instrumentation and other loads for safe plant start-up, operation, and shutdown under normal and emergency conditions.

The D.C. system consists of two 60 cell 125V batteries, each with two battery chargers, its own D.C. load center and distribution switchboards.

Normally, the two battery bus sections are operated independently, with the bus tie breaker open. Each charger supplies power for operation of equipment connected to that bus section and maintains a floating charge on its associated battery. The manually operated bus tie breaker provides for parallel operation of the chargers and batteries or operation with either battery or charger out of service for maintenance.

The four static battery chargers (two per 125V D.C. bus) are identical, each having an output of 300 Amp at 132V D.C. voltmeter, ammeter, ground detector, A.C. failure relay, and low charging current alarm relay. Loss of A.C. or low charging current is alarmed in the control room. Battery ground indicators are located in the control room. Battery voltage is indicated to the operator by annunicators and continuously recorded on recorders located in the emergency switchgear room. The battery chargers are energized from emergency motor control centers.

The battery distribution switchboards are NEMA Class II metal-clad structures, each with a 125V, two-wire underground main bus, and two-pole manually operated air circuit breakers.

During normal operation, the 125V D.C. load is fed from the battery chargers with the batteries floating on the systems. The batteries are sized for 2 hour of operation during or after which it is expected that station power or emergency generation power will be available to energize the battery chargers.

XII Design Evaluation

A. Introduction

A review of the North Anna and Surry Power Station one line diagrams indicates that there exists certain non-Class IE loads connected to busses feeding the Class IE loads. A review was then conducted to determine which of these loads are in an area subject to a design basis accident environment, in accordance with the guidelines provided in Section VIII-Specific Review Methodology.

Tables 1 and 2 have been prepared based on this review and present a list of non-Class IE loads, as described above, in North Anna and Surry Power Stations, respectively, which are considered to be of concern. Review so far indicates that these loads are connected to the Class IE busses through properly selected and coordinated circuit protective devices, such as circuit breakers. The criteria governing the selection of ratings and sizes of these breakers which forms the boundary between safety and nonsafety circuits, is based on reducing the affect on a Class IE system due to a fault occurring at these non-Class IE equipment. For example, the trip setting of the breaker closest to the device is selected to trip prior to the pick up setting of the main supply breaker. Typical analyses of each station's loads listed on Table 1 and 2 are provided below to demonstrate that the connection of these loads to Class IE busses are in accordance with criteria described in preceeding paragraphs and that the impact on the Class IE system remains within acceptable limits.

B. North Anna Power Station:

1) 4160V Auxiliary System:

Review of Table-1 indicates that there is one non-Class 1E 4160V load, namely one Residual Heat Removal Pump 300HP Motor connected to each of the emergency switchgear buses-1H and 1J, which could be subjected to a potentially harsh environment due to an accident.

A review of the North Anna Power Station FSAR indicates that during a CDA/CLS signal the Residual Heat Removal Pump is automatically shed from its emergency bus. The tripping circuit is designed to prevent single failure, as the tie breaker feeding both RHR pump and component cooling pump is also tripped by a SIS. Additionally, the Residual Heat Removal pump is fed through a properly selected and coordinated circuit breaker, which will trip in the event of an electrical fault prior to the tripping of the main feeder breaker to its emergency bus.

Based on the above discussion it is evident that the Class-1E system can not be impacted due to an environmentally induced failure of a RHR pump motor caused by harsh environment resulting from an accident.

It should be noted that 4160V one line diagram Figure - 7 incorrectly indicates that RHR pumps are safety-related, which will be corrected in the continued review process undertaken by VEPCO.

2) 480V Auxiliary System:

i) Review of Table-1 indicates that the 480V emergency buses 1H1 and 1J1, each feeding two (2) non-Class 1E loads-namely the Containment Recirculating Fan and Pressurizer Heater backup groups, which can be subjected to the impact of harsh environment resulting from an accident.

A detailed review of the control circuitry for the Containment Recirculating Fan indicates that the breaker feeding these motors are tripped on a CDA/CLS signal. Therefore, these loads are essentially disconnected from the safety system during an accident and cannot degrade the safety system.

The pressurizer heater backup group control panels are located in a area exposed to a mild environment. However, these panels subfeed individual heaters located at potentially harsh areas. The circuit feeding an individual group of heaters is again protected by an individual circuit breaker at the panel having a lower trip rating than that of the feeder breaker at the control panel. It is therefore believed that a fault in the circuit will trip the heater load breaker before it could trip the supply breaker from the bus. Chances of two (2) breakers failing to trip, and thus causing the 480V main supply breaker to trip, is further minimized due to proper coordination between the 480V supply breaker to the bus and the load breaker. Typical coordination for these loads, as applicable in Surry Station, are provided in Figures 34 and 35.

It is noted that Figure - 8 incorrectly indicates that these loads are Class 1E, which will be corrected in the continued review process discussed in this report.

ii) 480V Motor Control Centers (MCC's). Review of Table-1 indicates that there are several non-Class IE loads connected to various Class IE MCC's. Typically these loads are for feeds to distribution panels, power supply for an instrumentation system or power for motor operated valves. These circuits, except for MOV's, usually contribute a small amount of energy during an electrical fault condition. In addition the distribution panel feeds are provided with a single phase transformer, whose impedance will further reduce the available short circuit current. For circuits

feeding motor operated valves, the circuit breaker trip ratings are selected so that it will coordinate with the upstream breaker during a fault. Furthermore, a review of control circuitry for a typical motor operated valve indicates that the power supply circuit to the actuator is deenergized upon completion of valve strokes, which may range anywhere from 5 to 30 seconds. Therefore, even in case of a fault, the time the fault will remain in the system is sufficiently small so as to prevent exceeding the inherent time delay allowed in the coordination between the primary feeder breaker and the MCC bus breaker.

The above indicates that an electrical fault in circuits or equipment shown on Table 1 is of little significance. Good engineering practice requires that all load breakers be properly coordinated. Initial assessment of North Anna Station indicates that MCC load breakers are properly coordinated to clear the fault with minimum impact to the overall system.

Attached Figures 30 to 33 show the time current characteristics and settings for subject MCC's and demonstrates that applicable criteria stated in previous paragraphs are reasonably met.

The objective of these curves is to show that the largest load in the MCC (i.e., breaker with largest trip rating), which will see the maximum short circuit overcurrent, is co-ordinated with the primary breakers at the 480V switchgear feeding the MCC. Thereby, it is then established that all other breakers with a trip rating below the largest one will trip prior to the primary breaker.

A brief discussion is presented below for each curve.

Figure - 30 MCC 1H1-1 and MCC 1J1-1

MCC 1H1-1 is fed from 480V Switchgear Bus '1H' through a 600 Amp drawout circuit breaker, ITE type K-600 having a 600 Amp, type OD-4 dual (long-time and short-time) over-current element (1-Figure-30). The long time element of this device is set at the maximum continuous current rating of the circuit breaker, 600 Amp, and the minimum band is selected. The short time element should be set at minimum delay and at a trip setting slightly higher than the instantaneous trip setting of the largest breaker on the motor control centers. Curve 1 for the largest breaker on the MCC shows that the short time setting is to be set above 2400 Amp. This is set at 2600 Amp minimum band (approximately 5 times the long time setting). The sub-station transformer secondary breaker feeding the 480V switchgear bus is shown on curve 3. Minimum usable settings are utilized, so that this curve coordinates with the downstream 480V switchgear feeder breaker to its downstream MCC. The long time element is set at 120 percent of the coil rating.

Curve 1 shows the largest feeder on MCC 1H1-1, which has a 200 Amp trip, Klocker-Moeller molded case circuit breaker, type NZMH9-250, ZM9-225-2400A.

It can be seen that curve 2 for 480V feeder breaker to MCC1H-1, is entirely behind the curve 1 (the largest feeder) and will coordinate with all thermal magnetic breakers on the MCC. Curve 3 is coordinated with curve 2 so that in the event of a MCC 'breaker failure' only the specific 480V breaker feeding the MCC will trip and not the substation transformer secondary breaker.

Figure-31 MCC 1H1-4

MCC 1H1-4 is fed from 480V Switchgear Bus '1H' through a 600 Amp drawout circuit breaker type ITE, K-600 having a 600 Amp, type OD-4 dual (long time and short time) over-current element. The largest load in the MCC is the 60HP control room chiller which is therefore utilized for co-ordination purposes. This load is fed from the MCC through a 225 Amp frame size, 160 Amp trip rated, Klockner-Moeller molded case circuit breaker, type-NZN9-250/ZM9-225-2400, having thermal-magnetic trip elements. Principles of setting these devices are similar to that described in Figure 4.

It can be seen that curve 2 is behind curve 1, i.e., the largest size breaker at the MCC, and will therefore co-ordinate with all other thermal-magnetic breakers at the MCC.

Figure-32 MCC 1J1-2N and MCC 1J1-2S and
Figure-33 MCC 1H1-2N and MCC 1H1-2S

The basis for these figures is similar to that described for Figures 30 and 31. Each 480V MCC feeder is coordinated with its largest MCC load, thereby ensuring that the load breaker will trip before the feeder breaker. For MCC-1J1-2S, the largest load breaker considered is the 130 Amp trip rated, 225 Amp frame size breaker for the control rod cooling fan, and for MCC 1H1-2N, the largest load breaker considered is the 160 amp trip rated, 225 Amp frame size breaker for the 100 HP spent fuel pit pump. These breakers are provided with an instantaneous element and a thermal overload element which coordinate with the motor starter protective equipment.

The above discussion demonstrates that the protective devices at and below the MCC's are adequately selected so that a failure of non-Class IE loads (i.e., loads described in Table 1) will cause the tripping of their upstream load breakers, and therefore will not degrade the Class IE power system. Furthermore, the chances of having a failure of the load breakers are considerably reduced as all breakers at the safety related busses are procured under a strict quality assurance program in conformance with 10CFR50, Appendix B, applicable to safety-related equipment located in the mild environment.

3) 120VAC Vital Bus Power Distribution System

Review of Table 1 indicates that a few non-Class 1E loads which could be subjected to a harsh environment due to a design basis accident are connected to the same power supply source as those used for Class 1E loads. Review so far indicates that only one of the four redundant 120V A.C. vital power busses fed directly from 125VDC/120VAC inverters, with arrangement for alternate power supply from 480 Volt motor control centers, could be adversely affected.

The normal source of power supply to these busses are the inverters, which restrict the output power flow to 160% of their nominal rating. Therefore, in case there is a fault in the loads described in Table 1, the inverters are adequately protected. In the event of an inverter failure, the power would be automatically transferred to the normal A.C. power source from the connected 480V MCC through a 480/120V regulating transformer. The transformer provides sufficient impedance (approximately 2.5% at rated 10KVA base) so as to reduce the amount of fault current available to its downstream system.

The above discussion demonstrates that environmentally induced failures of non-Class 1E loads will not have sufficient capabililty to degrade the Class 1E system to the point whereby performance of safety function can not be accomplished. It has, however, been decided that a complete review of the North Anna Power Station 120VAC Vital Power Distribution System will be initiated to further verify the adequacy of every circuit, not withstanding its classification as safety or nonsafety-related. Upon completion of this review, its findings, including the need for modifications, if any, will be made available to NRC.

4) 125V D.C. Distribution System

Review of Table 1 indicates that certain non-Class 1E loads, consisting of the fire protection system and emergency lighting which can be influenced by design basis accident environment following an accident, are connected to the same power supply that is used by a Class 1E system.

Emergency lighting circuits are energized only during the time duration between loss of offsite power and connection of the diesel generator. Upon availability of diesel generator, these circuits are automatically disconnected. Therefore, chances of failure occurring at the same time are considered improbable.

Other involved circuits are for the fire protection system which is energized in the event of a fire. Failure of these circuits during an accident condition, while energized, is not considered a postulated event.

However, the 125V D.C. system, in general, is designed to limit the consequence of an electrical fault. The D.C. system protection main and feeder breakers are of the molded case thermal magnetic breaker type. The upstream main (battery charger supply breaker) molded case supply breaker will selectively coordinate, if the short circuit current value at the downstream thermal magnetic device is suffi-

ciently less than the magnetic trip setting of the upstream breaker. The magnetic element provides instantaneous tripping at 4 to 10 times the thermal trip rating which is set at the factory (nonadjustable).

Additionally, the occurrence of a short circuit on the branch circuit, which could also cause tripping of the main breaker, is unlikely due to the following reasons:

- o Battery short circuit current is believed to be substantially less than 10 times the one minute rating.
- o Due to the 125V D.C. ungrounded system design, the chances of a short circuit occuring are improbable.
- o Bolted faults are virtually impossible except on first closing a supply breaker following maintenance. Even small values of fault resistance will substantially reduce the fault current.

The above discussion indicates that design of each safety-related D.C. system is such that degradation of each Class 1E D.C. electrical system due to the failure of one or more non-Class 1E circuits is improbable. It has, however, been decided that a complete review of the North Anna Power Station D.C. system will be initiated to further verify the adequacy of every circuit, not withstanding its classification as safety or nonsafety-related. Upon completion of this review, its findings, including the need for modifications, if any, will be made available to NRC.

C. SURRY POWER STATION

1) 4160V Auxiliary System

Review of Table-2 indicates that there is one non-Class 1E 4160V load, namely one Residual Heat Removal Pump 300HP Motor connected to each of the emergency switchgear buses-1H and 1J, which could be subjected to a potentially harsh environment due to an accident.

It is expected that in the event of an electrical fault, resulting from an accident, the RHR pumps will be isolated prior to causing an electrical disturbance to the safety-related busses. This expectation is based on a review of electrical system design and the determination that 4160V load breakers are properly coordinated with the supply breaker to the bus.

Based on the above discussion it is evident that the Class-1E system can not be impacted due to an environmentally induced failure of a RHR pump motor caused by harsh environment resulting from an accident.

2) <u>480V Auxiliary System</u>

i. 480V Switchgear Busses.

Review of Table-2 indicates that 480V Emergency Busses 1H and 1J feed non-Class 1E Containment Recirc. Fans 1-VS-F-1A and 1-VS-F-1B, respectively, which are located in areas subject to harsh environment resulting from an accident.

Each of these loads (125 HP) is fed from the emergency bus through a 600 Amp drawout circuit breaker, ITE type K-600, having a type OD-6 (long time and instantaneous) overcurrent element with a 200 Amp coil rating. The feeder breaker to the 480V bus 1H and 1J from the 4160V bus 1H and 1J, respectively, is a ITE type K 600 draw-out circuit breaker having a OD-4 dual (long time and short time) overcurrent element with 1600 amp coil rating.

Figure 34 shows plots of time-current characteristic of these breakers. Curve 1 represents the load breaker. The instantaneous element is set at 2000 Amp at intermediate band (approximately 173% of motor locked rotor current) and the long time element is set at 120% of full load current.

Curve 2 shows the feeder breaker to the bus, whose long

time element is set at 120% of coil rating at minimum band and whose short time element is set at 400% of coil rating at maximum band.

As can be seen in Figure 34, curve 2 is entirely behind curve 1 and will allow tripping of the load breaker prior to tripping of the main feeder breaker to the bus for fault at the load side.

In addition to the above load, the emergency 480V switchgear also feeds the non-Class 1E pressurizer heater backup group control panel from each bus. Although located in a mild environment, this panel subfeeds individual heaters located at potentially harsh areas. However, as the circuit feeding an individual group of heaters is again protected by an individual circuit breaker at the panel with a lower trip rating than that of the feeder breaker at the control panel, it is believed that a fault in the circuit will trip the heater load breaker before it could trip the supply breaker from the bus. Chances of two (2) breakers failing to trip and causing a trip of the 480V main supply breaker to the bus is further minimized due to proper coordination among the 480V supply breaker to the bus and load breaker as shown on Figure 35.

The above discussion demonstrates that 480V emergency switchgear busses are adequately designed to protect against a fault occuring at the non-Class 1E equipment.

ii. 480V Motor Control Centers (MCC's). Review of Table 2 indicates that there are several non-Class 1E loads connected to Class 1E motor control centers.

Each of these loads are protected by a carefully selected and coordinated breaker. Feeder breakers to each affected MCC (MCC-1H1-1, 1H2-1, 1J1-1 and 1J1-2) are provided with a draw-

out circuit breaker having a long time and short time element while the load breakers are molded case thermal magnetic type. For motor loads, a combination breaker and starter is provided. The magnetic element of the breaker protects against short circuit and abnormal starting conditions, while the thermal overload device at the starter protects against the thermal overload of the motor.

A typical coordination between load breaker with the largest trip rating at the MCC and its corresponding feeder breaker to the MCC at the 480V switchgear is shown in Fig 36.

As shown on the curve, the feeder breaker to MCC is properly coordinated with the largest load breaker and thereby will coordinate with all other smaller rated breakers.

Above coordination ensures that emergency MCC's are adequately protected against a fault at the connected nonsafety-related equipment and therefore prevents a failure of the overall Class 1E system.

3) <u>120VAC Vital Bus Distribution System</u>

There is no equipment of concern on 120VAC Vital Busses 1-I, 1-II, 1-III, 1-IV and likewise for Unit 2.

4) <u>125V D.C. Distribution System</u>

Review of Table - 2 indicates that certain non-Class 1E loads, such as those involving the fire protection system and emergency lighting- and which can be influenced by design basis accident environment following an accident, are connected to the same power supply that is used for Class 1E system.

Emergency lighting circuits are energized only during the time duration between loss of offsite power and connection of the diesel gener-

ators. Upon availability of the diesel generator, these circuits are automatically disconnected. Therefore, chances of failure occurring at the same time is considered improbable.

Other involved circuits are for the fire protection system which is energized in the event of a fire. Failure of these circuits during an accident condition, while energized, is not considered a postulated event.

However, the 125V D.C. system, in general, is designed to limit the consequence of an electrical fault. The D.C. system protection main and feeder breakers are of the molded case thermal magnetic breaker type. The upstream main (battery charger supply breaker) molded case breakers will provide coordination if the short circuit current value is below the downstream thermal magnetic device rating and also is sufficiently less than the magnetic trip setting of the upstream breaker. The magnetic element provides instantaneous tripping at 4 to 10 times the thermal trip rating set at the factory (nonadjustable).

Additionally, the occurence of a branch feeder-located short circuit which would cause tripping of the main breaker is unlikely due to the following reasons:

- Battery short circuit current is believed to be substantially less than 10 times the one minute rating.
- Due to the 125V D.C. ungrounded system design, the chances of a short circuit occuring are small.
- Bolted faults are virtually impossible except on first closing a supply breaker following maintenance. Even small values of fault resistance will substantially reduce the fault current.

The above discussion indicates that design of each safety related D.C. system is such that degradation of each class 1E D.C. electrical system due to the failure of one or more non-class 1E circuits is improbable. It has, however, been decided that a complete review of

the Surry Power Station D.C. system will be initiated to further verify the adequacy of every circuit, not withstanding its classification as safety or non-safety related. Upon completion of this review, its findings, including the need for modifications, if any, will be made available to the NRC.

D. Additional Assurance

In addition, the initial design evaluation for both North Anna and Surry Power Stations demonstrates that the implementation of the applied design, operation and maintenance criteria, which follows, provide additional assurance that safety-related electrical systems are not degraded beyond their acceptable limit:

a) In the event of an accident signal (CDA/CLS), tripping of certain of the nonsafety-related loads is initiated-except for those required for prevention of damage to major plant equipment and equipment required to maintain safe operation such as emergency lighting. These breakers are tripped and locked out in the open position. Reclosure of these breakers can only be accomplished manually under strict administrative control.

b) All equipment which is part of the Class 1E system are procured under the strict quality assurance criteria of the plant which conform to the requirement of 10CFR50, Appendix B.

c) Controlled surveillance and maintenance methods, such as breaker test, accuracy measurement, and insulation test are utilized to reduce the occurrence of malfunction in safety-related electrical systems.

d) Plant monitoring and status indication provides sufficient early warning to plant operating personnel so that affected non-safety circuits are isolated prior to causing damage to the safety system.

e) For nonsafety related components, although quality assurance criteria were not applicable, good engineering and operating practice dictates application of a systematic procurement and

maintenance process. For example, cables (safety-related and nonsafety-related) are procured under the same strict quality control criteria.

Finally, the scope of this review has concentrated on electrical power system interconnection. In addition, a review is being continued to assure that there are no nonsafety- related equipment connections to safety-related electrical control circuits such that any nonsafety-related equipment malfunction or inadvertent operation will effect the functional capability of the safety-related equipment. Examples of typical control circuits reviewed are the steam generator high level signal for feedwater isolation and the charging pump lube oil pressure circuits.

X DOCUMENTATION REVIEWED

The documentation reviewed on North Anna and Surry Power Stations included the updated FSARs, the IEB 79-01B submittals (Surry 1&2, North Anna 1) and NUREG 0588 Category II submittal (North Anna 2), plant electrical specifications, plant electrical one line diagrams, available short circuit and coordination calculations, and physical arrangement drawings.

A specific list of the significant documents reviewed is included as/ or part of Appendices B and D and Figures 6 to 36.

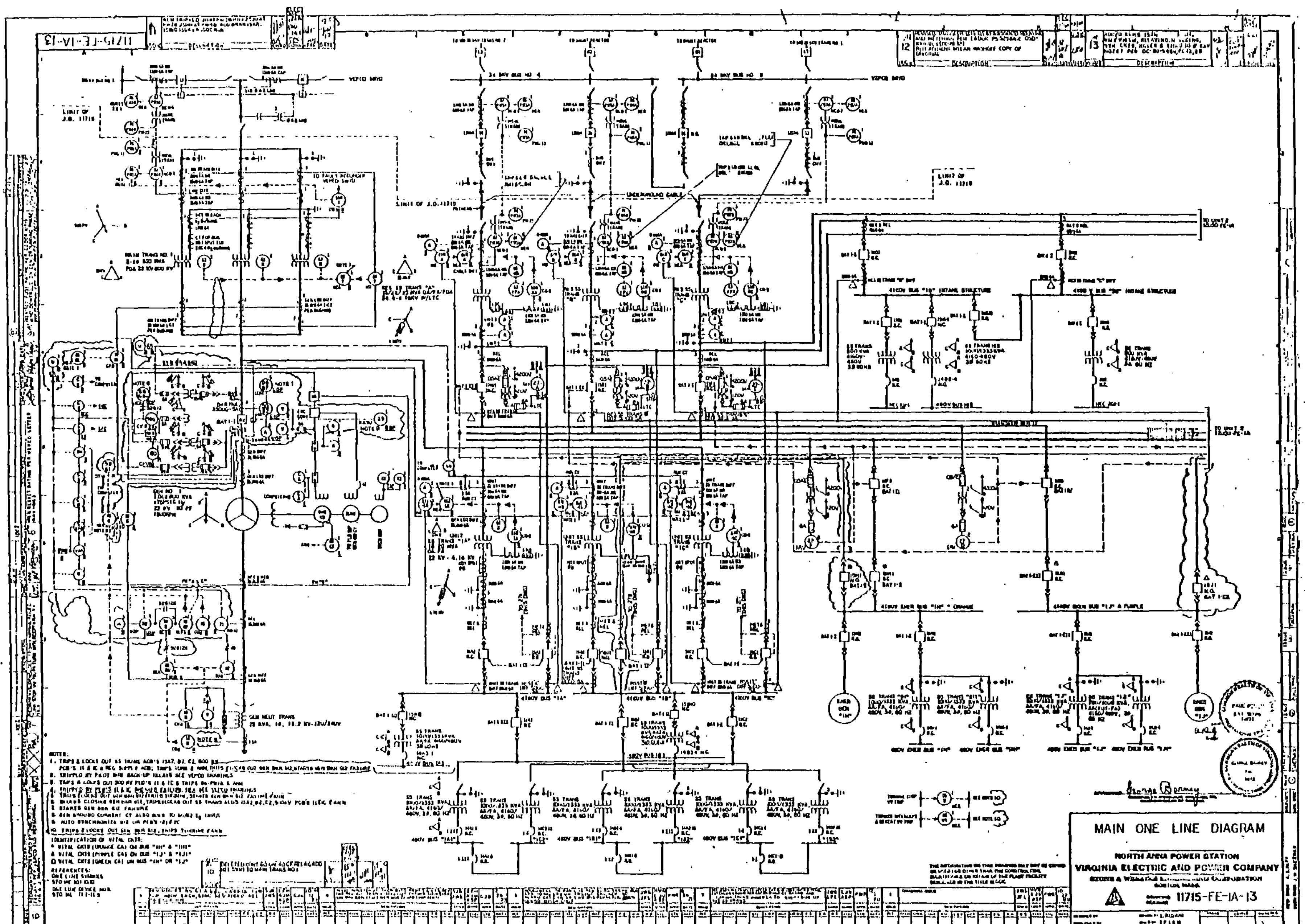
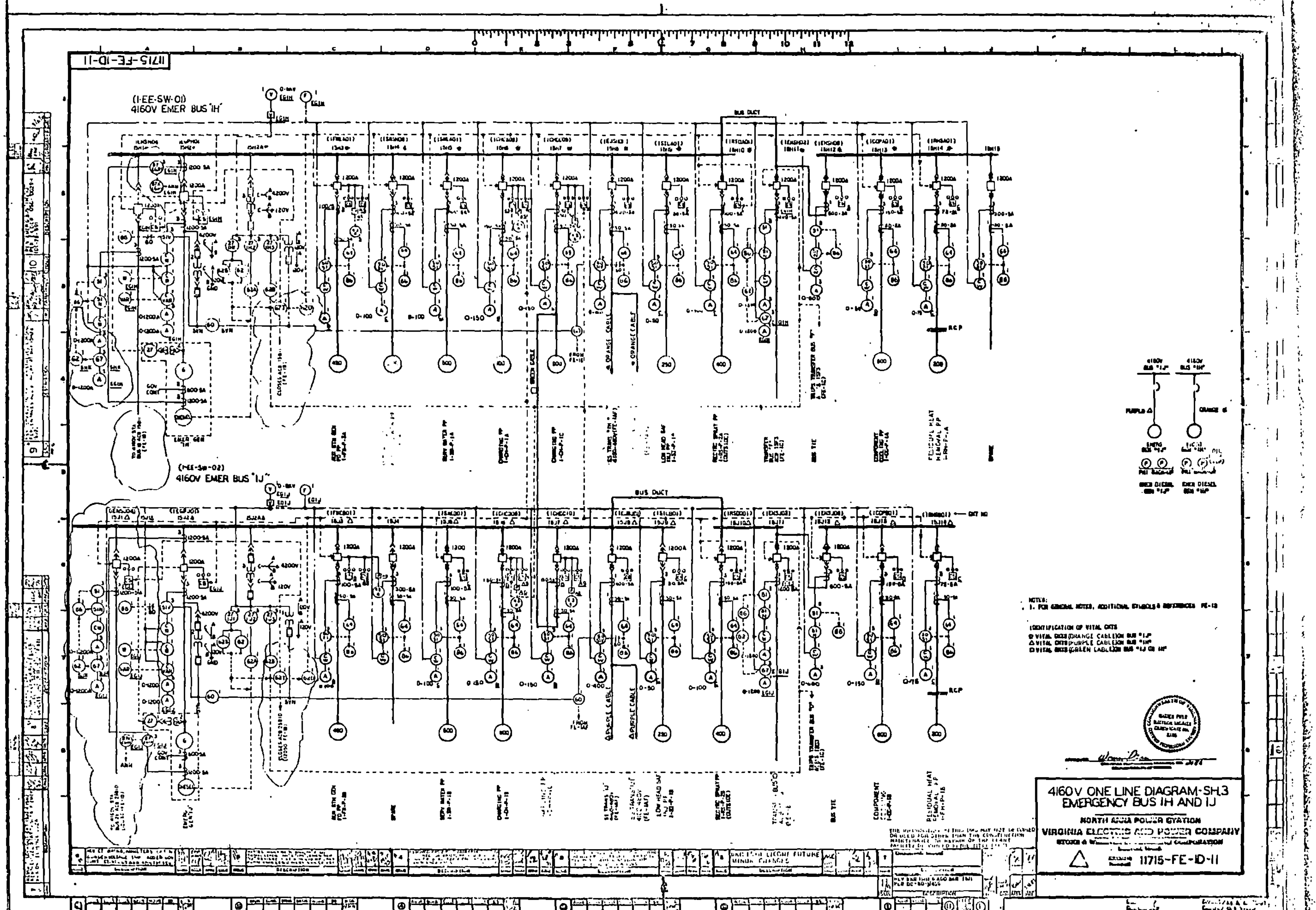

MAIN ONE LINE DIAGRAM
NORTH ANNA POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11715-FE-1A-13

Figure 6


11715-FE-1D-11
(1-EE-SW-01)
4160V EMER BUS "1H"
(1-EE-SW-02)
4160V EMER BUS "1J"
BUS DUCT
4160V ONE LINE DIAGRAM-SH.3
EMERGENCY BUS 1H AND 1J
VIRGINIA ELECTRIC AND POWER COMPANY
11715-FE-1D-11

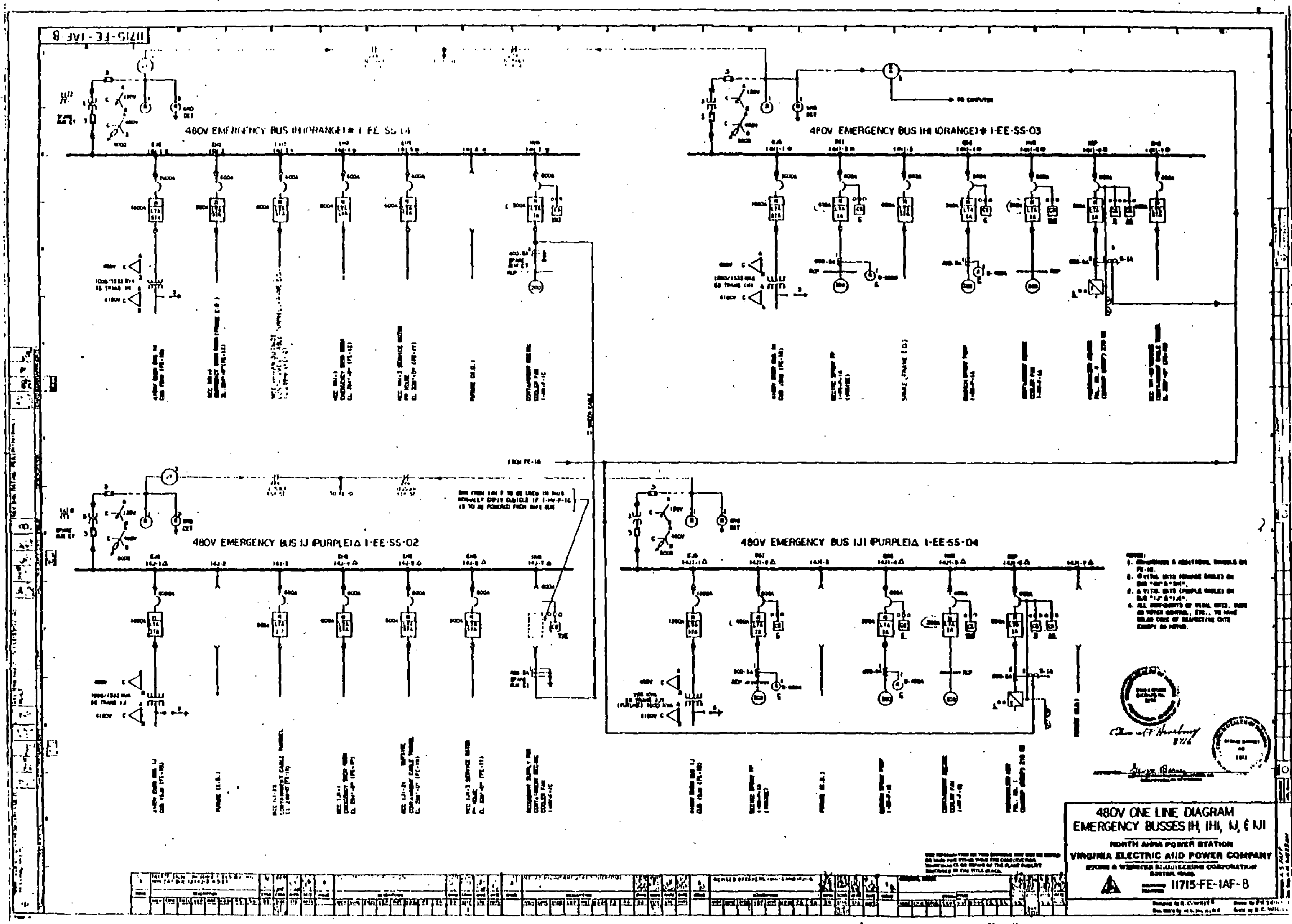
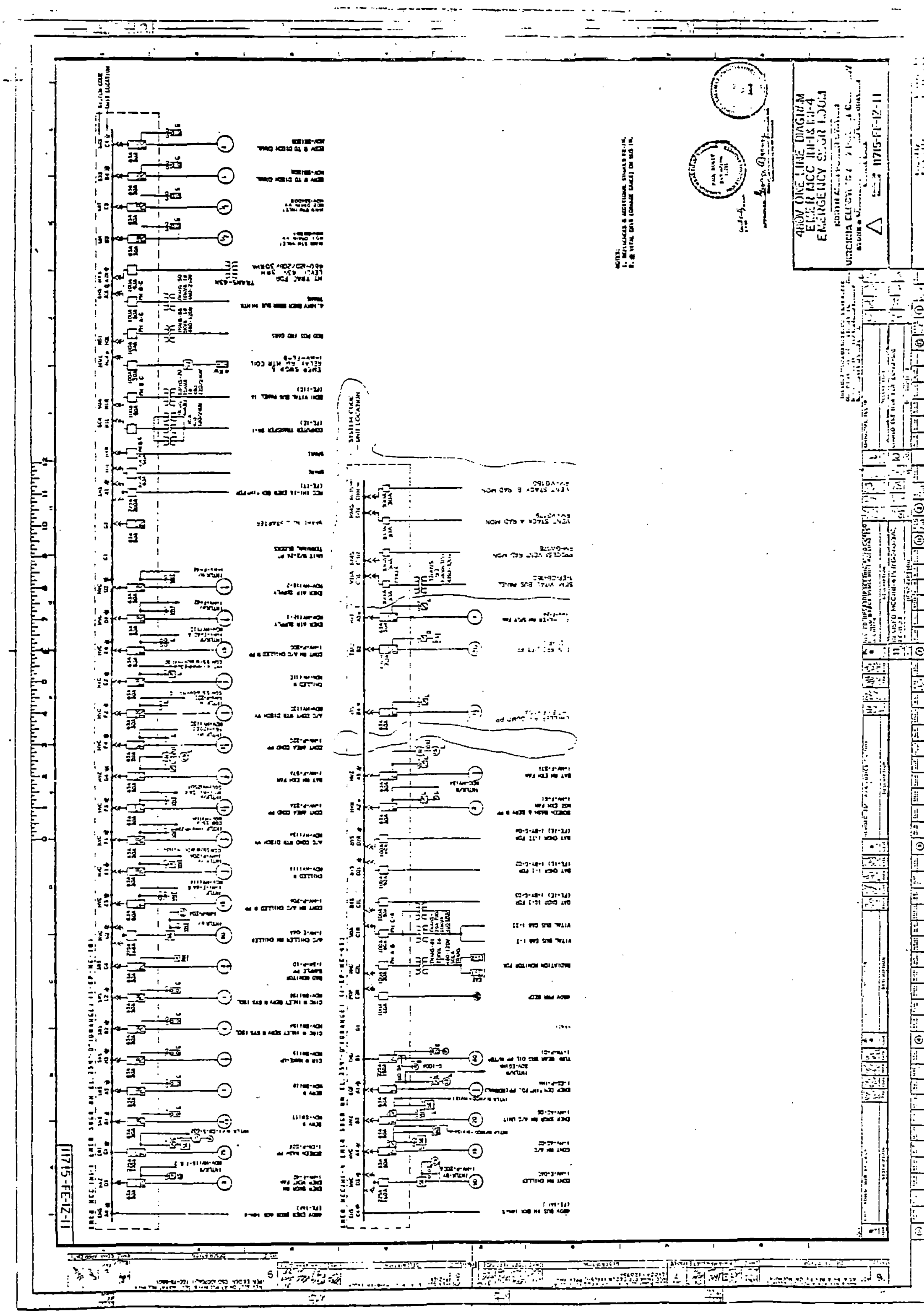
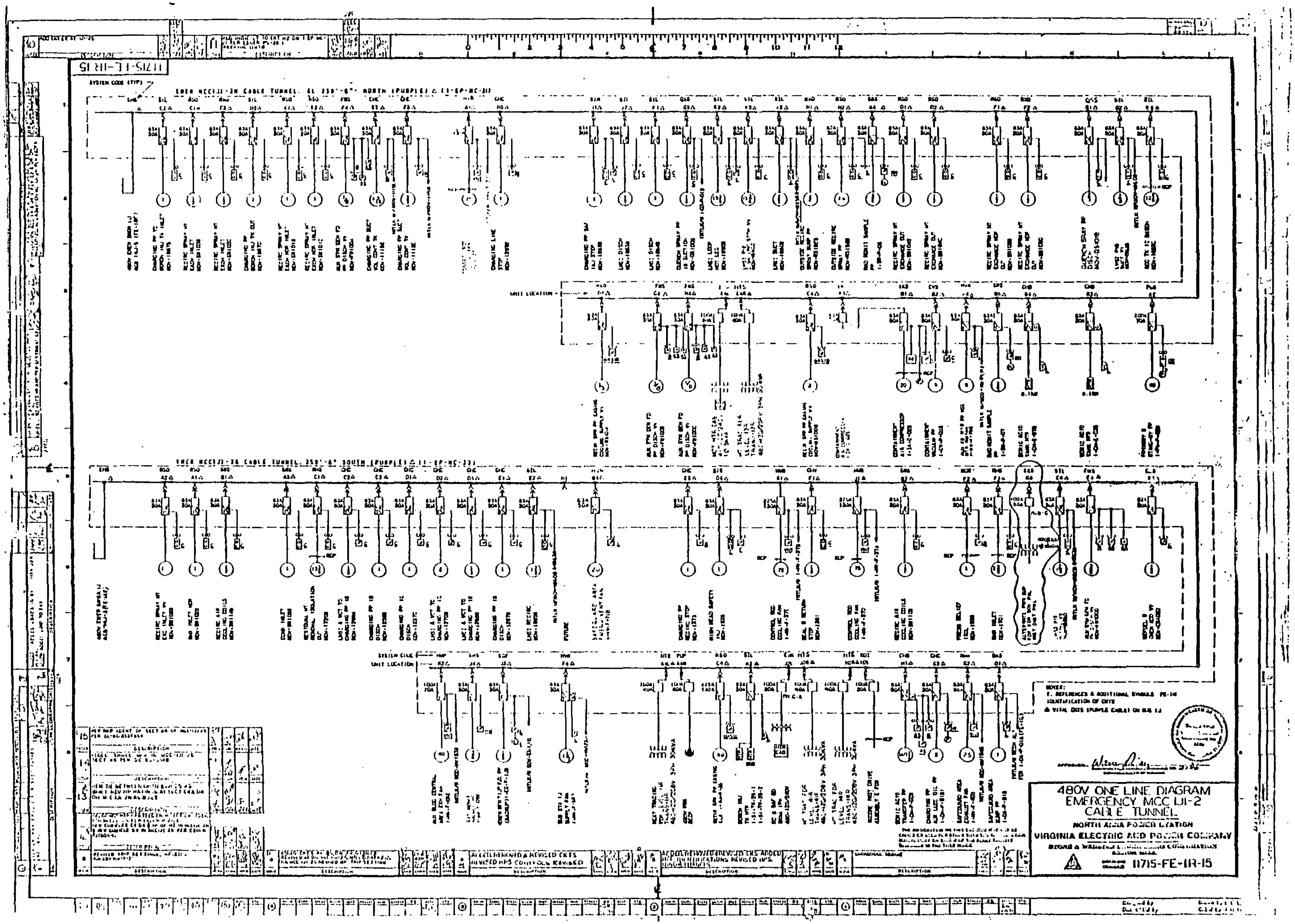

11715-FE-1AF-8
480V EMERGENCY BUS 1H (ORANGE)● 1-EE-SS-01
4P0V EMERGENCY BUS 1H1 (ORANGE)● 1-EE-SS-03
480V EMERGENCY BUS 1J (PURPLE)Δ 1-EE-SS-02
480V EMERGENCY BUS 1J1 (PURPLE)Δ 1-EE-SS-04
TO COMPUTER
480V ONE LINE DIAGRAM
EMERGENCY BUSSES 1H, 1H1, 1J, & 1J1
NORTH ANNA POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11715-FE-1AF-8

Figure 7

Figure 8


480V ONE LINE DIAGRAM
EMERGENCY SWGR ROOM
VIRGINIA ELECTRIC
11715-FE-1Z-11



480V ONE LINE DIAGRAM
EMERGENCY MCC 1J1-2
CABLE TUNNEL
NORTH ANNA POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11715-FE-1R-15

Figure 9

Figure 10

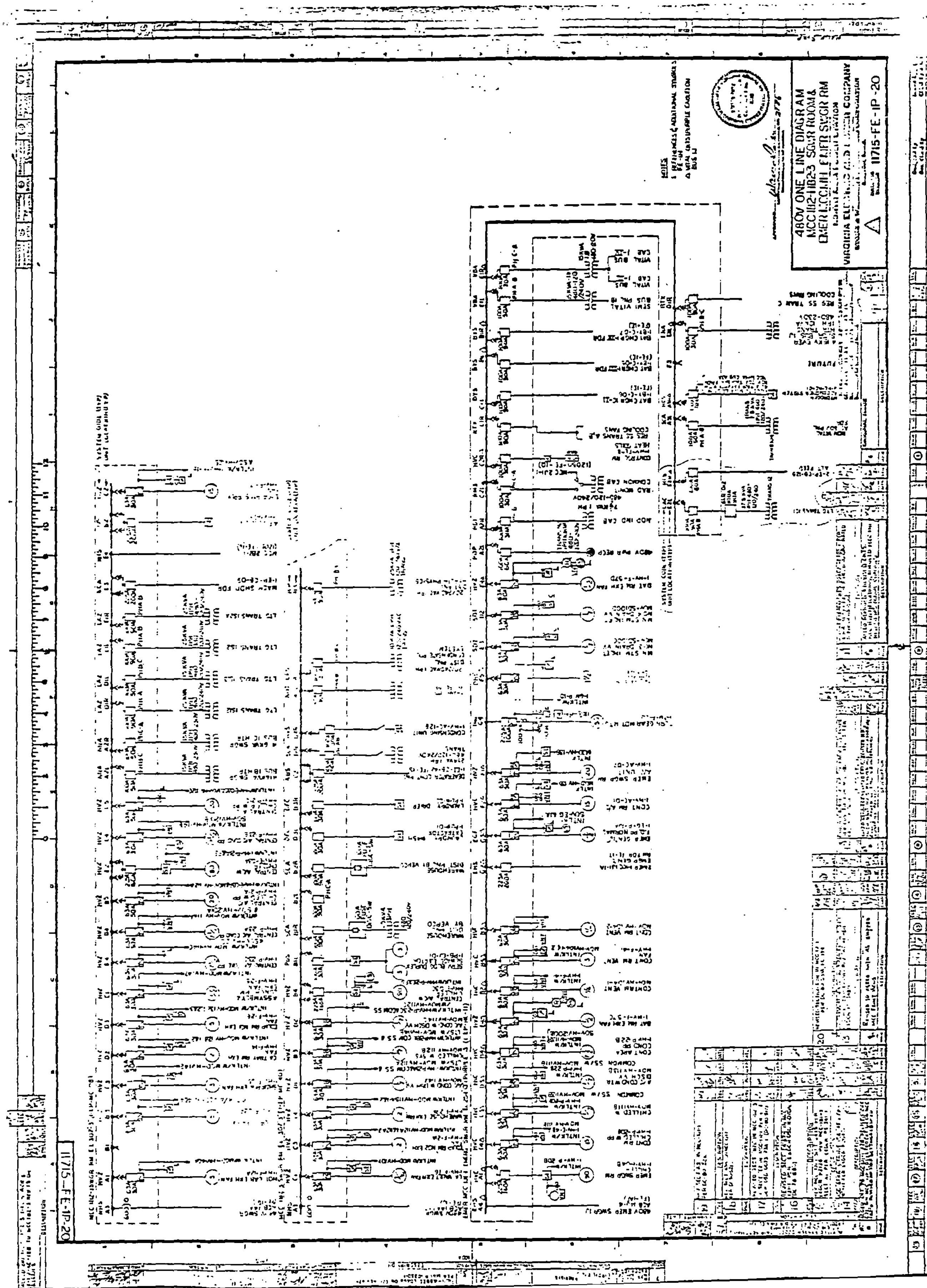

480V ONE LINE DIAGRAM
MCC1H2-1&2B3 SWGR ROOM &
EMER MCC1H1 EMER SWGR RM
VIRGINIA ELECTRIC AND POWER COMPANY
11715-FE-1P-20

Figure 11

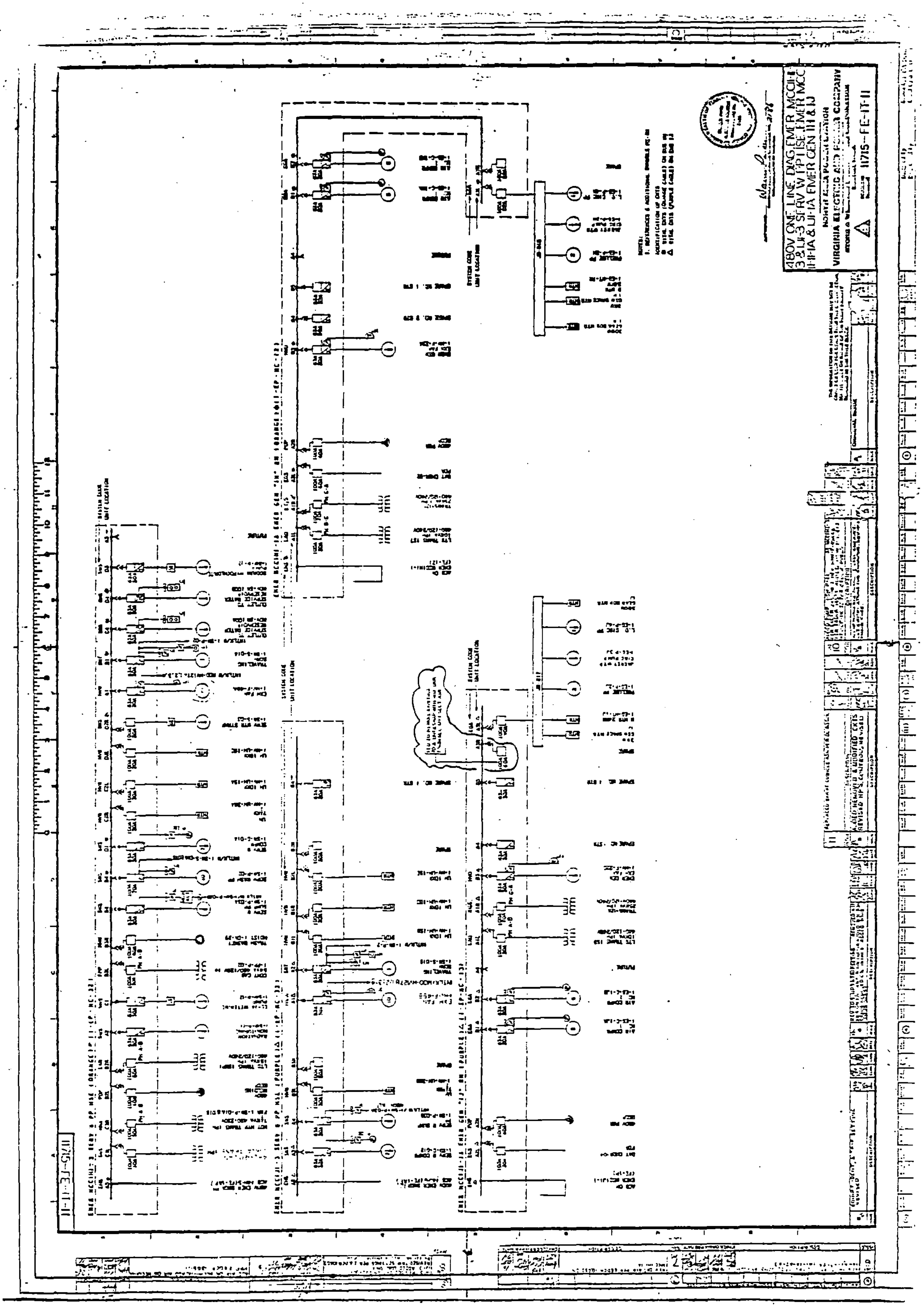
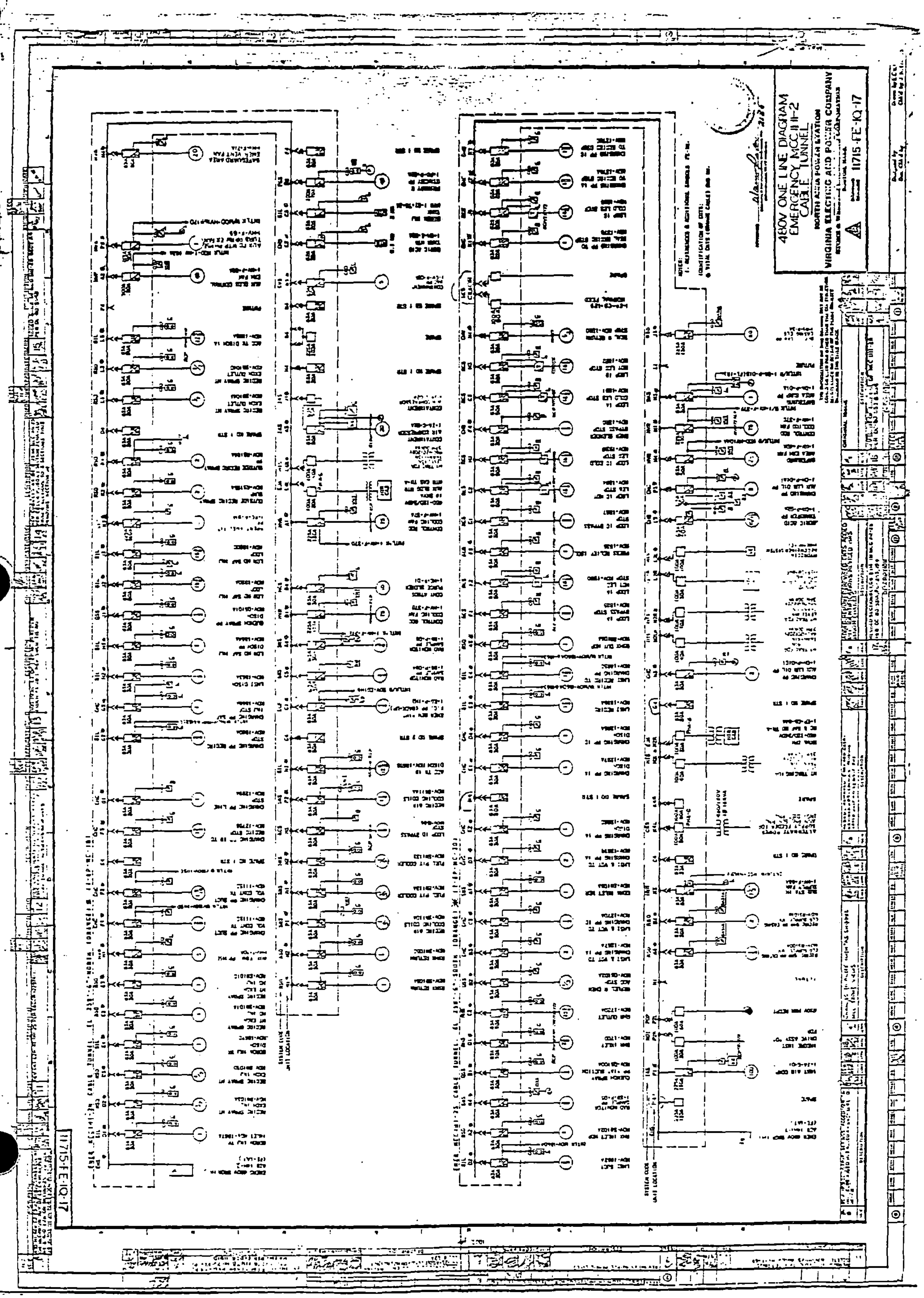
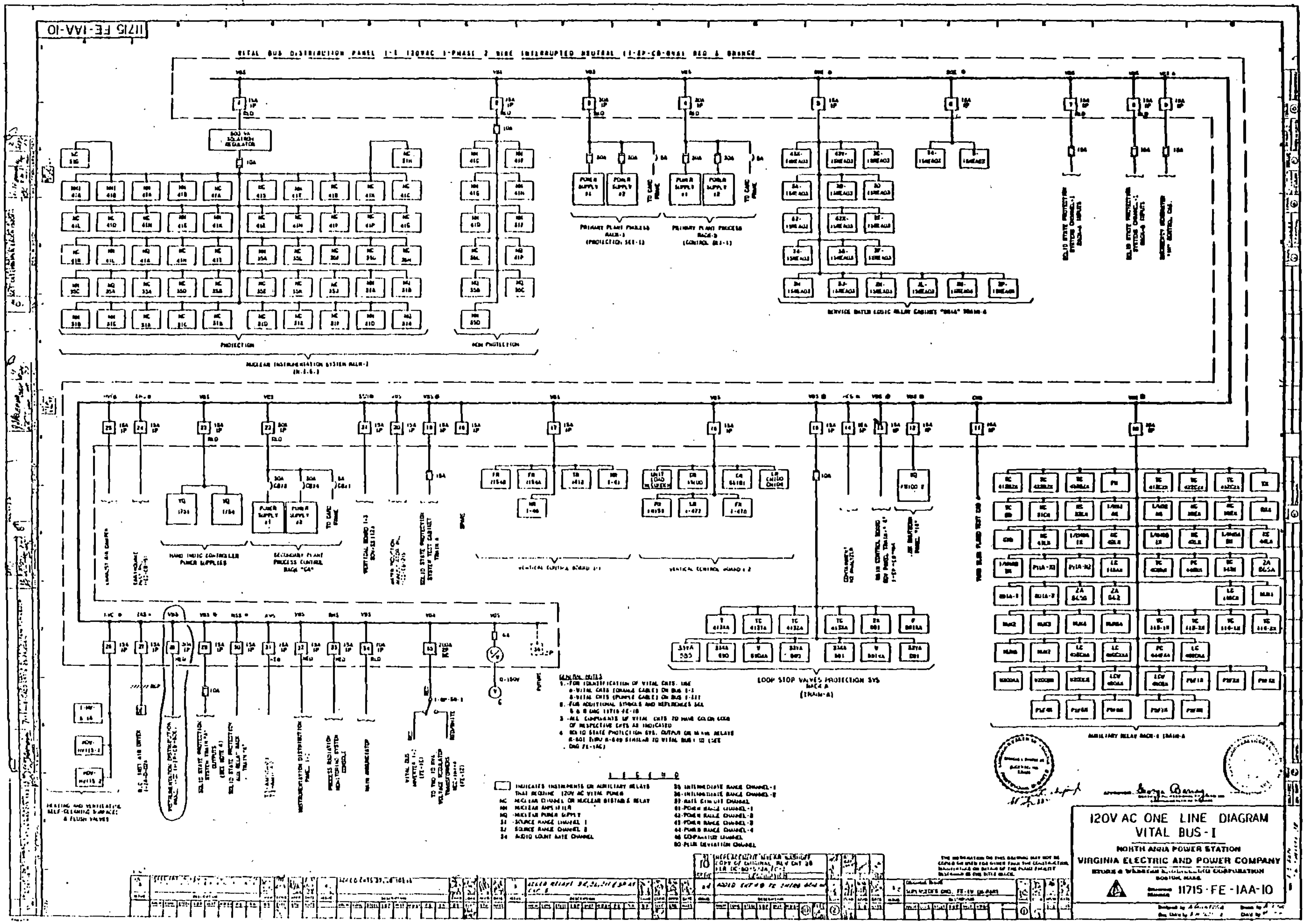


Figure 12


480V ONE LINE DIAGRAM
EMERGENCY MCC 1I1-2
CABLE TUNNEL
NORTH ANNA POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11715-FE-1Q-17



11715 FE-1AA-10
LOOP STOP VALVES PROTECTION SYS
120V AC ONE LINE DIAGRAM
VITAL BUS - I
NORTH ANNA POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11715 - FE - 1AA-10

Figure 13

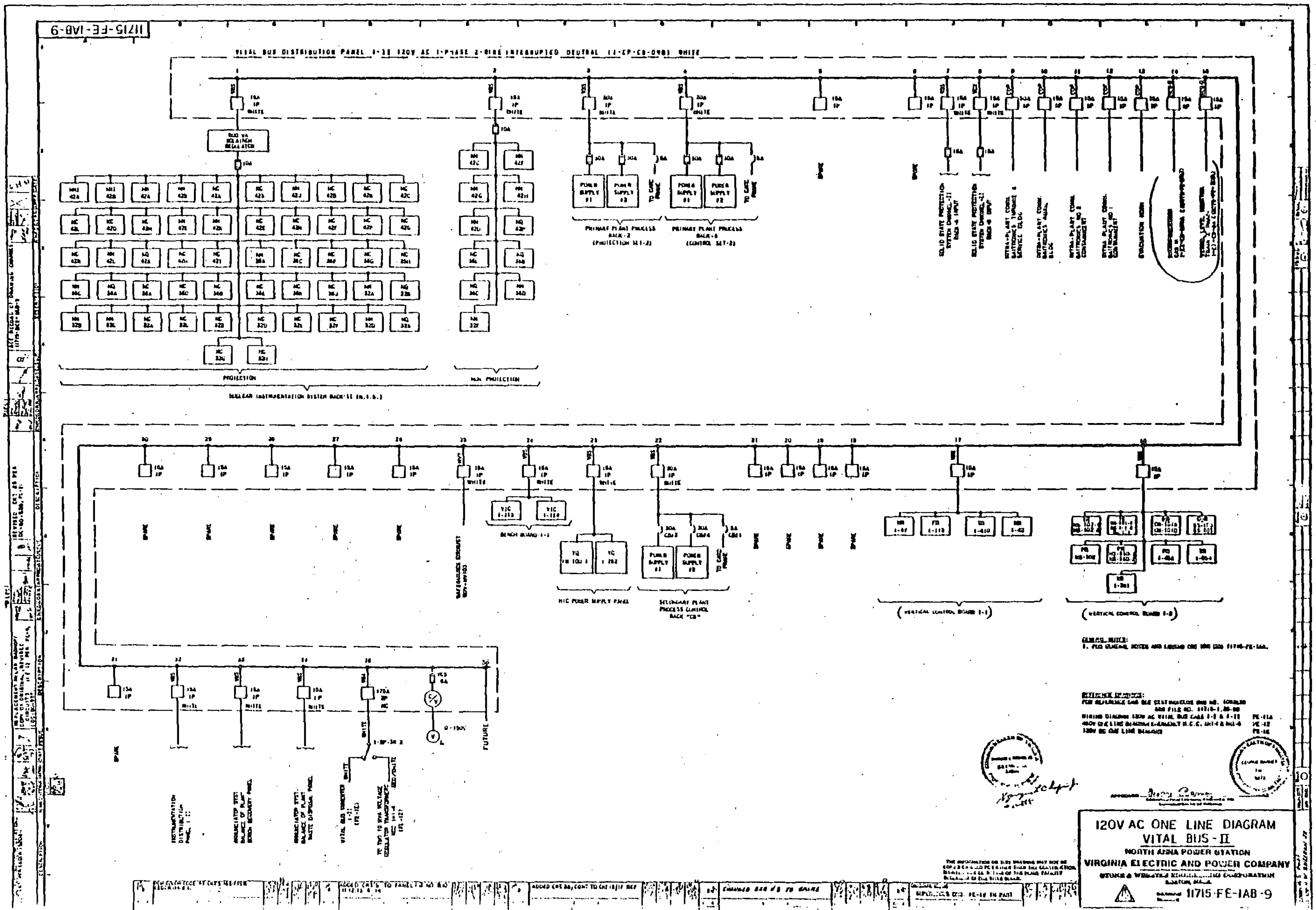

11715-FE-IAB-9
SPARE
FUTURE
120V AC ONE LINE DIAGRAM
VITAL BUS - II
NORTH ANNA POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11715-FE-IAB-9

Figure 14

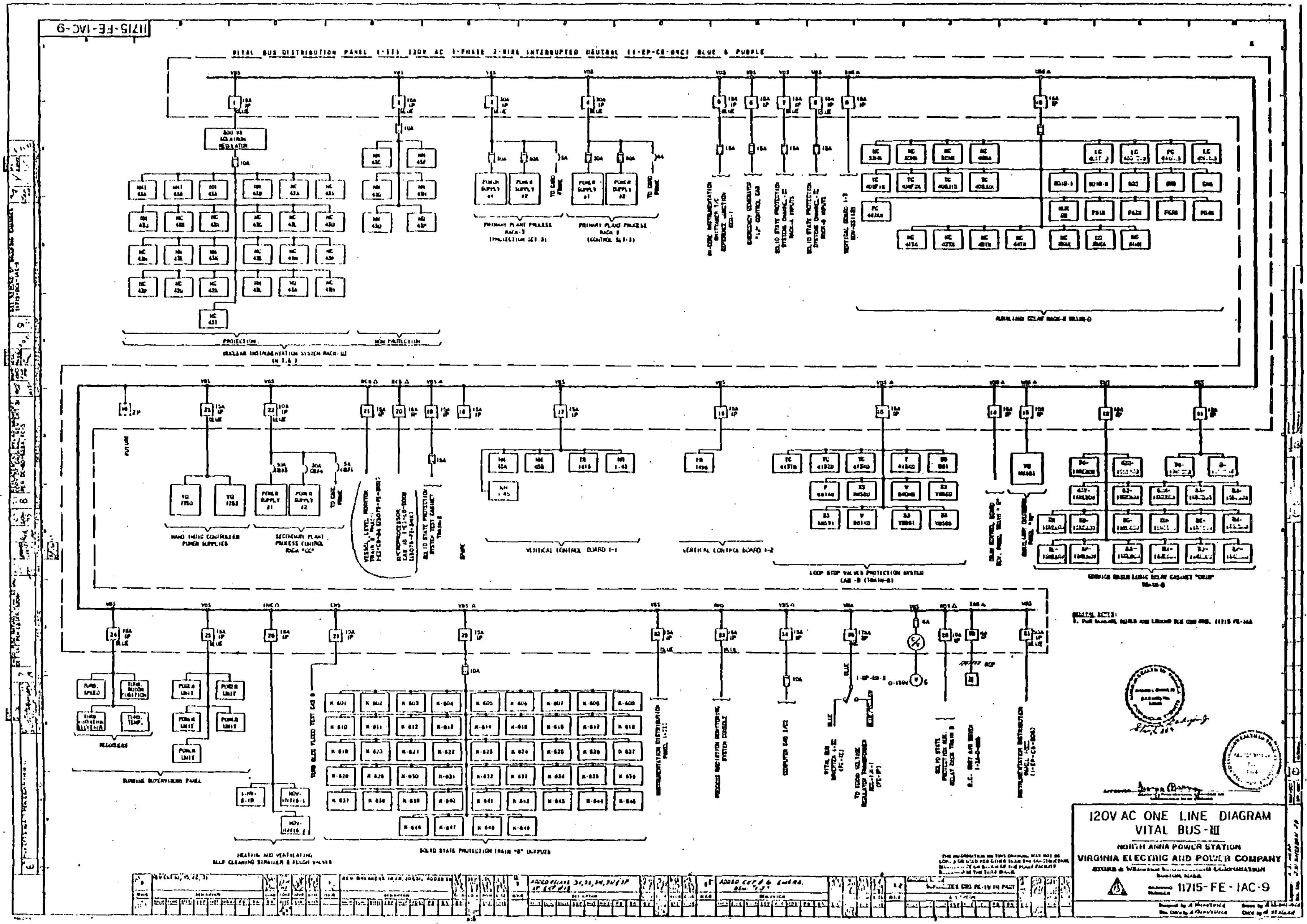

11715-FE-IAC-9
120V AC ONE LINE DIAGRAM
VITAL BUS-III
NORTH ANNA POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11715-FE-IAC-9

Figure 15

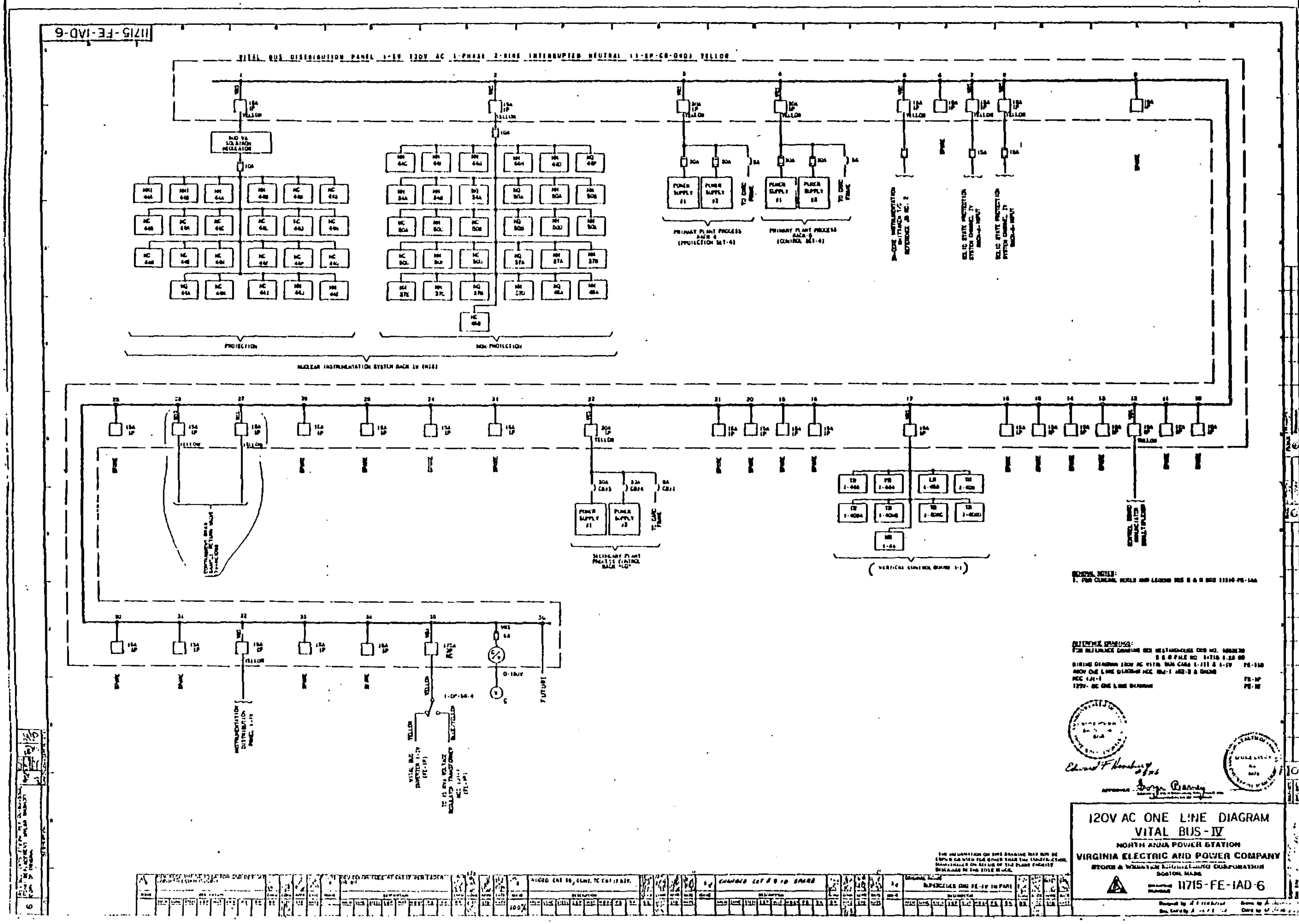

11715-FE-IAD-6
120V AC ONE LINE DIAGRAM
VITAL BUS-IV
NORTH ANNA POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
BOSTON, MASS.
11715-FE-IAD-6

Figure 16

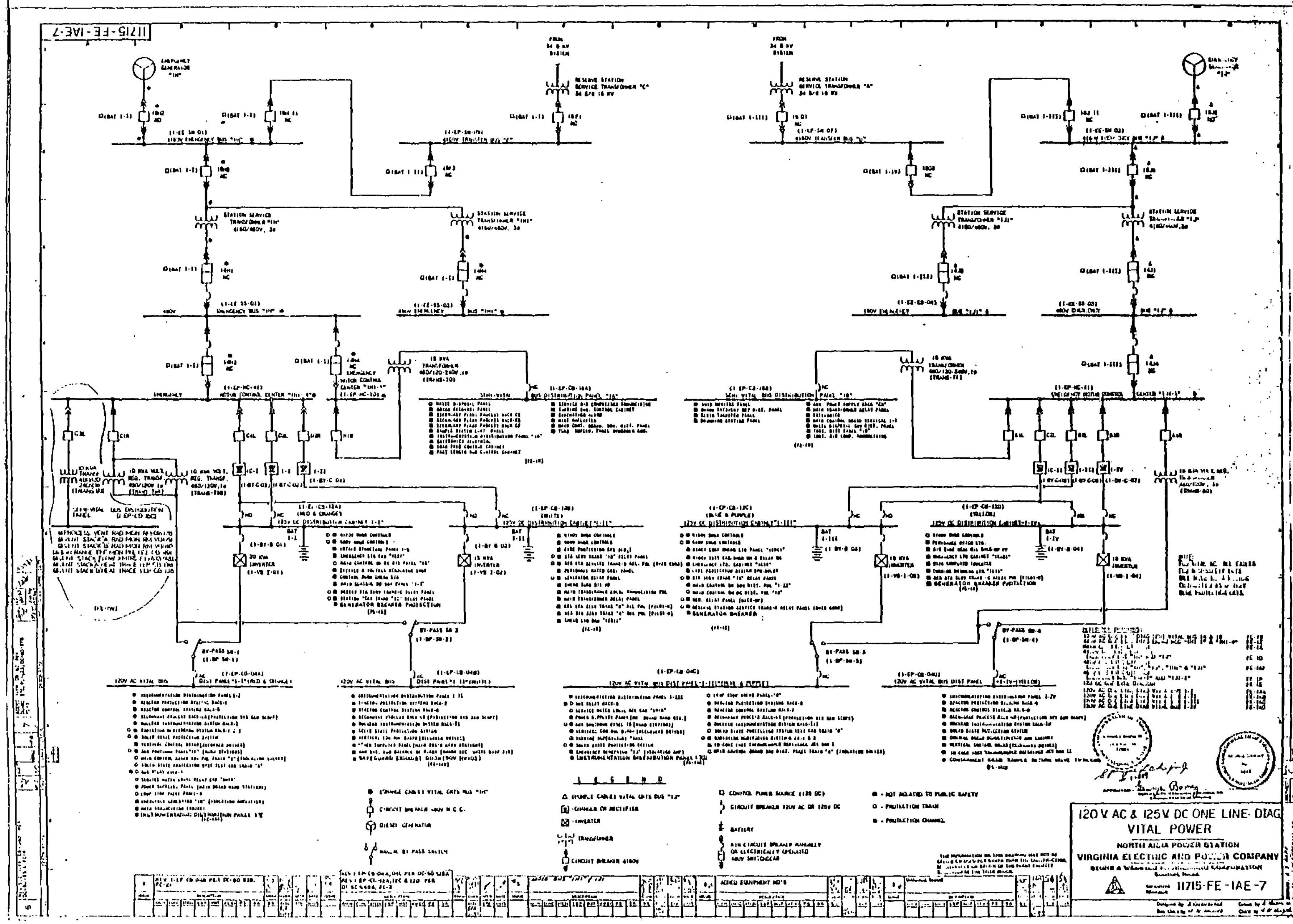

11715-FE-1AE-7
120 V AC & 125 V DC ONE LINE DIAG
VITAL POWER
NORTH ANNA POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11715-FE-1AE-7

Figure 17

Figure 18

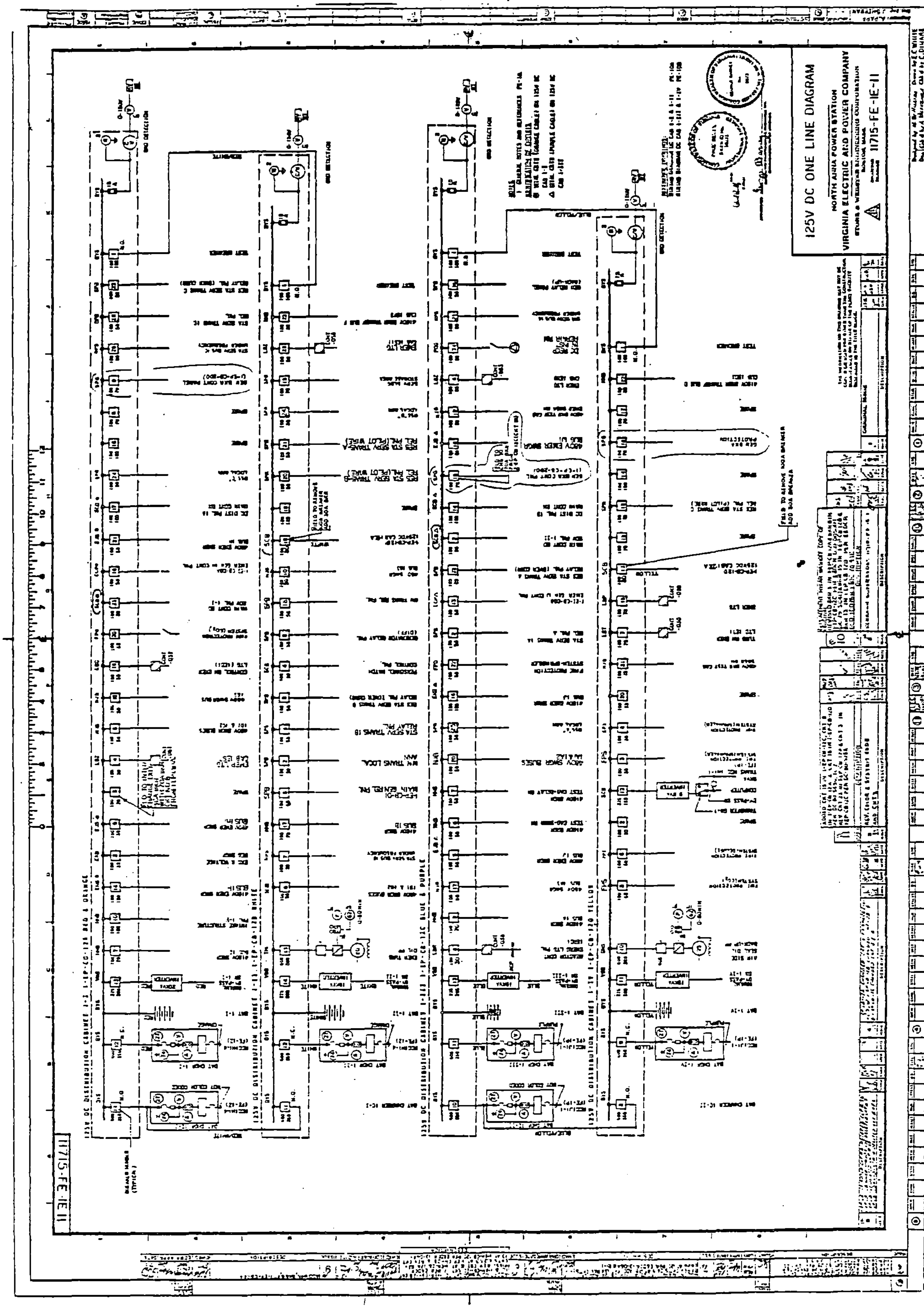

125V DC ONE LINE DIAGRAM
NORTH ANNA POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11715-FE-1E-11

Figure 19

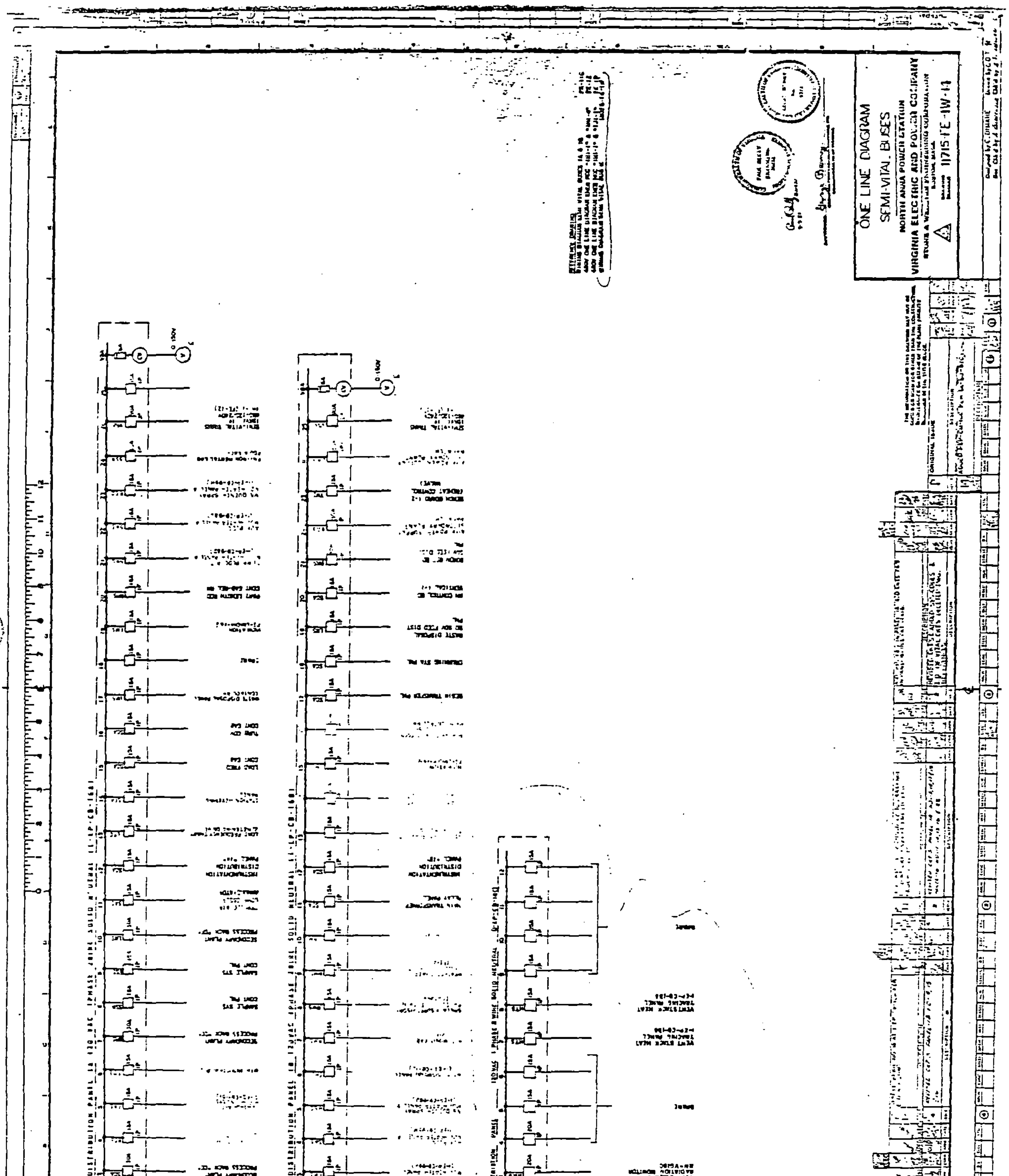

ONE LINE DIAGRAM
SEMI-VITAL BUSES
NORTH ANNA POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11715-FE-1W-14

Figure 21

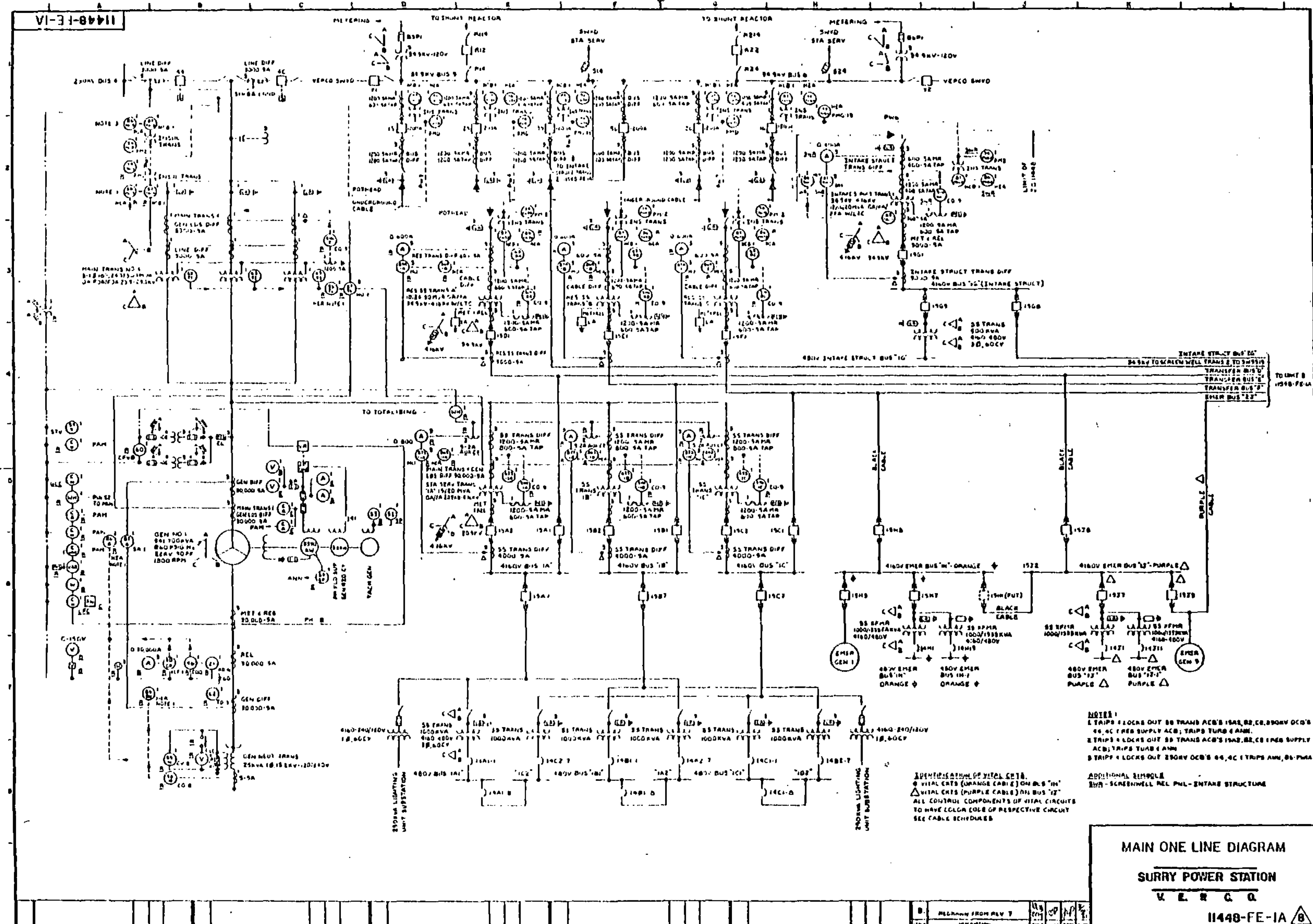


Figure 20

Pg. 6

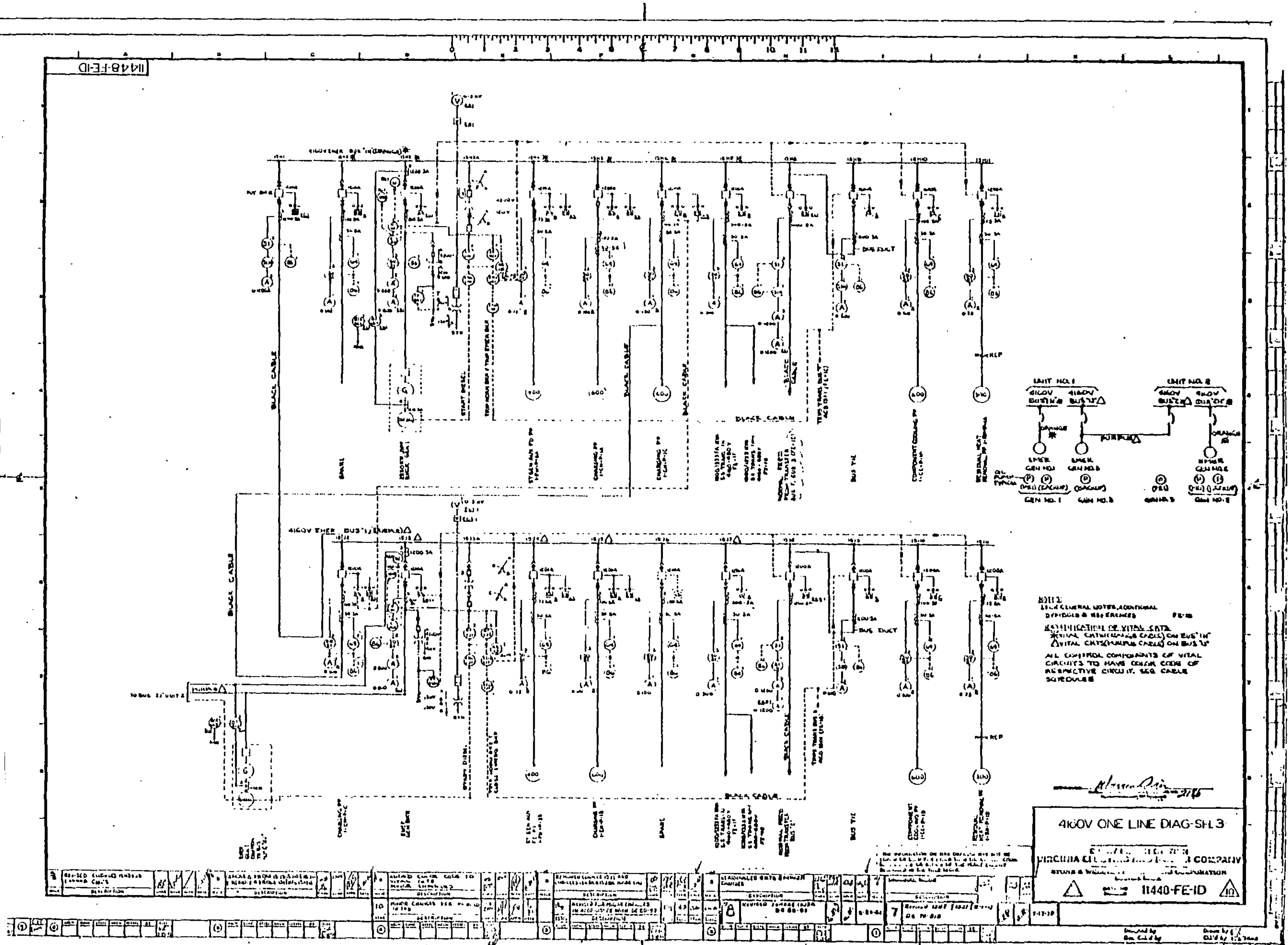
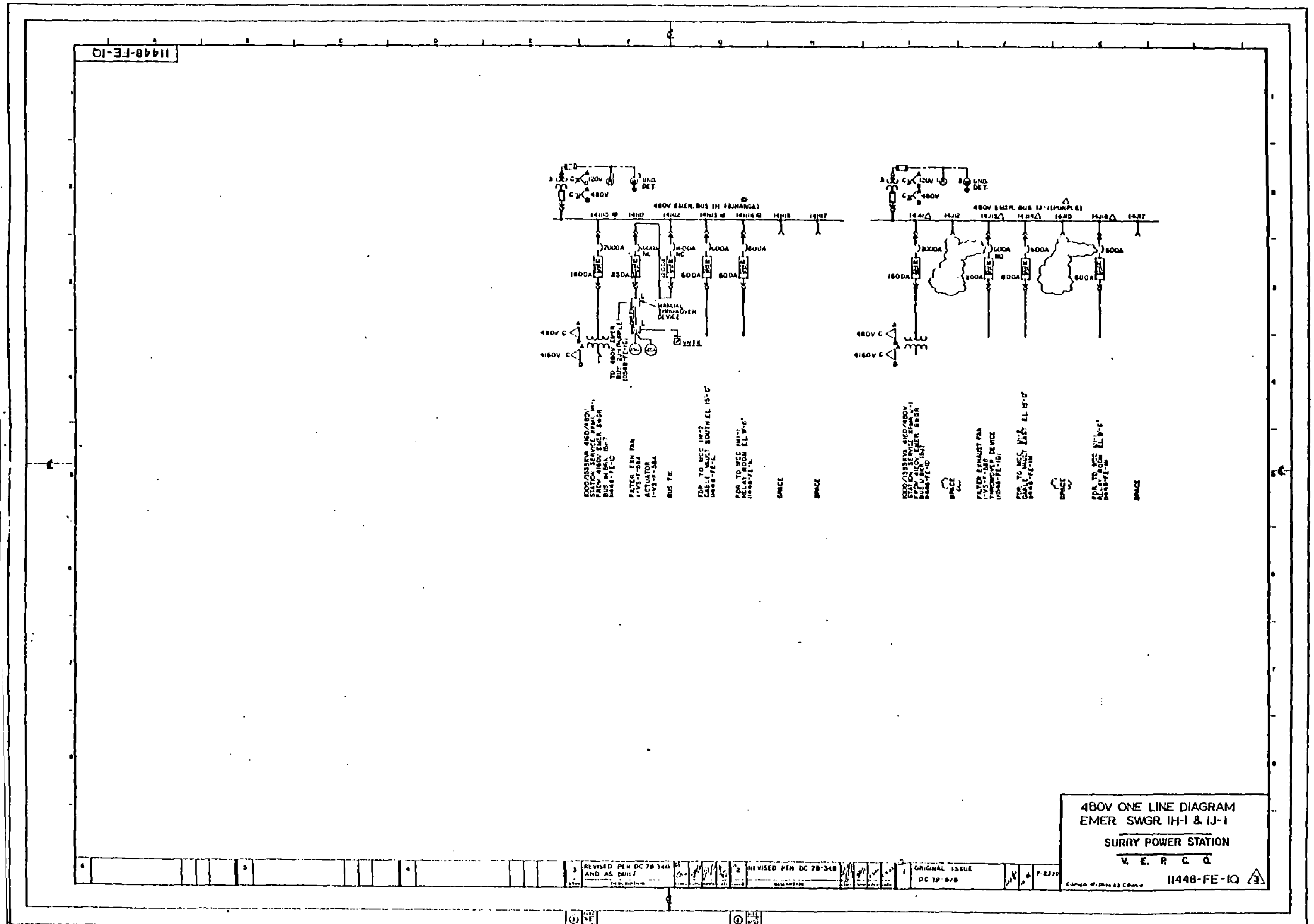

4160V ONE LINE DIAG-SH.3
11440-FE-ID
COMPANY
UNIT NO.1
UNIT NO.2
BLACK CABLE
BUS DUCT
SPARE
BUS TIE
NOTE:

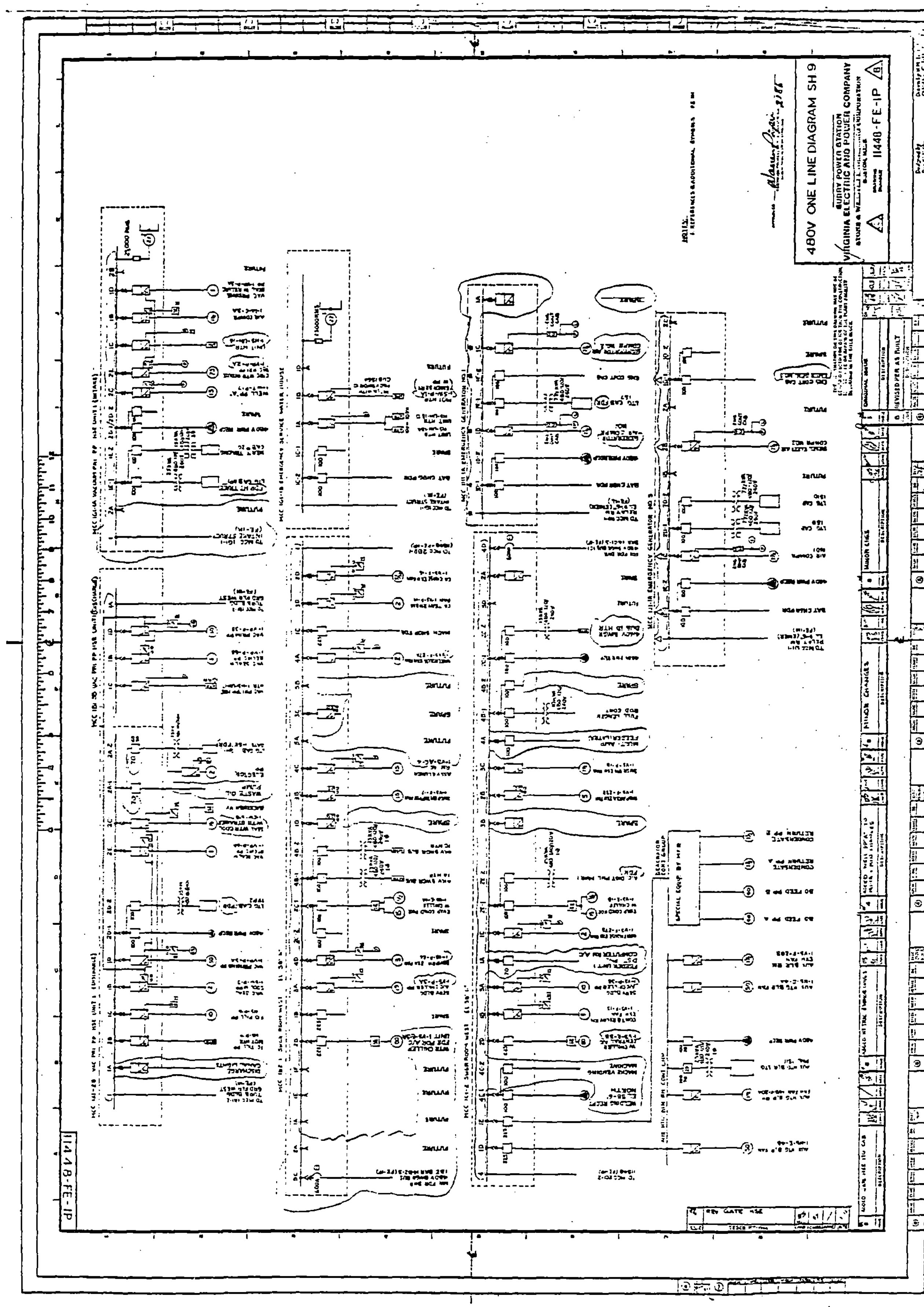
Figure 21

Figure 22



11448-FE-1Q
480V ONE LINE DIAGRAM
EMER SWGR 1H-1 & 1J-1
SURRY POWER STATION
V. E. P. C. O.
11448-FE-1Q
REVISED PER DC 78-348 AND AS BUILT
REVISED PER DC 78-348
ORIGINAL ISSUE

Figure 23


480V ONE LINE DIAGRAM SH 9
SURRY POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11448-FE-1P
11448-FE-1P

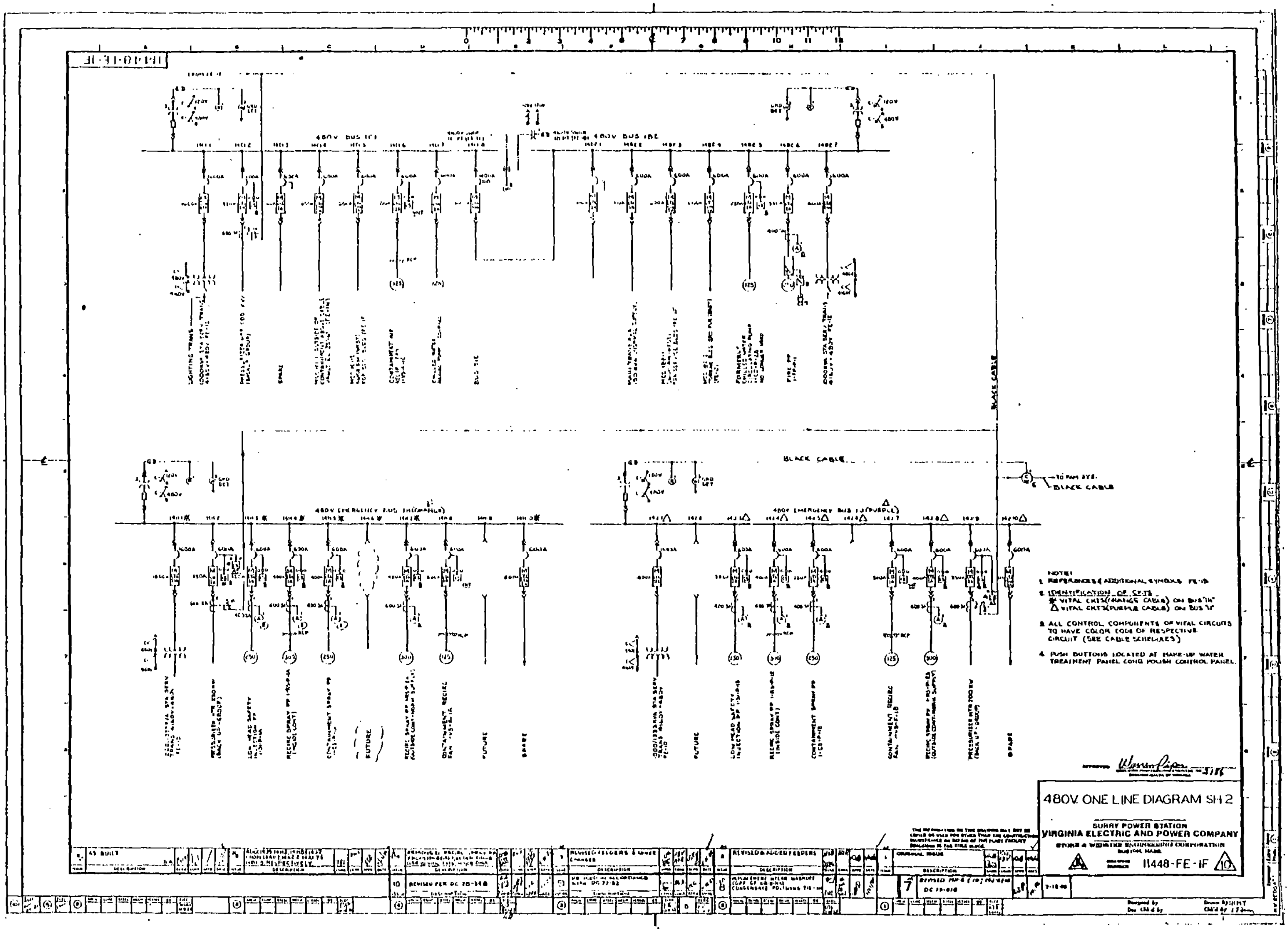

480V BUS 1H
480V BUS 1J
480V EMERGENCY BUS 1H (ORANGE)
480V EMERGENCY BUS 1J (PURPLE)
BLACK CABLE
TO PAM SYS. BLACK CABLE
SPARE
FUTURE
NOTES:
1. REFERENCES & ADDITIONAL SYMBOLS FE-1B
2. IDENTIFICATION OF CKTS
✱ VITAL CKTS (ORANGE CABLE) ON BUS "1H"
△ VITAL CKTS (PURPLE CABLE) ON BUS "1J"
3. ALL CONTROL COMPONENTS OF VITAL CIRCUITS TO HAVE COLOR CODE OF RESPECTIVE CIRCUIT (SEE CABLE SCHEDULES)
4. PUSH BUTTONS LOCATED AT MAKE-UP WATER TREATMENT PANEL COND POLISH CONTROL PANEL.
480V ONE LINE DIAGRAM SH 2
SURRY POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11448-FE-1F
AS BUILT
ORIGINAL ISSUE

Figure 24

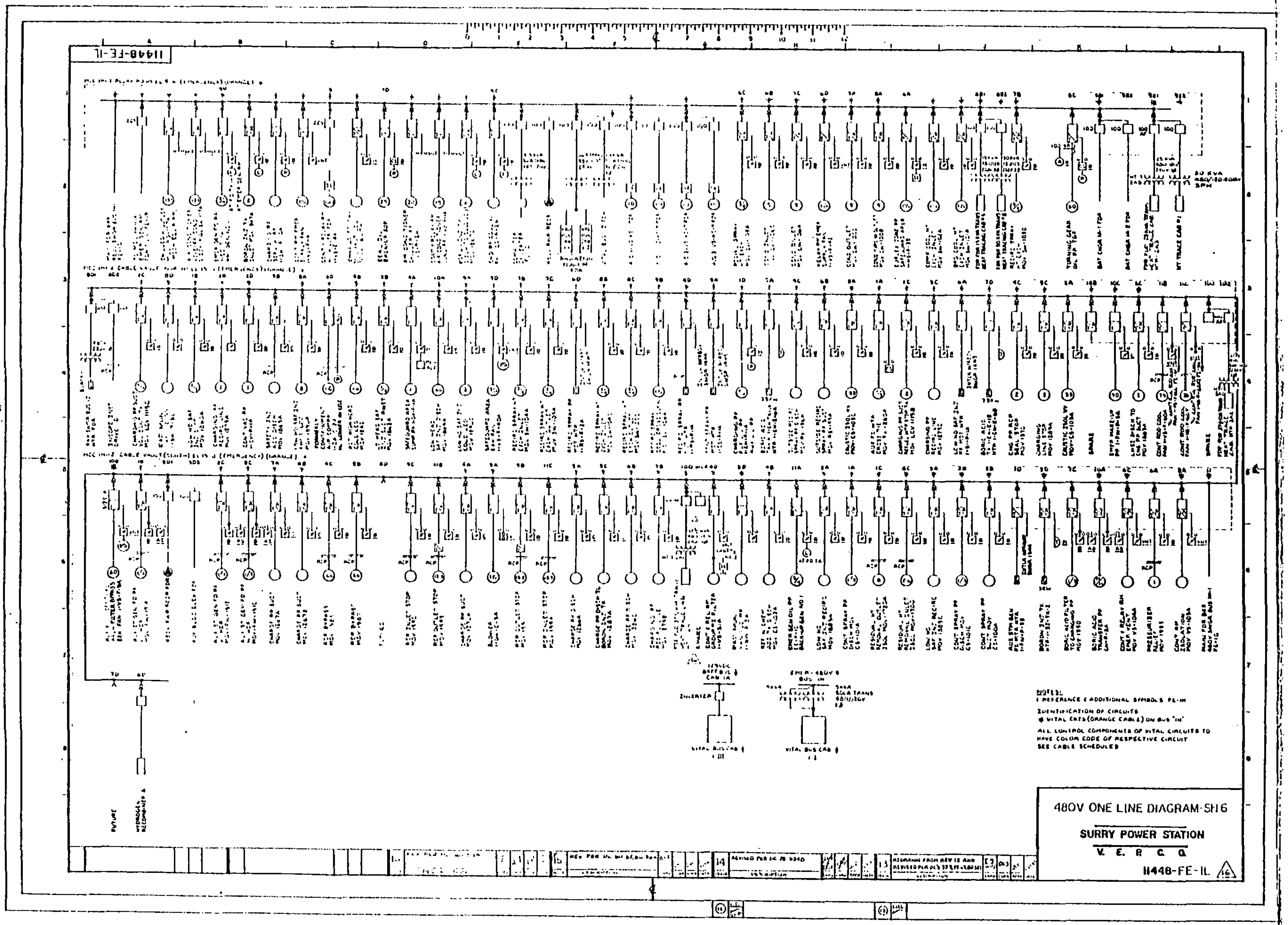

480V ONE LINE DIAGRAM-SH 6
SURRY POWER STATION
V. E. P. C. O.
11448-FE-1L

Figure 25

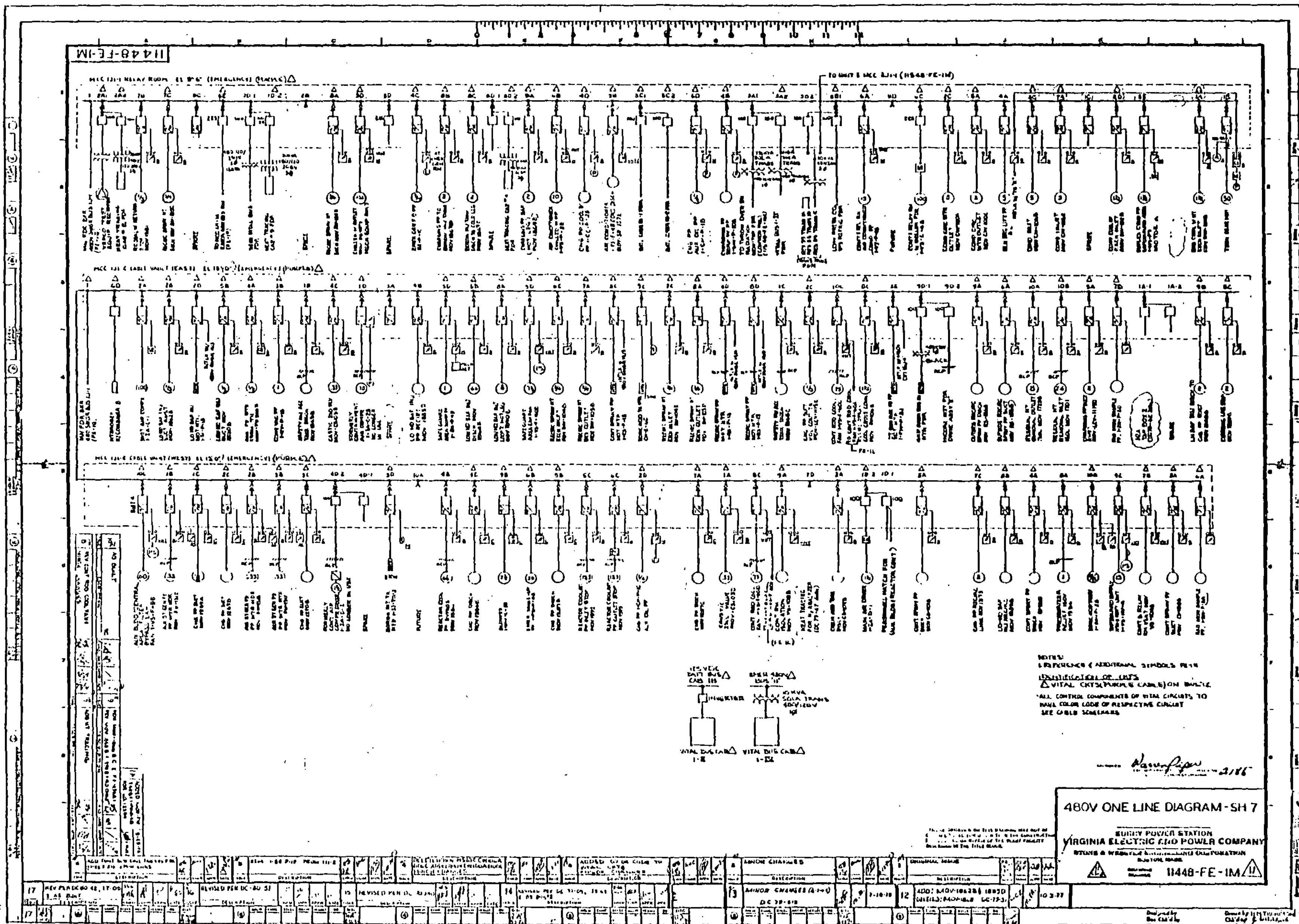

11448-FE-1M
480V ONE LINE DIAGRAM - SH 7
SURRY POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11448-FE-1M

Figure 26

Figure 27

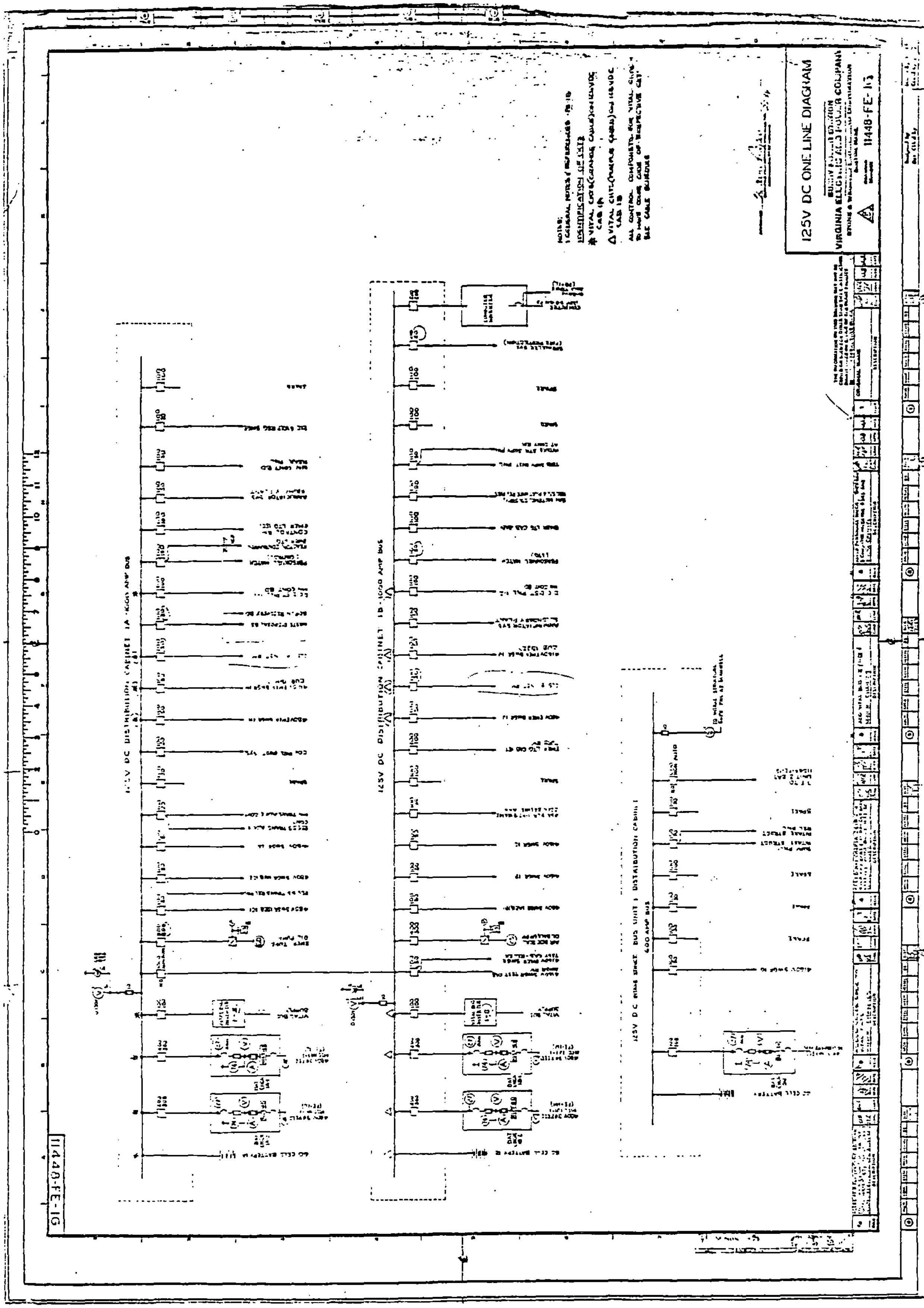


Figure 28

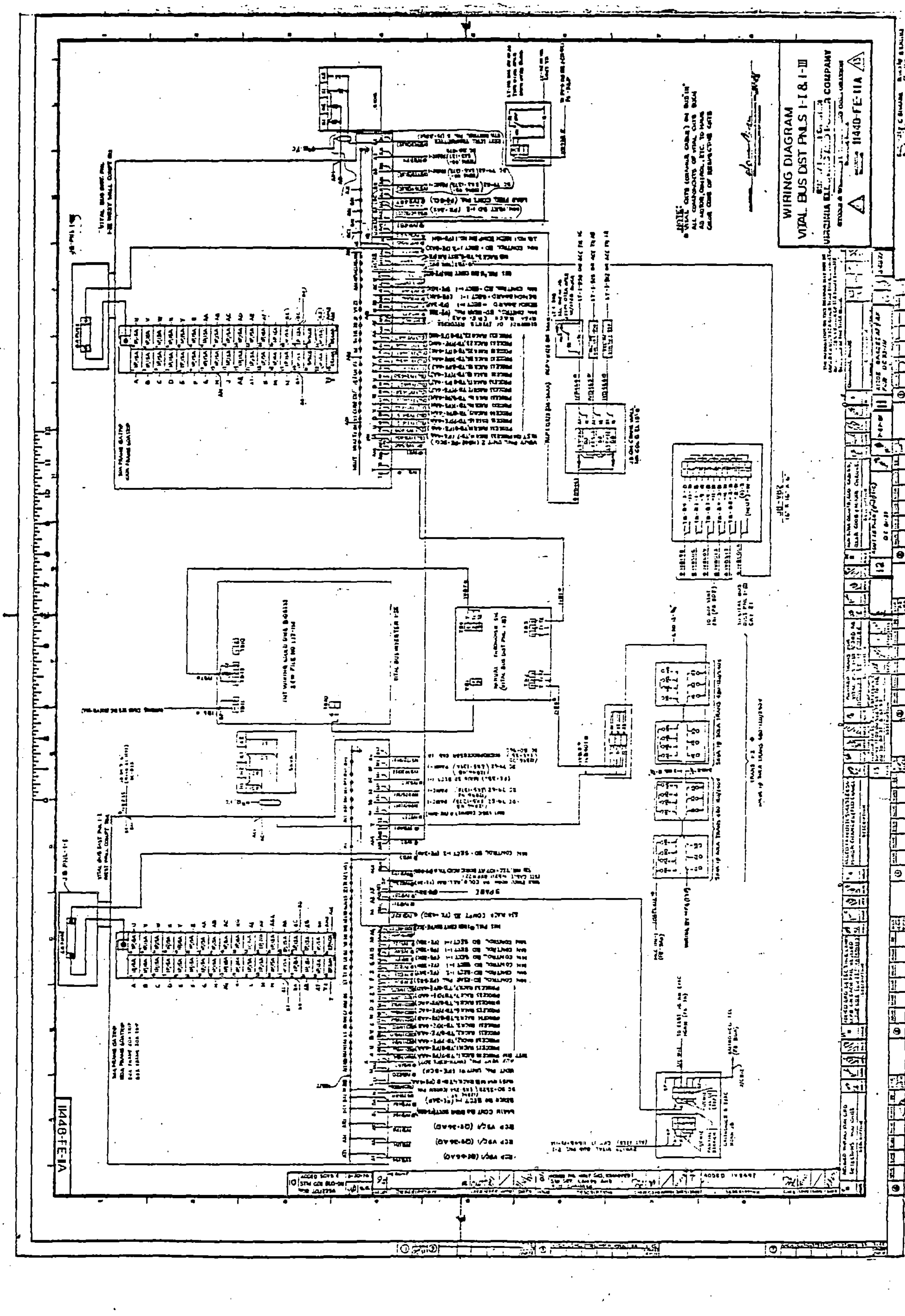
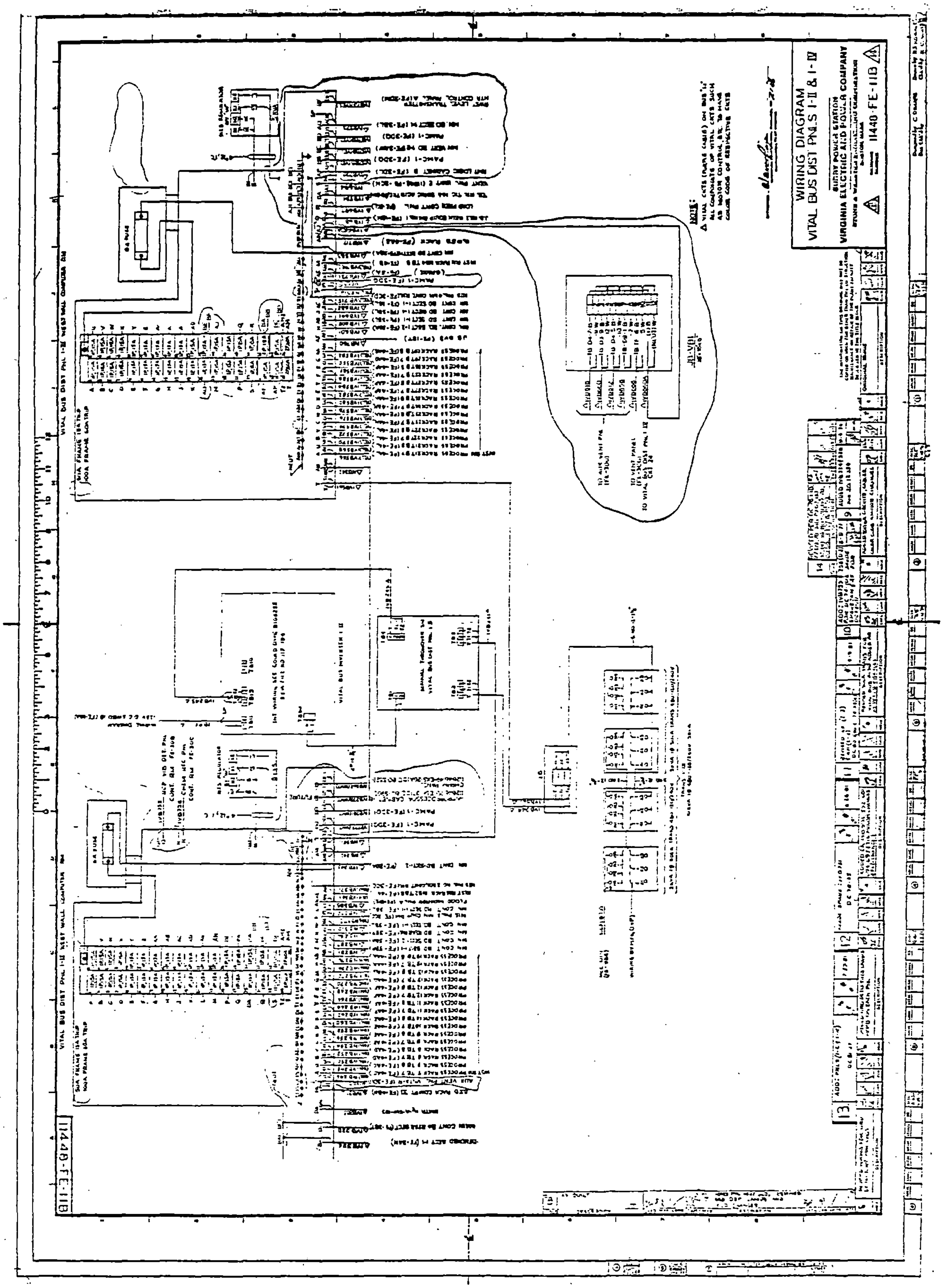

WIRING DIAGRAM
VITAL BUS DIST PNLS I-I & I-III
VIRGINIA ELECTRIC AND POWER COMPANY
11440-FE-11A
11440-FE-1A

Figure 29


WIRING DIAGRAM
VITAL BUS DIST PNLS I-II & I-IV
SURRY POWER STATION
VIRGINIA ELECTRIC AND POWER COMPANY
11440-FE-11B

EMERGENCY SWGR ROOM

TIME-CURRENT CHARACTERISTIC CURVES

For MCC 1H1-1 & MCC 1J1-1, 2H1-1, 2J1-1 Fuse Links. in

BASIS FOR DATA Standards Dated

1. Tests made at 480 Volts a-c at p-f, starting at 25C with no initial load

2. Curves are plotted to PR-NA-12-390 & TIE TO 6694 Test points so variations should be

No. 11715-SKE-112675ES2

Date 11/26/75 Z.J.

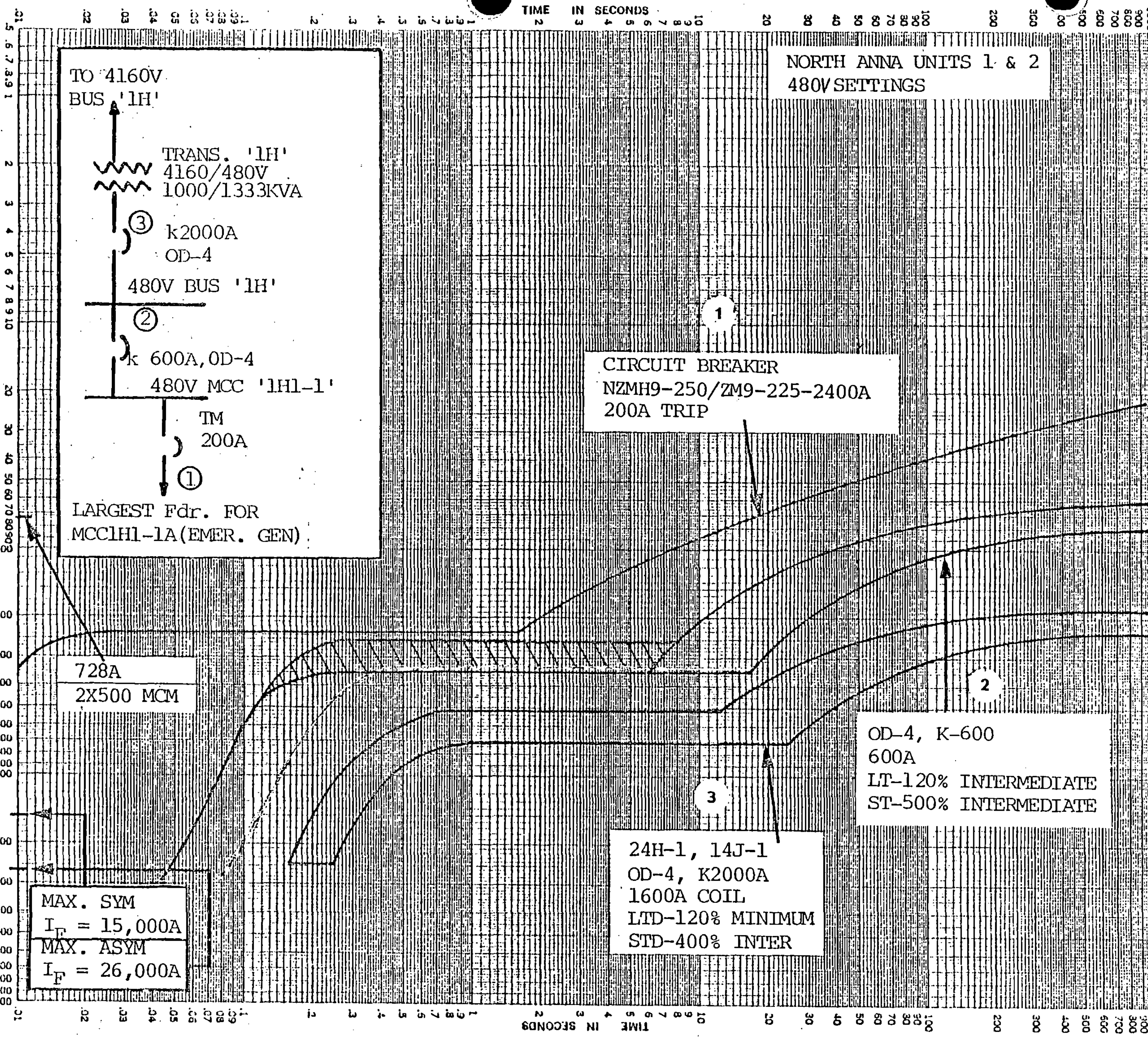


FIGURE- 30

NORTH ANNA POWER STATION

EMERGENCY SWGR ROOM

For MCC 1H1-4, 2H1-4 TIME-CURRENT CHARACTERISTIC CURVES

BASIS FOR DATA Standards

1. Tests made at 480 Volts 3-φ at ... p.f., starting at 25C with no initial load.
2. Curves are plotted to PR-NA-12-390 & ITE TD-6694 Test points so variations should be ...

No. 11715-SKE-112675ES1

Date 11/26/75 Z.J.

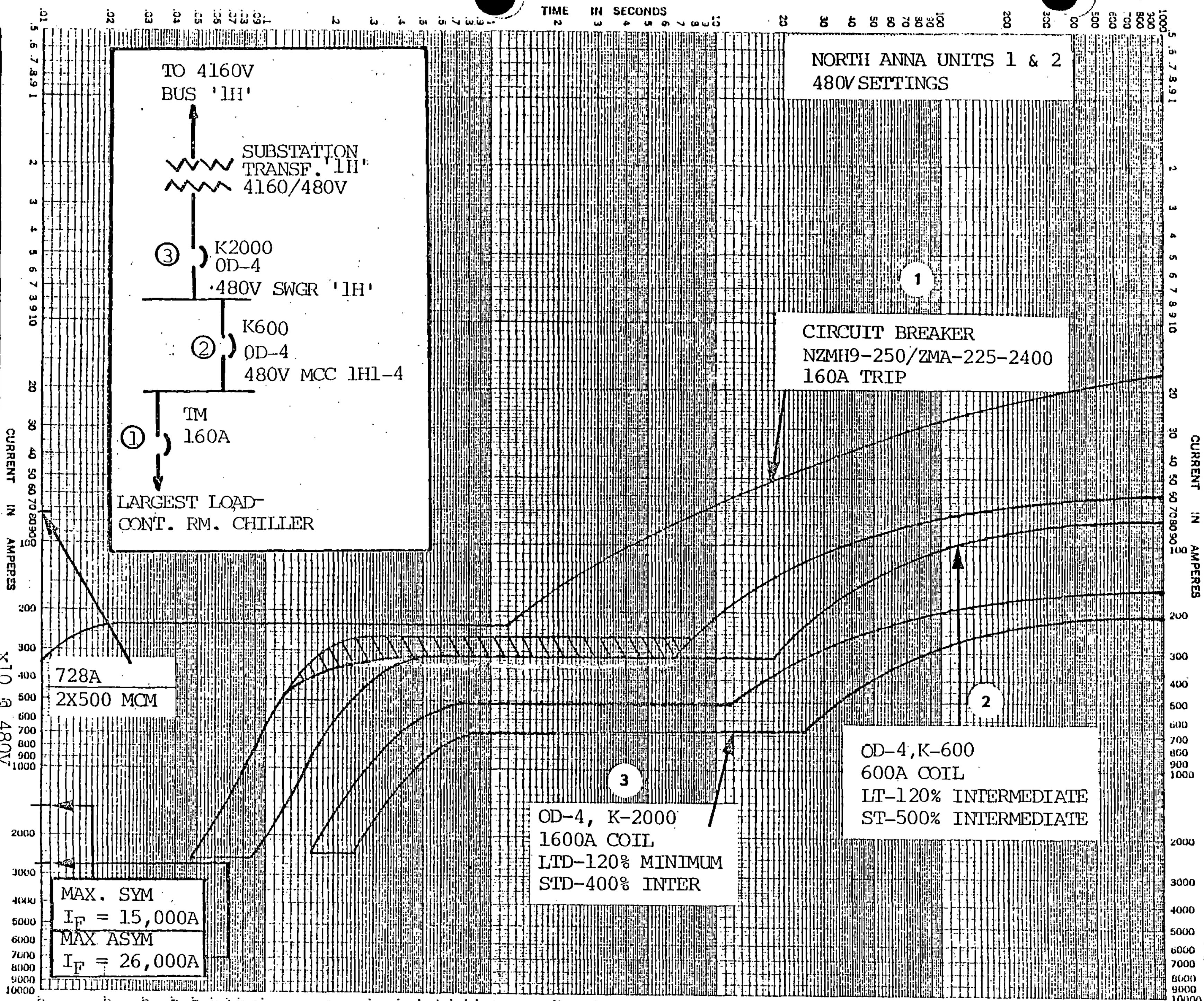
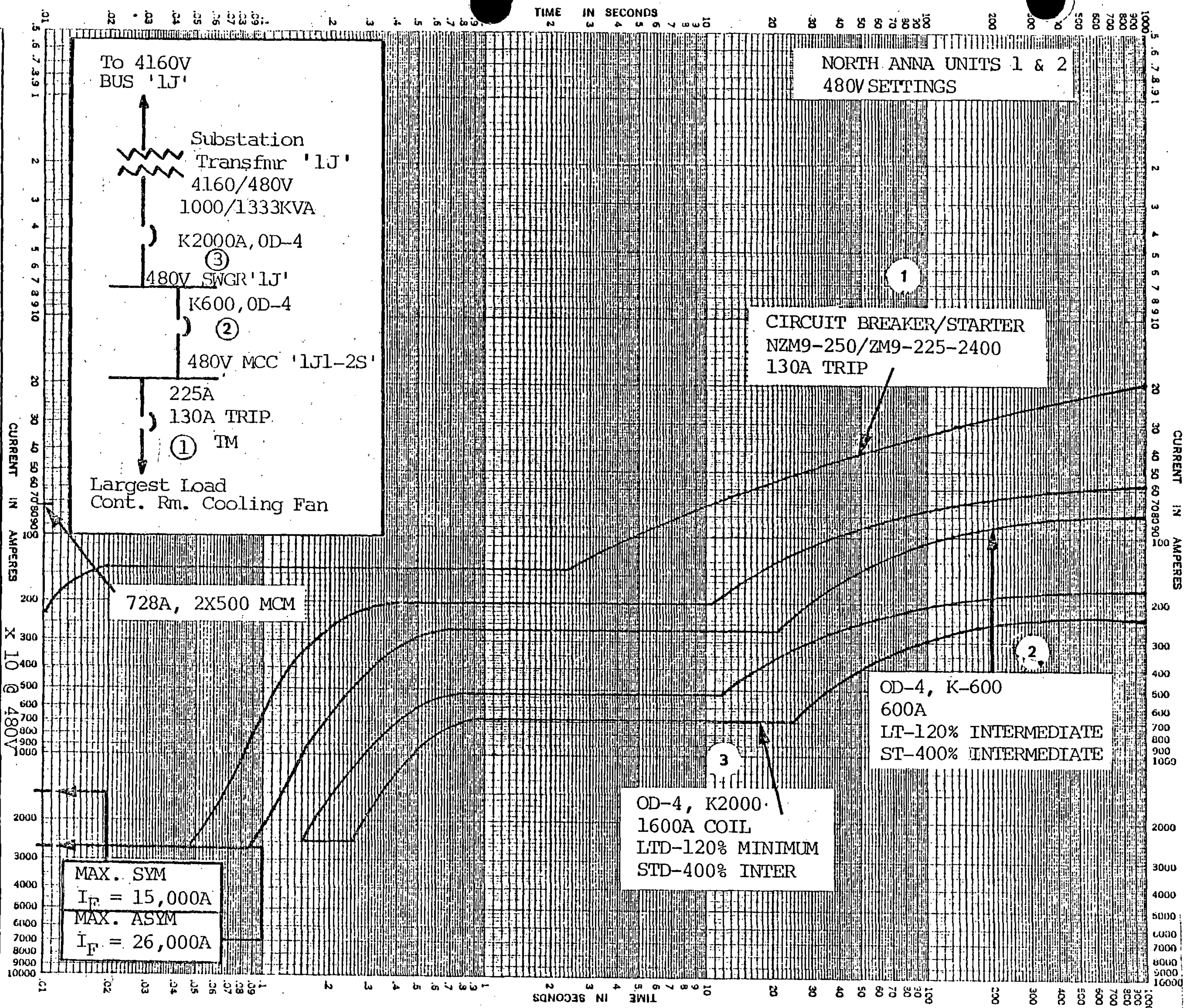


FIGURE-31

NORTH ANNA POWER STATION



TIME-CURRENT CHARACTERISTIC CURVES

For CONTAINMENT CABLE TUNNEL MCC 1J1-2N & MCC 1J1-2S

Fuse Links. In

BASIS FOR DATA Standards

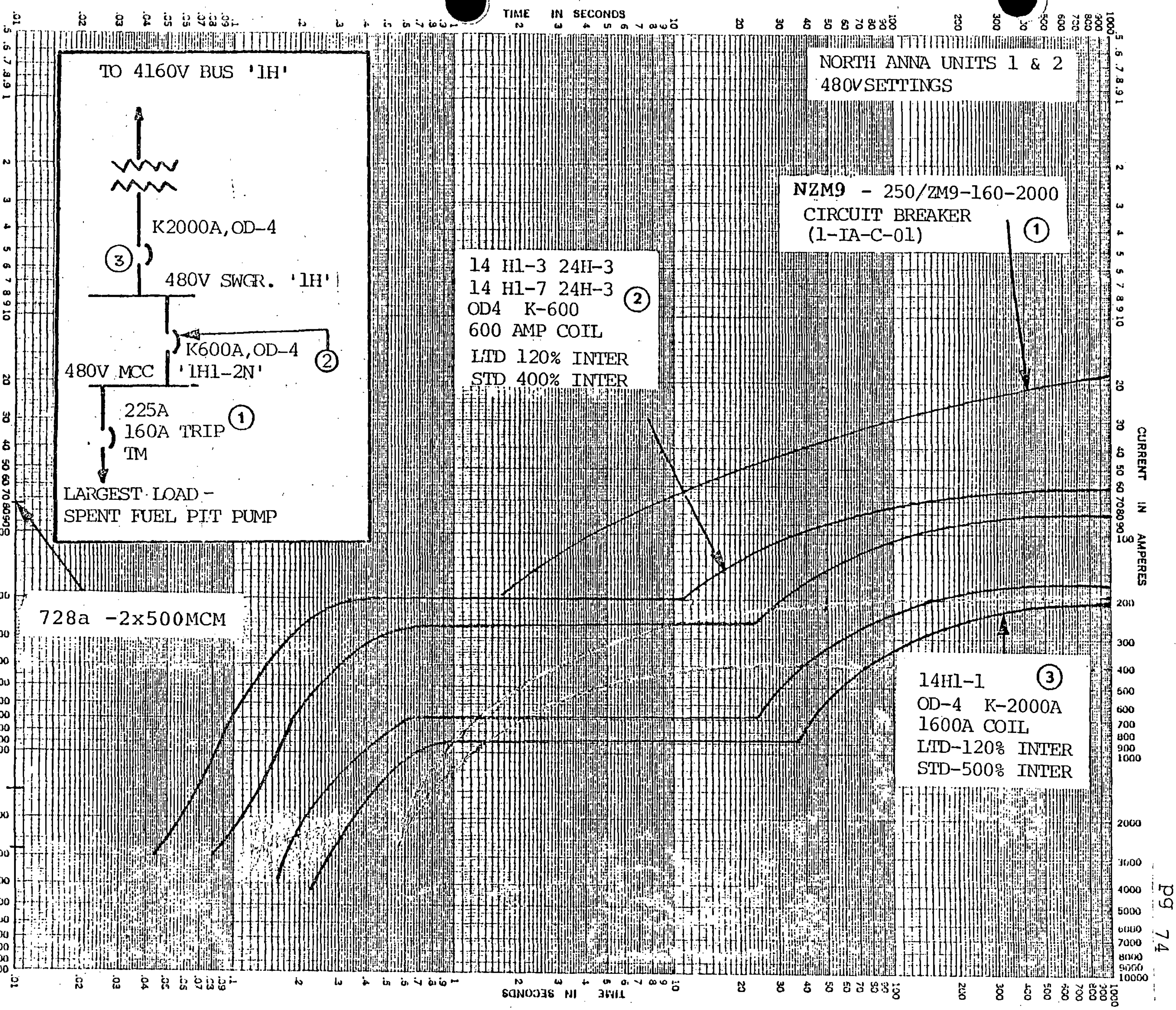
Dated

1. Tests made at 480 Volts at pf., starting at 25C with no initial load.
2. Curves are plotted to PR-NA-12-387 & TIE 26694 Test points so variations should be

No. 11715-SKE-11267SCCT
Date 11/26/75 ZJ

FIGURE- 32

NORTH ANNA POWER STATION



CONTAINMENT CABLE TUNNEL TIME-CURRENT CHARACTERISTIC CURVES

For MCC 1H1-2N & MCC 1H1-2S Fuse Links. In ___

BASIS FOR DATA Standards ___ Dated ___

1. Tests made at 480 Volts a-c at ___ p.f., starting at 25C with no initial load.

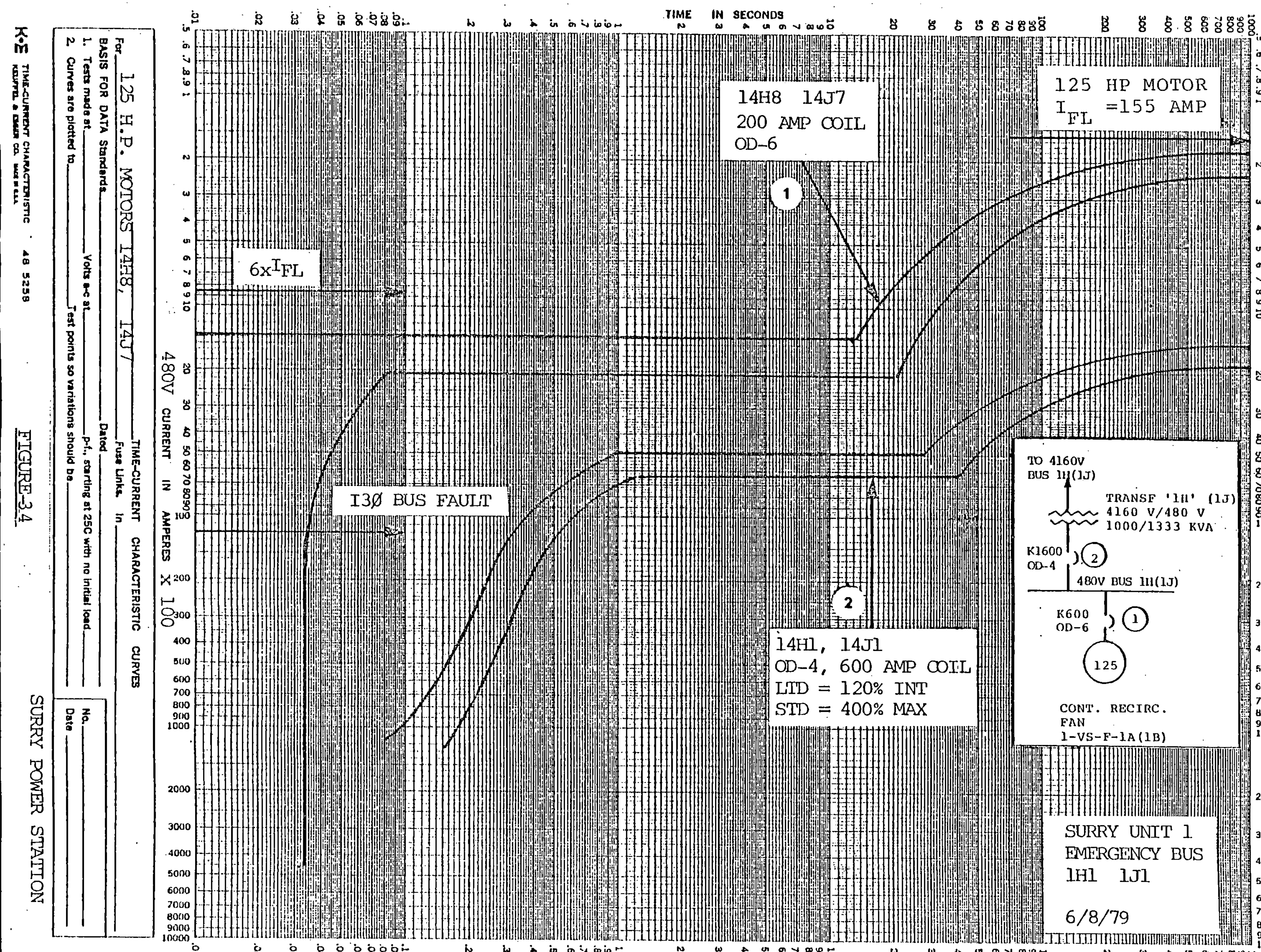
2. Curves are plotted to ___ Test points so variations should be ___

No. ___

Date 1-13-76 BSD

FIGURE 33

NORTH ANNA POWER STATION



K•E TIME-CURRENT CHARACTERISTIC 48 5258
KEUFFEL & ESSER CO.
For 125 H.P. MOTORS 14H8, 14J7 TIME-CURRENT CHARACTERISTIC CURVES
Fuse Links. In
BASIS FOR DATA Standards. Dated
1. Tests made at Volts a-c at p-f., starting at 25C with no initial load.
2. Curves are plotted to Test points so variations should be
No.
Date
FIGURE-3.4
SURRY POWER STATION
TIME IN SECONDS
480V CURRENT IN AMPERES X 100
CURRENT IN AMPERES
125 HP MOTOR
I_{FL} =155 AMP
14H8 14J7
200 AMP COIL
OD-6
6xI_{FL}
I3Ø BUS FAULT
14H1, 14J1
OD-4, 600 AMP COIL
LTD = 120% INT
STD = 400% MAX
TO 4160V
BUS 1H(1J)
TRANSF '1H' (1J)
4160 V/480 V
1000/1333 KVA
K1600
OD-4
480V BUS 1H(1J)
K600
OD-6
125
CONT. RECIRC.
FAN
1-VS-F-1A(1B)
SURRY UNIT 1
EMERGENCY BUS
1H1 1J1
6/8/79

TIME-CURRENT CHARACTERISTIC CURVES

For 14H-2 Existing — Fuse Links. In ___

BASIS FOR DATA Standards ___ Dated ___

1. Tests made at ___ Volts a-c at ___ p-f., starting at 25C with no initial load ___
2. Curves are plotted to ___ Test points so variations should be ___

No. ___

Date ___

K+E TIME-CURRENT CHARACTERISTIC 48 5258

KEUFFEL & ESSER CO.

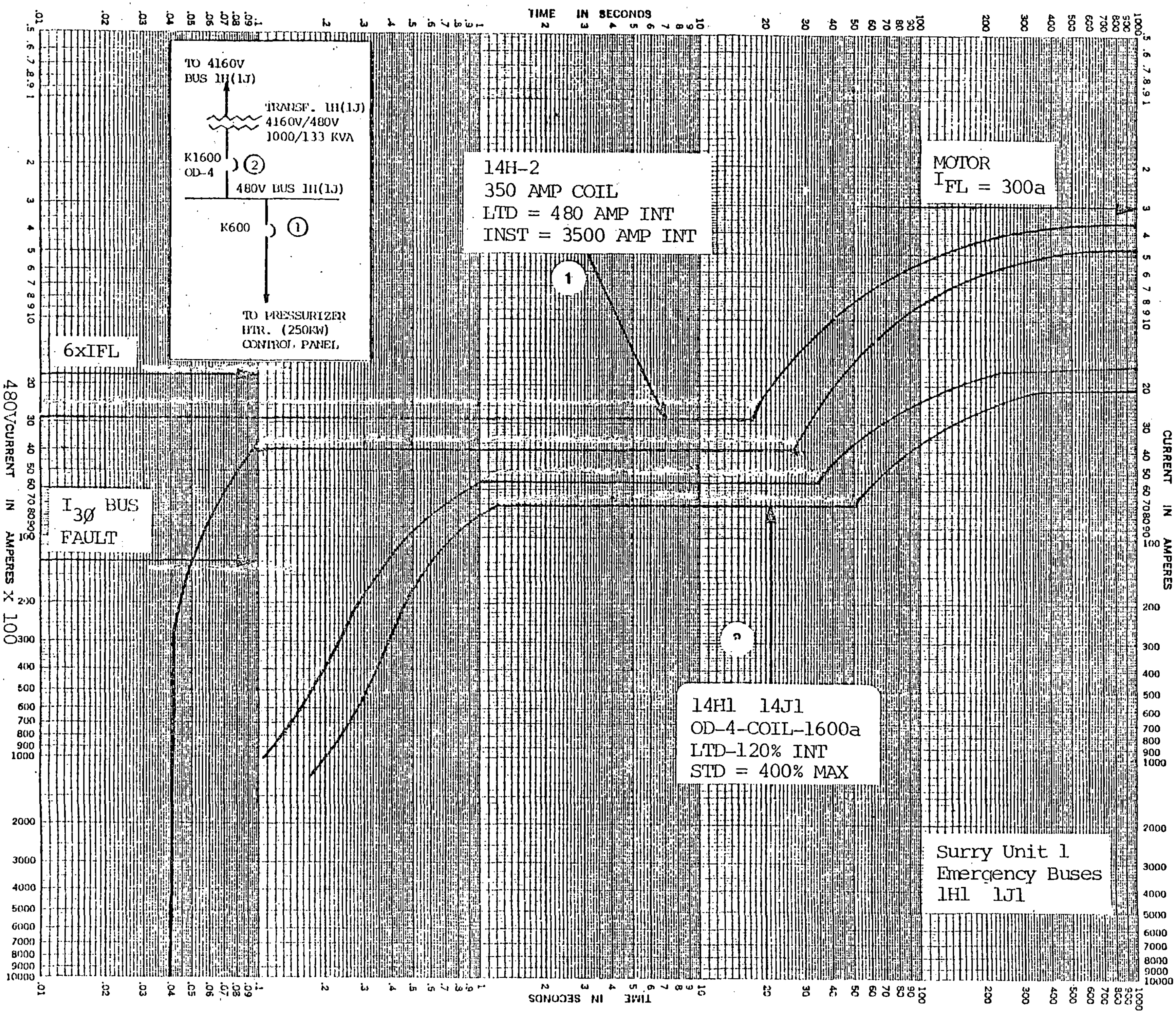


FIGURE 35

SURRY POWER PLANT

Surry Emer. Motor Center

For Emer. 480V load centers 1H-1, 1J-1 TIME-CURRENT CHARACTERISTIC CURVES

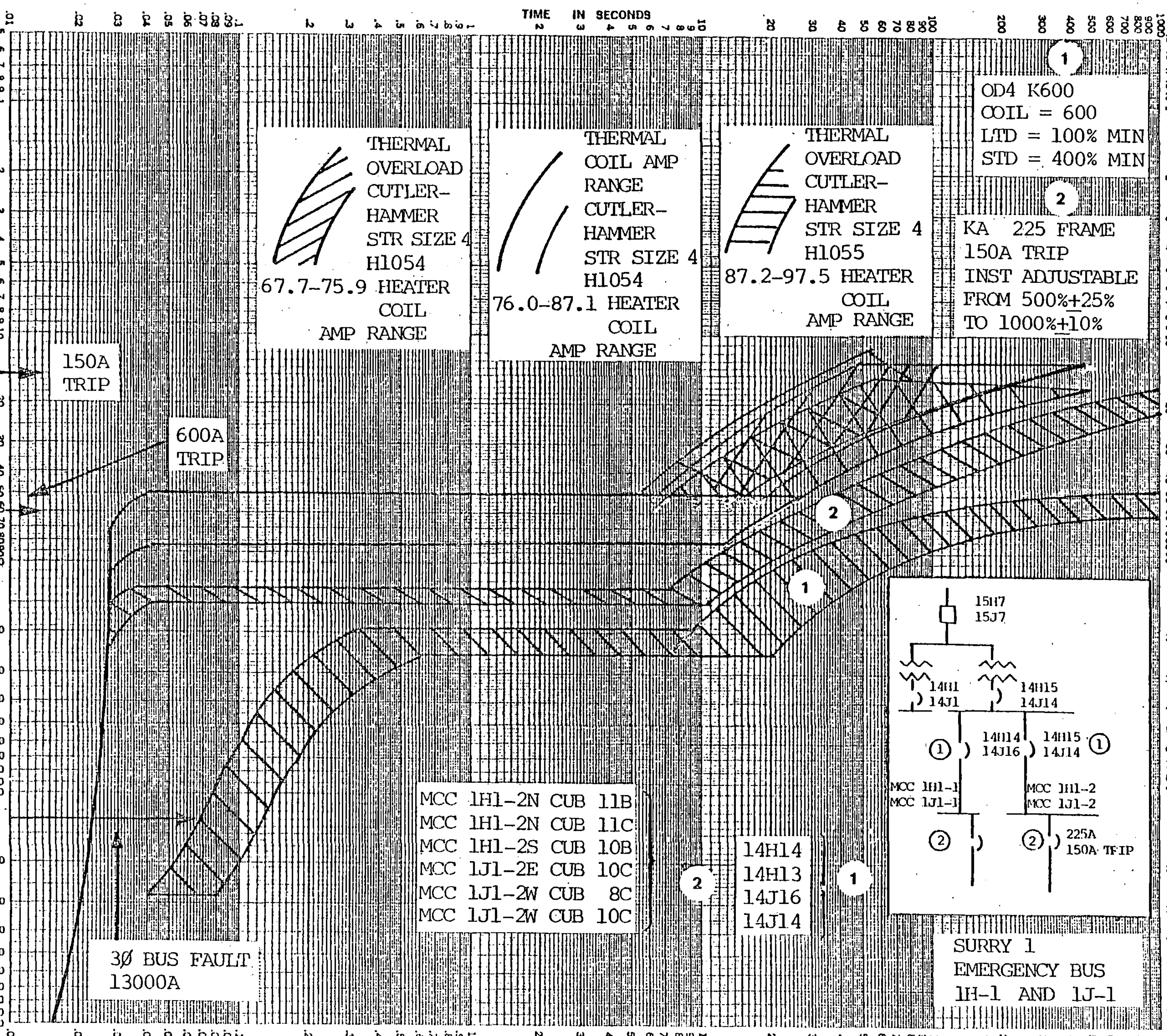
Fuse Links. In

BASIS FOR DATA Standards. Dated

1. Tests made at Volts a-c at p-f., starting at 25C with no initial load.
2. Curves are plotted to Test points so variations should be

No.
Date RCB 3/7/83

CURRENT IN AMPERES X 10 @ 480V



K+E TIME-CURRENT CHARACTERISTIC KEUFFEL & ESSER CO. MADE IN U.S.A. 48 5258

FIGURE-36

SURRY POWER STATION

P977

TABLE 1

NORTH ANNA POWER STATION

Units 1 (Unit - 2 Similar)

NONSAFETY-RELATED LOADS LOCATED IN HARSH ENVIRONMENT*

AND CONNECTED TO SAFETY BUSSES

DWG# 11715- FE	Safety-Related Bus No./ Location	CKT No.	Nonsafety Equipment Description	N. Anna Unit Loc.- Elevation
1D	4160V - 1H	15H14	RHR Pump 1-RH-P-1A	RC-217'
1D	4160V - 1J	15J14	RHR Pump 1-RH-P-1B	RC-217'
IZ	480V MCC IHI-1 (Emer. SWGR RM)	B3	Main Stm. Inlet No. 2 Drain VV. MOV-SD100A	TB-254'
1AF	480V - 1H1		Pressurizer Htr. 270KW (Backup Group)	RC-264'
1AF	480V - 1H1		Contmt. Recirc. Fan 1-HV-F-1A	RC-292'
1AF	480V - 1J1		Pressurizer Htr. 215KW (Backup Group)	RC-264'
1AF	480V - 1J1		Contmt. Recirc. Fan 1-HV-F-1B	RC-292'

*NOTE: The classification of location area for listed loads as "harsh" is based on consultant's independent and conservative judgement, as zone maps describing the non-essential areas of the North Anna Power Station are not available at this time. It is anticipated that the list will be reduced during the continuing evaluation.

Table 1 (cont.)

DWG# 11715- FE-	Safety-Related Bus No./ Location	CKT No.	Nonsafety Equipment Description	N. Anna Unit Loc.- Elevation
IZ	480V MCC IHI-1 (Emer. SWGR RM)	C3	Main Stm. Inlet No. 2 Drain VV. MOV-SD100B	TB-254'
IZ	480V MCC IHI-4 (Emer. SWGR. RM)	C2R	480V Power Receptacle	SB-254'
IZ	480V MCC IHI-4 (Emer. SWGR RM)	C2L	Radiation Monitor Fdr.	SB-254'
IZ	480V MCC IHI-4 (Emer. SWGR RM)	C3R	Process Vent RAD Mon.RM - GW178	SWGR-307'
IZ	480V MCC IHI-4 (Emer. SWGR RM)	DIL	Vent Stack A Rad Mon. RM - VG179	TB-303'
IZ	480V MCC IHI-4 (Emer. SWGR RM)	DIR	Vent Stack B Rad Mon. RM - VG180	TB-303'
IZ	480V MCC IHI-4 (Emer. SWGR RM)	C3L	Semivital Bus Panel I-EP-CB-16C	SB-260'
IR	480V MCC IJI-2N (Cable Tunnel)	A2	Primary W. Standby PP 1-PG-P-02B	FHB-249'
IR	480V MCC IJI-2S (Cable Tunnel)	K4	Alternate Pwr. Supply FDR. for SOV PNL. Inst. Dist. PNL.	SB-277'
IR	480V MCC IJI-2S (Cable Tunnel)	A4R	480V PWR. Recp.	SB-258'

Table 1 (cont.)

DWG# 11715- FE-	Safety-Related Bus No./ Location	CKT No.	Nonsafety Equipment Description	N. Anna Unit Loc.- Elevation
IP	480V MCC IJI-1 (Emer. SWGR. RM)	E3	Main Stm. Inlet No. 3 Drain VV. MOV-SD100C	TB-254'
IP	480V MCC IJI-1 (Emer. SWGR. RM)	D2	Main Stm. Inlet No. 4 Drain VV MOV-SD100D.	TB-254'
IP	480V MCC IJI-1 (Emer. SWGR. RM)	A2L	480V PWR. Recp.	SB-254'
IP	480V MCC IJI-1 (Emer. SWGR. RM)	E2L	LTG. Transf. 1C1	SB-277'
1Q	480V MCC IHI-2S (Cable Tunnel)	FI	Loop 1A Bypass Stop MOV-1585	RC-266'
1Q	480V MCC IHI-2S (Cable Tunnel)	F2	Loop 1A Hot Leg Stop MOV-1590	RC-266'
1Q	480V MCC IHI-2S (Cable Tunnel)	G1	Loop 1C Bypass Stop MOV-1587	RC-267'
1Q	480V MCC IHI-2S (Cable Tunnel)	G2	Loop 1C Hot Leg Stop MOV-1594	RC-267'
1Q	480V MCC IHI-2S (Cable Tunnel)	H2	Loop IC Cold leg Stop MOV-1595	RC-267'
1Q	480V MCC IHI-2S (Cable Tunnel)	G3	Loop IA Cold Leg Stop MOV-1591	RC 266'

Table 1 (cont.)

DWG# 11715- FE-	Safety-Related Bus No./ Location	CKT. No.	Nonsafety Equipment Description	N. Anna Unit Loc.- Elevation
1Q	480V MCC IHI-2S (Cable Tunnel)	H3	Loop IB Hot Leg Stop MOV-1592	RC-267'
1Q	480V MCC IHI-2S (Cable Tunnel)	J1	Loop IB Cold Leg Stop MOV-1593	RC-267'
1Q	480V MCC IHI-2S (Cable Tunnel)	P2R	Incore Inst. Drive Assy "D" Fdr.	RC-270'
1Q	480V MCC IHI-2S (Cable Tunnel)	P2L	480V PWR Recp.	AB-264'
1Q	480V MCC IHI-2S (Cable Tunnel)	M2R	HTR. Cab 5KVA, 1PH, 480-120/240V RC & SFGD. TR-A I-EP-CB-84A	QS-260'
1Q	480V MCC IHI-2S (Cable Tunnel)	L2R	HTR. Cab. 480V Aux. Bld. Mtr Htr.cab 1-EP-CB-84F1	AB-260'
1Q	120V Vital Bus Dist. Panel 1-II	10	Intraplant Comm. Gaitronics.- Aux. Bldg.	SB-254'
1Q	120V Vital Bus Dist. Panel 1-II	11	Intraplant Comm. Gaitronics No. 2- Containment	SB-254'

Table 1 (cont.)

DWG# 11715-FE-	Safety-Related Bus No./ Location	CKT No.	Nonsafety Equipment Description	N. Anna Unit Loc.-Elevation
1Q	120V Vital Bus Dist. Panel 1-II	12	Intraplant Comm. Gaitronics No. 1-Containment	SB-254'
1E	125V DC Dist. Cab 1-I(1-EP-CB-12A)	20	Fire Prot System (CO_2)	SB-254'
1E	125V DC Dist. Cab 1-II(1-EP-CB-12B)	4	Junction Box 1487	AB-297'
1E	125V DC Dist. Cab 1-II (1-EP-CB-12B)	8	Dist. Cabinet I-EP-CB-01	SB-254'
1E	125V DC Dist. Cab 1-II (1-EP-CB-12B)	10	Dist. Cabinet I-EP-SS-09	AB-291'
1E	125V DC Dist. Cab 1-III(1-EP-CB-12C)	8	Reactor Contmt. Emerg. Ltg. Pnl IERC1	Rod Ctl. RM-285'
1E	125V DC Dist. Cab 1-III(1-EP-CB-12C)	22	Fire Prot. Syst. Sprinkler	SB-254'
1E	125V DC Dist Cab. 1-IV(I-EP-CB-12D)	5	Fire Prot. Syst (CO_2)	TB-272'
1E	125V DC Dist Cab. 1-IV(I-EP-CB-12D)	6	Fire Prot Sys (Deludge)	TB-276'
1E	125V DC Dist Cab. 1-IV(I-EP-CB-12D)	3	Fire Prot Sys (Sprinkler)	WH-272'

Table 1 (cont.)

DWG# 11715-FE-	Safety-Related Bus No./ Location	CKT No.	Nonsafety Equipment Description	N. Anna Unit Loc.- Elevation
1E	125V DC Dist Cab. 1-IV(I-EP-CB-12D)	4	Fire Prot. Sys (Sprinkler)	SB-272'
1E	125V DC Dist Cab. 1-IV(I-EP-CB-12D)	15	Emerg. Ltg.	AB-278'

Table 2

Surry Power Station

Units 1 (Unit - 2 Similar)

NONSAFETY-RELATED LOADS LOCATED IN HARSH ENVIRONMENT AND CONNECTED TO SAFETY BUSSES

DWG #11448- FE-	Safety Related Bus No./ Location	CKT No.	Nonsafety Equipment Description	Surry Unit Location - Elevation
ID	4160V-IH	5H11	RHR Pump 1-RH-P-1A	RC-(-) 13'-0"
ID	4160V-1J	15J11	RHR Pump 1-RH-P-1B	RC-(-) 13'-0"
IQ	480V-1H1	14H12	Filter Ext. Fan 1-VS-F-58A	AB-Roof
IF	480V-1H	14H-2	Pressurizer Htr. 250KW (Back-Up-Group)	RC-3'-6"
IF	480V-IH	14H-8	Contmt. Recirc. Fan 1-VS-F-1A	RC-(-) 27'-0"
IF	480V-1J	14J-9	Pressurizer Htr. 200KW (Back-UP Group)	RC-(-) 3'-6"
1F	480V-1J	14J-7	Contmt. Recirc. Fan 1-VS-F-1B	RC-(-)27'

Table 2 (cont.)

DWG# #11448- FE-	Safety Related Bus No./ Location	CKT No	Nonsafety Equipment Description	Surry Unit Location - Elevation
IL	MCC1H1-1	———	Radiation Monitor FDR Duplex Cond PP	DB (Bsmt.)
IL	MCC1H1-1	6A	Safeguard Area 1-HSP-3B	DB (Bsmt.)
IL	MCC1H1-1	8D1	Incore Inst. Drive "D"	RC
IL	MCC1H2-1	2A	Caustic Isol MOV CS 103A	SFGD- 27'-0"
IL	MCC1H2-1	11B	Cont. Rod Cool Fans 1-VS-F-60A 1-VS-F-60C	RC-3'-6"
IL	MCC1H2-1	11C	Cont Rod Cool Fans 1-VS-F-60A 1-VS-F-60D	RC-3'-6"
IL	MCC1H2-1	11A1	FDR for 37½ KVA Cab HTR-2A2 Heat Trace	(Not Available)
IL	MCC1H2-1	5D1	480V PWR Recp Fdr & Aux Bldg Elev. Fdr	(Not Available)

Table 2 (cont.)

DWG# #11448- FE-	Safety Related Bus No./ Location	CKT No	Nonsafety Equipment Description	Surry Unit Location - Elevation
IL	MCC1H2-1	4C	RCP Bypass MOV 1585	RC-18'-0"
IL	MCC1H2-1	5B	RCP Bypass MOV 1587	RC-18'-0"
IL	MCC1H2-1	9C	RCP Inlet Stop MOV 1590	RC-18'-0"
IL	MCC1H2-1	11B	RCP Outlet Stop MOV 1595	RC-18'-0"
IL	MCC1H2-1	9B	RCP Outlet Stop MOV Stop 1591	RC-18'-0"
IL	MCC1H2-1	11C	RCP Inlet Stop MOV 1594	RC-18'-0"
IL	MCC1H2-1	7C	Boric Acid Filter To Chrg PP MOV 1350	AB-13'-0"
IL	MCC1H2-1	6D	Hydrogen Recombiner	AB-13'-0"
1M	MCC1J1-1	7B	RC Seal W Return Stop MOV 1381 To Throw Over SE	AB-(-) 2'-0"

Table 2 (cont.)

DWG #11448- FE-	Safety-Related Bus No./ Location	CKT No.	Nonsafety Equipment Description	Surry Unit Location - Elevation
1M	MCC1J1-1	3A-1	Radiation Monitor Fdr (Common Pnl) (11548-FE-IM)	(Not Available)
IM	MCC-1J1-2	10C	Cont Rod Cool Fan 1-VS-F-60C	RC-3'-6"
IM	MCC-1J1-2	3E	St. Gen Aux FD PP Htr. 1-FW-P-3A	SFGD
IM	MCC-1J1-2	9D-1	Incore Inst. for Drive Assy "E"	RC
IM	MCC-1J1-2	1A-1	H2A Tap Box 2 (DC79-62-later)	RC
IM	MCC-1J1-2	4D-2	Cont. Air	RC
IM	MCC-1J1-2	5C	Reactor Coolant PP Outlet Stop MOV 1592	RC-18'-4"
IM	MCC-1J1-2	6C	Reactor Coolant PP Outlet Stop MOV 1593	RC-18'-4"
IM	MCC-1J1-2	8C	Cont Rod Cool Fan 1-VS-F-60D & To Cont. Rod Cool Fan 1-VS-F-60F	RC-3'-6"

Table 2 (cont.)

DWG #11448-FE-	Safety-Related Bus No./ Location	CKT No.	Nonsafety Equipment Description	Surry Unit Location - Elevation
IM	MCC-1J1-2	8A	Pressurizer Relief ISOV MOV 1536	RC-58'-0"
IM	MCC-1J1-2	9C	Safeguard Supply HTG Vent Unit 1-VS-HV-4	(Not Available)
1G	125 VDC Dist. Cab 1A	--	CO_2 Fire Prot. Sys	(Not Available)
1G	125 VDC Dist. Cab 1A	--	Waste Disposal BD & Boron Recovery BD	(Not Available)
1G	125 VDC Dist. Cab 1A	--	Personnel Hatch Reactor Contmt. Emer. LTG	AB-45'-10"
1G	125 VDC Dist. Cab 1B	--	Aux BLR. 1-HS-E-4A&4B Deline Ann	SB-27'-0"
1G	125 VDC Dist. Cab 1B	--	Emer LTG Cab 1E AB1	(Not Available)
1G	125 VDC Dist. Cab 1B	--	Personnel Hatch (LTG)	AB-45'-10"
1G	125 VDC Dist. Cab 1B	--	Sprinkler Sys (Fire Prot)	(Not Available)

APPENDIX A

APPENDIX A

Excerpts from 10CFR50.49-Paragraphs (a),(b),(c) and (g)

REFERENCE:
Federal Register / Vol. 48, No. 15 / Friday, January 21, 1983 / Rules and Regulations, pg. 2733.

50.49 Environmental qualification of electric equipment important to safety for nuclear power plants.

(a) Each holder of or each applicant for a license to operate a nuclear power plant shall establish a program for qualifying the electrical equipment defined in paragragh (b) of this section.

(b) Electric equipment important to safety covered by this section is:

(1) Safety-related electric equipment[3]: This equipment is that relied upon to remain functional during and following design basis events to ensure (i) the integrity of the reactor coolant pressure boundary, (ii) the capability to shut down the reactor and maintain it in a safe shutdown condition, and (iii) the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures comparable to the 10 CFR Part 100 guidelines. Design basis events are defined as conditions of normal operation, including anticipated operational occurances, design basis accidents, external events, and natural phenomena for which the plant must be designed to ensure functions (i) through (iii) of this paragragh.

(2) Nonsafety-related electric equipment whose failure under postulated environmental conditions could prevent satisfactory accomplishment of safety functions specified in subparagraghs (i) through (iii) of paragragh (b)(1) of this section by the safety-related equipment.

(3) Certain post-accident monitoring equipment.[4]

(c) Requirements for (i) dynamic and seismic qualification of electric equipment important to safety, (ii) protection of electric equipment important to safety against other natural phenomena and external events, and (iii) environmental qualification of electrical equipment important to safety located in a mild environment are not included within the scope of this section.

A mild environment is an environment that would at no time be significantly more severe than the environment that would occur during normal plant operation, including anticipated operational occurances.

(g) Each holder of an operating license issued prior to February 22, 1983, shall, by May 30, 1983, identify the electric equipment important to safety within the scope of this section already qualified and submit a schedule for either the qualifications to the provisions of this section or for the replacement of the remaining electric equipment important to safety within the scope of this section. This schedule must establish a goal of final environmental qualification of the electrical equipment within the scope of this section by the end of the second refueling outage after March 31, 1982 or by March 31, 1985, whichever is earlier. The Director of the Office of Nuclear Reactor Regulatory may grant requests for extensions of this deadline to a date no later than November 30, 1985, for specific pieces of equipment if these requests are to be filed on a timely basis and demonstrate good cause for the extension, such as procurement lead time, test complications, and installation problems. In exceptional cases, the Commission itself may consider and grant extensions beyond November 30, 1985, for completion of environmental qualification.

---

[3]Safety-related electric equipment is referred to as "Class 1E" equipment in IEEE 323-1974. Copies of this standard may be obtained from the Institute of Electrical and Electronics Engineers, Inc. 345 East 47th Street, New York, NY 10017.

[4]Specific guidance concerning the types of variables to be monitored is provided in Revision 2 of Regulatory Guide 1.97. "Instrumentation of Light-Water Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident." Copies of the Regulatoyr Guides can be obtained from Nuclear Regulatory Commission. Document Management Branch, Washington, DC 20555.

APPENDIX B

APPENDIX B

List of References

1. 10CFR50.49 "Environmental Qualification of Electric Equipment Important to Safety".

2. USNRC letter dated April 4, 1983, Steven A. Varga to W. L. Stewart "Clarification of Environmental Qualification Safety Evaluation Report" for Virginia Electric and Power Company, Surry Power Station Units 1 and 2.

3. USNRC letter dated March 24, 1983, Robert A. Clark to W. L. Stewart "Safety Evaluation for Environmental Qualification of Safety Related Equipment" for North Anna Power Station, Units 1 and 2.

4. VEPCO letter dated May 20, 1983, W. L. Stewart to Harold R. Denton "Environmental Qualification of Safety Related Electrical Equipment" for North Anna Power Station Units 1 and 2.

5. VEPCO letter dated May 20, 1983, W. L. Stewart to Harold R. Denton "Environmental Qualification of Safety Related Equipment" for Surry Power Station Units 1 and 2.

6. USNRC letter dated April 8, 1983, Richard H. Vollmer and Roger Mattson for Darrell Eisenhut "Guidance For Licensees and License Applicants to demonstrate compliance with 10CFR50.49, Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants".

7. IEEE Std-279-1971 "Criteria for Protection System for Nuclear Power Generating Station".

8. IEEE Std-308-1980 "Standard Criteria for Class IE Power Systems for Nuclear Power Generating Systems."

APPENDIX B

List of References (cont'd)

9. IEEE Std-323-1974 "IEEE Standard for Qualifying Class IE Equipment for Nuclear Power Stations."

10. IEEE Std-323A-1981 (Supplement to IEEE Std-323-1974) "IEEE Standard for Qualifying Class IE Equipment for Nuclear Stations."

11. IEEE Std-384-1981 "Criteria for Independence of Class IE Equipment and Circuits."

12. IEEE Std-603-1980 "Trial-use Standard Criteria for Safety Systems for Nuclear Power Generating Stations."

13. IEEE Std-627-1980 "Standard Quality Assurance Program Requirements for the Design and Manufacture of Class IE Instrumentation and Electric Equipment for Nuclear Power Generating Stations."

14. Reg. Guide 1.106, Rev-1, 1977 "Thermal Overload Protection for Electric Motors on Motor-Operated Vavles."

15. Reg. Guide 1.118, Rev. -2, 1978 "Periodic Testing of Electric Power and Protection Systems."

16. Reg. Guide 1.32, Rev-2, 1977 "Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants."

17. Reg. Guide 1.47, Rev.-0, 1978 "Bypassed and inoperable Status Indication for Nuclear Power Plant Safety Systems."

18. Reg. Guide 1.6, Rev.-0 1971 "Design Response Spectra for Seismic Design of Nuclear Power Plants."

19. Reg. Guide 1.63, Rev.-2, 1978 "Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants."

APPENDIX B

List of References (cont'd)

20. Reg. Guide 1.75, Rev.-2, 1978 "Physical Independence of Electric Systems."

21. Reg. Guide 1.89, Rev-0, 1974 (Proposed Rev-1 to Reg. Guide 1.89) "Qualification of Class IE Equipment for Nuclear Power Plants."

22. Reg. Guide 1.93, Rev-0, 1974 "Availability of Electric Power Sources."

APPENDIX C

APPENDIX - C

Bibliography of Technical Source Data

1. IEEE Std. 242-1975-"Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems".

2. ANSI/IEEE Std 399-1980 Recommended Practice for Power System Analysis.

3. Beeman, D.L., Ed., "Industrial Power System Handbook" New York, McGraw-Hill, 1955.

4. Robert N. Smeaton, Switchgear and Control Handbook, McGraw-Hill, 1977.

5. IEEE Transactions on Power Apparratus and Systems, PAS-92/#1 Paper No. T72232-2 "Optimal Application of Major Electrical Equipment to Generating Station Auxiliary Systems", January/February, 1973.

6. IEEE Transactions on Industrial Applications, "Total Motor Branch Circuit-Protection with Instantaneous Trip Type Circuit Breakers and High Fault Circuit Protectors (HFCP)", Vol. 1A11, No. 4, July/August, 1975.

7. Technical paper F78 138-0 "An Approach to Associated Power Circuits" by E.J. Gough, E.I. Fabri, Bechtel Power Corporation, GM McHugh, Jr., Boston Edison Company, Presented at the IEEE Power Engineering Society Winter Meeting, January 29 - February 3, 1978.

8. Technical Paper A 78 046-5 "Electrical Aspects of Safety-Related Equipment in Nuclear Power Plants" by L. Rebenstein, Stone & Webster Engineering Corporation, IEEE PES Winter Meeting January 27 to February 1, 1974.

APPENDIX-C (con't.)

Bibliography of Technical Source Data

9. Conference Paper 71-CP652-PWR "Applications of Static Uninteruptible Power Supplies in Central Power Generating Stations" by L.C. Gonzalez and S. Cunninghis, Ebasco Services, Inc., IEEE Summer Meeting, July 18-23, 1971.

10. General Electric Publication No. 2779D, "Application and Selection, Molded Case Circuit Breakers, February, 1973.

11. General Electric Review, "Co-ordination of Protective Devices for Control-Power Circuits", by James R. Palmer, December 1949.

12. "Co-ordinating Protection for Electrical Systems in Plants", Part I, by Irwin Lazar, Heyward-Robinson Co., Inc., Specifying Engineer, April, 1976.

13. Applied Protective Relaying, Westinghouse Electric Corporation, Newark, N.J.

APPENDIX D

APPENDIX - D

List of specific and significant VEPCO documents reviewed:

1. North Anna Power Station, Units 1 and 2 - UFSAR, Chapter 3, 6, 7, and 8.

2. Surry Power Station, Units 1 and 2 - UFSAR, Chapter - 3, 6, 7, and 8.

3. North Anna Power Station, Unit 1 - IE Bulletin 79-01B, 90 day review.

4. North Anna Power Station Unit 2 - NUREG-0588 review.

5. Surry Power Station, Unit 4, IE Bulletin 79-01B, 90 day review.

6. Surry Power Station, Unit 2 IE Bulletin 79-01B, 90 day review.

7. North Anna Power Station, Unit 1, Response to Safety Evaluation Report.

8. Surry Power Station Units 1 and 2, Response to Safety Evaluation Report.

9. VEPCO, North Anna Power Station, Units 1 and 2, Environmental Zone Description, Volume - 1.

10. VEPCO, Surry Power Station, Units 1 and 2, Environmental Zone Description, Volume -1.

11. Plant Manual, North Anna Power Station, Units 1 and 2, Volumes - 1 thru 12.

12. System Description and Logic Diagrams, Surry Power Station, Units 1 and 2.

13. North Anna Power Station, Units 1 and 2 - Electrical One Line Diagrams.

14. Surry Power Station, Units 1 and 2 - Electrical One Line Diagrams.

15. North Anna Power Station - Equipment Specification

NAS - 34 : 480V Unit Substation
NAS - 46 : 4160V Metal Clad Switchgear
NAS - 70 : Battery Distribution Cabinets
NAS - 198 : AC Distribution Panel
NAS - 123 : Motor Control Centers

16. Surry Power Station, equipment specifications:

NUS - 76 : 4160V Metal Clad Switchgear
NUS - 108 : 480V Low Voltage Metal Clad Switchgear
NUS - 123 : Lighting Unit Substations
NUS - 262 : Battery Distribution Switchgear boards
NUS - 359 : Motor Control Centers
NUS - 9055 : Low Voltage Motor Control Centers
NUS - 9135 : Panels boards Lighting and Power Distribution A&C

17. VEPCO, Nuclear Power Station, Quality Assurance Manual.

18. North Anna Power Station, Units 1 and 2, "Safety Related Electrical Schematics" NA-TR-1001, May 10, 1973.

19. VEPCO Internal Memo: From N. B. Tweed Jr. to J. T. Emery, "480V Switchgear Setting Criteria", dated June 15, 1977.

APPENDIX E

Resumes of Key Leadership
of 10CFR50.49 (b)(2)
Review Effort

LAWRENCE P. GRADIN, P.E. 11/83
PROJECT MANAGER

EXPERIENCE SUMMARY

Mr. Gradin is a registered professional engineer with more than 17 years of experience in electrical, instrumentation and control, and related power engineering activities for fossil, nuclear, and advanced nuclear reactor power plants (14 years with nuclear power). His unique contributions to the nuclear industry include the creation, leadership, and development of the first:

- -- Solid state modular safety related heat tracing control system for nuclear power plants;
- -- Integrated plant security and fire detection system satisfying detailed USNRC criteria;
- -- Technology training program in Electrical, Instrumentation and Control Technology for the USNRC and industry;
- -- Equipment Qualification Program to pass a USNRC audit to the criteria established by the USNRC Orders in 1980.

EXPERIENCE

As Manager of Electrical, Instrumentation and Control, Mr. Gradin is responsible for all nuclear power related EI&C activities at NPS. This encompasses a full range of engineering and design activities, from selection of sensors, logic and control functions and equipment, control room reviews, through to and including the complete power supply systems in utility, industrial and commercial facilities. Additionally, as Associate Director of the NPS Technical Institute, Mr. Gradin, in conjunction with the Institute Director, assures that the Institute technical training programs and workshops are organized under responsible leadership, capable direction and qualified instruction. Representative programs are provided for the following disciplines: mechanical, electrical, civil, seismic, instrumentation and control and quality assurance. Mr. Gradin's membership in the IEEE Nuclear Power Engineering Committee's Subcommittee 1, "General Plant Criteria" and Subcommittee 3, "Operations, Surveillance, and Testing", plus selection as a leading lecturer in the Advanced Equipment Qualification seminar by IEEE for fall 1983 demonstrates industry recognition of his contribution.

Equipment Qualification Program Manager success included direct management of a multi-discipline, multi-project engineering and scientific team which addressed equipment qualification on a generic and specific nuclear power plant basis. Accomplishments included the development, preparation, review, presentation and ultimate acceptance by the USNRC of the nation's first successful EQ effort in response to NUREG 0588 Category I requirements, as well as successful response to IEB 79-01B and NUREG 0588 Category II requirements. This effort included interpretation of USNRC documents, methodology to determine radiation source terms, thermal and mechanical aging, preparation of computer based documentation packages, interface with industry groups such as Atomic Industrial Forum, Electric Power Research Institute, IEEE Nuclear Power Engineering Committee, etc.

Mr. Gradin also led the development of a Nuclear Plant Equipment Data System which integrates Cable and Raceway Schedules, Instruments Lists, Valve Lists, Computer Aided Design, Radiation Temperature and Humidity Zone Mapping, Generation of Equipment Qualification Component Evaluation Sheets and Life Cycle/Maintenance, Support of Fire Protection Zoning, Human Factors Engineering Control Room Equipment Listing, Safe Shutdown Lists, etc. Technical Training expertise and past experience includes the preparation, supervision direction and presentation of high technology, continuing education technical training. Training experience includes training of US Nuclear Regulatory Commission utility, national laboratory and professional personnel from the international community.

As a Former Supervising Engineer of Instrumentation and Control, Mr. Gradin was responsible for the direct supervision of Lead I&C Discipline Engineers and approximately twenty-five professionals for St. Lucie 1 & 2. Services included performing necessary upgrading and licensing procedures for the retrofit of a nuclear plant and other I&C tasks (e.g. NUREG 0737, RG 1.97, NUREG 700, Appendix "R"etc.) for both an operating nuclear unit and a unit under construction. Other management Electrical, Instrumentation and Control experience included serving as the Assistant Section Manager of the Electrical, Instrumentation, and Control disciplines. In this capacity, Mr. Gradin was responsible for the direct supervision of four Group Supervisors and approximately forty engineering personnel in electrical, instrumentation and control engineering for the Clinch River Breeder Reactor Plant.

Electrical engineering experience included serving in senior level positions such as Principal Electrical Engineer and Lead Discipline Engineer for major nuclear power plants. Mr. Gradin was responsible for all electrical engineering functions and direction of the Electrical/Design team (approximately 25 professionals) necessary to design these plants.

As Senior On-Site Project Electrical Engineer at the St. Lucie #1, he was responsible for technical supervision of an on-site Electrical Engineering and Design Staff with regard to electrical general arrangement drawings, lighting drawings, sizing of electrical equipment, design of plant security systems,fire protection systems, equipment specification, purchasing of electrical equipment, engineering estimates and manpower forecasts and participation in meetings and hearings with NRC and ACRS.

In addition, Mr. Gradin has served as a Lead Discipline Engineer on several fossil-fueled projects.

EDUCATION

New York Institute of Technology, B.S., Magna Cum Laude, 1969.

Mr. Gradin has also successfully completed NSSS Nuclear Reactor Technology Courses, a certification program at the American Management Research Institute and Dale Carnegie, various nuclear energy, electrical design, and equipment qualification study groups, and several management courses at New York University.

LICENSES

Professional Engineer: New York and California

PROFESSIONAL

Institute of Electrical and Electronics Engineers (IEEE) - Sr. Member:

1) Power Engineering Society (Nuclear Power Engineering Committees SC-1, SC-3)
2) Industrial Applications Society
3) Instrumentation & Measurement Society
4) Nuclear & Plasma Sciences Society
5) Reliability Society
6) Program Committee of New York and Long Island Sections, Joint Power Engineering Society and Industrial Applications Society Chapter
7) Former Working Group Member Electric Heat Tracing Committee

Instrument Society of America (ISA) - Sr. Member: Power Division
American Nuclear Society:

1) Human Factors Division
2) Nuclear Safety Division
3) Power Division

American Society of Industrial Security
Underwriters Laboratory Open Forum
Atomic Industrial Forum - Environmental Qualification Subcommittee Member
American Society for Engineering Education - Member:

1) Continuing Professional Development
2) Electrical Engineering
3) Engineering Management
4) Instrumentation
5) Nuclear Engineering
6) Relations with Industry

HONORS

New York State Regents Scholar
Listed in "Who's Who in the East"
Listed in "Who's Who in Frontier Science and Technology"

PUBLICATIONS

1. Principal Author, "Electrical Technology for Nuclear Power Plant Safety Systems", (An Engineering Seminar's Three Volume Text - First Edition - 1980, Second Edition - 1982).

2. Principal Author, "USNRC Training Program - Electrical Training Course", Comprehensive Six Volume Text for USNRC Personnel, 1979

3. "Environmental Qualification - Use of Industry/Commercial Standards in Lieu of Surveillance Maintenance," Nuclear Plant Safety, March/April 1983.

4. "IEEE Advanced Equipment Qualification Seminar, Two Comprehensive Session Texts: (1) "Systems Engineering Approach to Equipment Qualification" (2) "Practical Use of Commercial Grade Equipment and Industrial Standards for Equipment Qualification."

5. "Independent Design Verification and Quality Assurance Auditing for Nuclear Plants", Nuclear Plant Safety, November/December, 1983.

6. "Usefullness of Commercial Electrical Standards for Qualified Life Determination", American Nuclear Society, 1983 Winter Meeting.

GOBIN GANGULY, P.E. 11/83
PROJECT ENGINEER

EXPERIENCE SUMMARY

Mr. Ganguly is a registered professional engineer with more than fifteen (15) years of experience in electrical, instrumentation and control and related power engineering activities for fossil, nuclear and advanced nuclear reactor power plants. Senior level positions have included Lead, Principal or Project Engineer on new utility power plants, consultant in major architect-engineering firm in equipment qualification, lead electrical engineer on breeder reactor development.

EXPERIENCE

As Project Engineer and Assistant Project Manager, responsibilities include direct leadership of Equipment Qualification and RG 1.97 effort at VEPCO for the North Anna and Surry Power Stations.

Among responsibilities as Principal Electrical Engineer have been electrical engineering and design for a multi-unit pressurized water reactor Westinghouse plant (each unit being 900 MWE). He was involved in all aspects of electrical engineering activities, and provided guidance to a team of 12 engineers and many electrical and wiring designers for design of the plant. Included in this assignment was project supervision for fire protection, Appendix R, environmental qualification of electrical equipment, evaluations of NRC and industry positions on equipment qualification, FSAR preparation, incorporation of NUREG 0737 and Regulatory Guide 1.97 requirements, and all related activities.

Responsibilities as an Equipment Qualification Engineer required direct participation in a major architect-engineering firm's corporate approach to equipment qualification on operating nuclear units, near term operating license (NTOL) plants and construction permit (CP) plants. Mr. Ganguly has demonstrated familiarity with IEB 79-01B (DOR Guidelines), NUREG 0588, and recently promulgated 10CFR50.49. He acted as lead

in the development of a cost-sensitive approach to equipment qualification which maximizes use of commercial/industry standards and demonstrates equipment qualification in lieu of unnecessary testing. Mr. Ganguly possesses working level as well as leadership knowledge of aging analysis methodology, equipment safety categorization, preparation of master lists, and submittal to NRC.

As Lead Engineer for oil to coal conversion projects, his responsibilities have ranged from initial preparation of proposal package for the overall project to development of initial plant design criteria, plant layout and cost benefit studies for major equipment such as precipitators, coal handling system, etc.

Mr. Ganguly also functioned as Lead Electrical Engineer for engineering and design of the nation's first demonstration plant utilizing Breeder Reactor Technology for the U.S. Department of Energy. In that capacity, his responsibilities included electrical system design and development of plant one line diagrams and system design criteria, as well as determination of equipment size and ratings with associated design support. He assumed supervision responsibility for the electrical engineers and design team.

Special activities have involved leading the development of plant data acquisition and control systems utilizing multiplexing and microprocessor based technology for both nuclear and non-nuclear systems. He evaluated and implemented the regulatory requirements towards satisfying the Licensing requirements, especially with regard to remote shutdown and independence requirements, and also performed review of design change requests.

Mr. Ganguly's work experience reflects full development of electrical system design (short circuit, voltage drop, relay coordination) studies and preparation of engineering drawings and associated equipment estimating, specifications and purchasing. His experience base encompasses meetings with NRC staff, response to NRC questions, and on-site Start-Up engineering.

Practical "hands-on" equipment and maintenance-oriented experience includes 10 years of power plant operation and maintenance activity, procedures development and actual direction as an Electrical Operation Engineer for a four (4) unit power plant, site assignments, relay maintenance/ setting, scheduled start-up and shutdown activities for fossil and nuclear power plants.

EDUCATION

Polytechnic Institute of New York, M.S. (Systems Engineering) - 1974

BS, Electrical Engineering.

Other course work includes participation in various energy policy and issues study groups at Polytechnic Institute of New York, electrical distribution and coordination studies with General Electric, and project management system workshops.

LICENSE

Professional Engineer, New York

PROFESSIONAL

Institute of Electrical and Electronics Engineers (IEEE):

1) Power Engineering Society
2) Industrial Applications Society
3) Program Committee of New York and Long Island Sections, Joint Power Engineering Society and Industrial Applications Society Chapter.

RICHARD A. LEONE 11/83

LEAD ENGINEER

EXPERIENCE SUMMARY

Mr. Leone is a senior level engineer with more than 15 years of experience in electrical engineering for nuclear and fossil power plants. His experience has included nuclear related licensing activities in risk assessment, as well as, the classical engineering activities of electrical protection and design.

EXPERIENCE

As Risk Assessment Engineer - Nuclear Operations, Mr. Leone was responsible for reliability/availibility analysis of nuclear power plant systems and associated electrical, mechanical and instrument and control sytems in response to NRC safety/risk assessment related requirements. This work includes failure modes and effects analysis developement, fault tree construction and analysis, failure data base developement and reviewing system operating, test and maintenance practices. Mr. Leone's project experience includes the Shearon Harris Emergency Load Sequencer Reliability Study, and participating in the Waterford 3 and Shearon Harris Control System Failure Studies and the Waterford 3 SOAR instrumented fault three effort. He also provided technical support to the department's engineering staff.

As System Protection and Control Engineer, Mr. Leone designed and engineered numerous power related protection and control systems, including early generator-turbine valve action initiation, single phase line fault tripping and reclosing, power line communication systems for control and protection, generating station distribution systems, bulk transmission systems (765,500, 345, 138, and 69 KV) and automatic capacitor bank control. This work included system selection and conceptual design, relay settings, relay/fuse coordination, checking and approving project elemen-

tary, wiring and field change drawings, and/or carrier reverse polarization analyses for such substations and plants as Cook Nuclear, Rockport, Kammer, Muskingum River, and Tidd fossil plants, and Smith Mountain and Claytor hydroelectric generating stations.

Other significant assignments included participation in a six week onsite investigation of Cook's plant performance, and analysis of high horse power fluid coupling applications for large transmission system connected synchronous condensers and variable speed drives for induced draft fan use to ultra large coal scrubbers. Technical research, interviewing and writing skills were demonstrated in addition to training less experienced and new engineers.

As Electrical Engineer/Power Engineer-Operations and Maintenance, Mr. Leone participated in the design, engineering and construction of a major air and water pollution control project and a multi-fluid pumping installation. He investigated chemical process facilities' efficiency improvement means, both for steam generation and utilization, and electricity distribution and use.

EDUCATION

New Jersey Institute of Technology, B.S., Electrical Engineering, 1968.

Illinois Institute of Technology and Midwest College of Engineering: Graduate level courses in Nuclear Rector Control, Control Theory, Advanced Mathematics and Business (Contract) Law, 1968-1970.

PROFESSIONAL

Member of Electrical and Electronics Engineers (IEEE).