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Southern Nuclear Operating Company
the southern electric system

January 26, 1994

Docket Nos. 50-348
50-364

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Joseph M. Farley Nuclear Plant
Request for Additional Information Regarding
Southern Nuclear Operating Company Responses To
Issues Related to FNP Electrical Distribution System Functional Inspection

Gentlemen:

By letter dated November 16, 1993, the NRC requested additional information regarding Southern Nuclear Operating Company responses to issues related to the Farley Nuclear Plant (FNP) Electrical Distribution System Functional Inspection (EDSFI). During a conference call involving NRC NRR personnel and SNC staff, additional clarification was provided regarding the NRC Request for Additional Information (RAI). Attached is the information that SNC agreed to provide for each RAI topic.

If further clarification is necessary, please advise.

Respectfully submitted,

Dave Morey

DPH/clt:edsfireq.doc

Attachment

cc: See next page.

A001

cc: U. S. Nuclear Regulatory Commission, Washington, D.C.
B. L. Siegel

U. S. Nuclear Regulatory Commission, Region II
S. D. Ebneter, Regional Administrator
T. M. Ross, Senior Resident Inspector

Attachment

Request for Additional Information Regarding
Southern Nuclear Operating Company Responses To
Issues Related to FNP Electrical Distribution System Functional Inspection

NRC Requests:

Unresolved Item 348, 364/92-17-05, Degraded Grid Voltage Relay Settings Specified by Technical Specifications (TS) are Inadequate.

Issue:

The licensee's calculations indicated that the degraded voltage relay setpoints currently utilized in the Technical Specifications (TS) would not ensure sufficient voltage was maintained to all safety loads. As a result before the minimum settings would be reached, some safety-related loads below the 600 V level would become inoperable. Administrative controls had been implemented to ensure adequate voltage, with the offsite dispatch center having the primary responsibility. The administrative lower limit resulted in a minimum expected steady state voltage for an accident scenario of 93.7 percent at the 4160 V safety-related buses. Region II confirmed that this voltage translated to adequate voltage throughout the safety-related systems. The minimum acceptable degraded voltage relay setpoint specified by TS Table 3.3.4 was 87.45 percent at 4160 Vac safety-related busses.

Request for licensee:

The NRC staff issued generic correspondence dated August 8, 1979, addressing "Adequacy of Station Electric Distribution System Voltages." This correspondence required each licensee to review the electric power systems at each of their nuclear power plants and determine analytically if the offsite power system is of sufficient capacity and capability to automatically start, as well as operate, all required safety loads. This correspondence also required that the analytical results be verified. In response to this generic correspondence, Alabama Power Company (APC) submitted voltage analyses and verification results on December 11, 1979. This submittal was reviewed and evaluated by the Idaho National Engineering Laboratory (EG&G). By letter dated February 18, 1981, the NRC technical staff provided a safety evaluation (SE) that concluded the voltage analyses and test results provided by APC were acceptable. Table 2, "Comparison of Analyzed Voltage and Undervoltage Relay Setpoints," in the Technical Evaluation Report, dated January 1981, and provided to support the staff SE indicates that the relay setpoints for degraded grid are 89.65 percent (±1) at 4.16kV safety-related buses with 20-30 second time delays. Currently, minimum acceptable degraded voltage relay setpoints specified by TS Table 3.3.4 are 87.45 percent at 4.16kV safety-related busses. This being the case, provide technical bases for changing the degraded voltage relay setpoints. In addition, provide a list of safety and/or non-safety related loads that have been added or deleted since the last degraded grid voltage study was performed. Further, explicitly identify the 120 Vac safety-related loads that are not supplied by an inverter or a voltage regulation transformer.

Attachment

In recent years, Southern Company Services (SCS) has developed a load study to evaluate the adequacy of voltages to safety-related components using updated analysis models for the electrical system to a level of detail that includes 208 Vac and 120 Vac systems. Describe how SCS verified the accuracy of the updated analysis models and associated analyses results. In addition, identify what safety-related loads and non-safety-related loads have been included in these analyses and describe how the updated load study ensures that the current degraded grid voltage relay setpoints are technically adequate and acceptable.

SNC Response:

In response to the NRC request dated August 30, 1977, APC letter dated November 7, 1977, provided the design basis for the degraded grid relay set point. APC proposed inverse time relays set at approximately 90% of nominal bus voltage with the time dial selected to avoid nuisance tripping. As the details of the design were developed, this set point was specified as 3675V or 88.34% of 4160V. The relay scheme and Technical Specifications include lower and upper tolerance limits of 3638V (-1% or 87.45% of 4160V) and 3749 (+2% or 90.12% of 4160V) respectively. As documented and referenced in the Technical Evaluation Report (TER) of January 1981, APCo's submittal of the basis and setpoint for the above relay scheme were evaluated according to the NRC criteria and position, and found to be acceptable. However, Table 2 of the TER incorrectly identifies the setpoint as 89.65%. This voltage level is not the set point but was the minimum expected voltage at the 4160V safety-related bus, as is also indicated in the same Table 2 and further supported by Case A2 of Figure SKE-1002 of our December 11, 1979, letter. Neither the basis nor the set point of the degraded grid relays have changed since our first submittal as evidenced in Item 7.b of Table 3.3-4 in our Technical Specifications.

Since 1979, changes to the configuration and operation of the transmission system have resulted in a higher minimum expected grid voltage today of 101.61% of 230kV. Annual calculations document the current configuration as well as proposed load changes to the FNP electrical auxiliary system. A comparison of the voltage levels evaluated in the December 11, 1979, letter with the voltage levels which would be experienced today, reveals that bus voltages have improved. This would indicate that load changes have not had an adverse impact and that the voltage levels at 120V non-regulated buses have improved.

In recent years, Southern Company Services has expanded analytical capabilities to evaluate voltages at selected safety-related loads down to the 208V level, in addition to the 4160/600V buses. This model was validated by comparison with field test data in 1986 and again in 1988 with the test data and model which had been validated in the original studies for Unit 2 in 1980. These expanded calculations include all buses, specific motors of interest (all 4kV, large 600V and selected smaller loads) but are limited to three phase models. Manual calculations provide specific evaluations of smaller individual loads, single phase loads and control circuits. Proposed changes are evaluated for impact to these calculations. These calculations ensure adequate voltage to all safety related components at the minimum expected switchyard voltage.

As summarized in the TER of January 1981, voltage levels were within the operating limits of Class 1E equipment for all expected plant and system grid operating conditions, and spurious operation of voltage protection relays would not occur with the offsite grid voltage within its expected limits. As stated above, the bus voltage levels which formed the basis for the relay scheme acceptance in 1981 have improved. Improvements have been made in offsite source voltage range, system grid operations and plant-system interface by the implementation of our Power Quality Guide. FNP has made additional advances in calculation methods and details. As a result, various design improvements to low voltage loads have been implemented as deemed prudent.

As discussed in the SNC response to Unresolved Item 92-17-05 dated November 5, 1992, administrative controls are in place to address the potential of plant operation with switchyard voltage above the degraded grid relay setpoint but below the minimum expected voltage. Per procedure FNP-1/2-AOP-5.2, plant operation with 4160V bus voltage less than the voltage corresponding to the minimum expected switchyard voltage is limited to one hour prior to initiation of an orderly shutdown. It is the SNC position that this procedural means of addressing potential undervoltage conditions is the preferred mechanism in terms of minimizing the challenge to plant safety systems and the electrical grid. Existing measures ensure plant safety is maintained while allowing a reasonable period of time to restore adequate system voltage and avoid separation from preferred power.

NRC Requests:

Unresolved Item 348, 364/92-17-07, Auxiliary Building Battery voltage is Marginal for Present Load Requirements.

Issue 1:

The TS and FSAR imply two hours of adequate battery voltage in the absence of other DC sources. The licensee's calculation demonstrated only a one-minute capability. The licensee's personnel stated that this was sufficient in that, within one minute of a loss of offsite power, EDGs would be in operation providing DC power through the chargers.

Request for licensee:

It is our understanding that the 2-hour battery capacity requirement is derived from a recommendation contained in NUREG-0611 (referenced in Standard Review Plan (SRP) Section 10.4.9) in which turbine-driven auxiliary feedwater (AFW) pumps are to be available for 2 hours assuming a total loss of AC power and control power to these pumps is from DC sources. This being the case, each auxiliary building safety-related battery is required to have adequate storage capacity to carry vital DC loads for 2 hours assuming a total loss of AC power. Thus, explain in detail how each auxiliary building safety-related battery complies with this requirement.

Section 4.8.2.3.2.c.5 of the TS requires verification at least once per 18 months that the battery capacity is adequate to supply and maintain in OPERABLE status all of the actual emergency loads for 2 hours when the battery is subjected to a battery service test or the individual cell voltage does not decrease below 1.75 volts when the battery is subjected to the equivalent load profile based on anticipated breaker operations required during loss-of-offsite power (LOSP) and loss-of-coolant accident (LOCA) conditions as described in the Final Safety Analysis Report. Provide the current vs. time curve for the equivalent load profile referred to above and verify that each auxiliary building battery is tested to this profile.

SNC Response:

The FNP turbine driven AFW system is supported by an uninterruptible power system (UPS) which has a dedicated battery. As documented in FNP FSAR Update section 8.3.3, the UPS is independent of the Auxiliary Building batteries and has adequate capacity to supply the turbine driven AFW system for a period of 2 hours in the absence of AC power.

The current versus time profile for the Auxiliary Building batteries is documented in FNP FSAR Update section 8.3.2.1.1.1.2. The surveillance test procedures for the Auxiliary Building batteries ensure that each battery is tested to the appropriate profile. These procedures were reviewed by the NRC during the recent EDSFI follow-up inspection as documented in NRC Inspection Report 50-348, 364/93-27 (2.9) dated November 24, 1993.

NRC Requests:

Issue 2:

Region II questioned the licensee's justification for the adequacy of DC voltage to close 4kV breakers following a loss of AC power. The vendor's data for 4kV breaker close and trip coils had been ignored in favor of measured test data that produced a lower calculation volt drop. These measurements were made by the licensee on a small sample and employed neither statistical sampling techniques nor an approved test procedure. Further, new acceptance values were not included in the procurement specification for replacement parts to ensure capabilities of the replacements.

Request for licensee:

Using the auxiliary building battery minimum voltage values as specified in the TS and using 4 amperes in calculating voltage drops to the 4kV breaker closing and tripping coils, provide DC voltage values at the terminals of the closing and tripping coils.

Provide information from the manufacturer's documents that describes the method/approach to be used to determine the minimum current values necessary to operate the 4kV breaker closing and tripping coils. Explain in detail why the measured current values obtained using a small sample population and employing neither statistical sampling techniques nor an approved test procedure are considered technically adequate and acceptable for use in calculations.

Provide technical justification for not including the new acceptable current values in procurement specifications for 4kV breaker replacement parts to provide assurance of the capabilities of these parts.

SNC Response:

During the recent EDSFI follow-up inspection, calculations were performed that demonstrated adequate voltage to the 4kV breakers based on vendor published data and the minimum expected voltage that would be provided by the battery at the time of breaker operation. This evaluation assumed no credit for design input from site specific testing. On this basis, this issue was closed by the NRC during the recent EDSFI follow-up inspection as documented in NRC Inspection Report 50-348, 364/93-27 (2.6) dated November 24, 1993.

NRC Requests:

Inspection Follow-up Item 348, 364/92-17-13, Inadequate Motor Overload Protection

Issue 1:

The reactor coolant pump motors have narrow tolerances between the thermal limits and the full load and starting currents. Their protective relay settings were selected to avoid spurious tripping during acceleration and running, thus making it impossible to protect the motors on overloads. Both relays used in motor protection (IAC66K and CO11) were set above the thermal limits of the motor for acceleration and running conditions. Therefore, the motors were not provided with protection for overload conditions. The thermal limit curve indicated that, if the motors were allowed to run at 90 percent of the rated voltage, they would be damaged in nine minutes.

Request for licensee:

Provide time-current characteristic curves for equipment items associated with the reactor coolant pump motors. The response should include: (1) inrush current (Is) curves with 80 percent and 100 percent bus voltage available, (2) both relay curves used for the RCP motor protection (IAC66K and CO11), (3) thermal limit curves for RCP motor stator and rotor windings, (4) RCP motor bus upstream main breaker thermal limit curves, (5) RCP motor cable thermal limit curves, (6) containment penetration thermal limit curves, and (7) fuse thermal limit curves, if fuses are connected in series between the RCP motor feeder breaker and the RCP motor. In addition, provide relay trip setpoints for protective relays IAC66K and CO11.

Assuming that the thermal limits of RCP motor windings are exceeded frequently, discuss the possibility that the RCP seal could be damaged due to overheating and/or excessive vibration. If this is not considered possible, provide a detailed explanation to include technical bases in the response.

SNC Response:

The following curves are attached:

- RCP Motor Acceleration and Thermal Limit Curve
- Protective Relaying Curves
- RCP Main Breaker and RCP Motor Cable Thermal Limit Curves
- Containment Penetration Thermal Limit Curve

Power circuits for the FNP RCPs do not employ fuses.

As discussed in the SNC response to EDSFI issues dated November 5, 1993, the FNP design provides motor winding temperature alarms to ensure protection during motor running (i.e., normal operation below 2000 amps). During motor starting, protection is provided by the combination of IAC66K relay and the CO-11 relay. This combination provides complete protection from approaching the motor thermal limit from 2000 amps to approximately 3700 amps. Above 3700 amps it is possible to exceed the RCP motor thermal limit for a few seconds prior to protective relay actuation. Although this relaying scheme does not afford complete protection from exceeding the thermal limit, this scheme was determined to be optimal, in terms of maximizing motor protection while limiting nuisance trips, during plant design and startup. Experience has confirmed these settings to be adequate.

It should be noted that exceedance of the RCP thermal limit would only be expected under conditions involving binding of the RCP (i.e., locked rotor). The occurrence of such an event would result in thorough investigation to remedy the source of the binding and verify that the RCP motor was not damaged. Because the RCP motor is designed for 4000 starts at 80% rated terminal voltage, even if the thermal limit were slightly exceeded there would not be a significant reduction in motor life. The FNP load study indicates that the minimum starting voltage for a RCP would actually be 87% or greater; thus, limiting the potential encroachment on RCP thermal limits. Existing periodic maintenance ensures that any long term effects that could result from thermal damage would be detected.

An increase in RCP motor temperature will have no effect on the RCP seals due to spatial considerations between the motor and the seals. In addition, accumulation of thermal stresses associated with exceeding the RCP motor thermal limit will have no effect on the coast down capability of the motor. On this basis it can be concluded that the protection scheme for the RCP motors is an economic consideration only and not a safety concern. The existing mechanisms for RCP motor protection at FNP have proven adequate to preclude motor damage.

Issue 2:

Long time delay trip settings of circuit breakers supplying 600 Vac motors appeared to be too high, permitting operation of the motors at excessive currents. A typical example related to the control rod drive mechanism motor generator set 1A motor (150 HP), where the circuit breaker setting could cause tripping at 160 percent of motor full load current (bandwidth of 132 to 162 percent). ANSI Standard C37.16-1988 recommends that the trip device be set not greater than 130 percent of full load rating for a service factor of 1.0 (the service factor for the motors in question).

Request for licensee:

Provide the technical basis for the Bechtel criteria used to select circuit breaker settings at 160 percent of motor full load current.

Explicitly identify the 600 Vac safety-related motors whose long time delay trip settings of their feeder breakers are set at 160 percent of motor full load current.

Based on historical data, explicitly identify the 600 Vac safety-related motors that were damaged due to overload because their feeder breaker has been set at 160 percent of motor full load current.

Provide time-current characteristic coordination curves for 600 Vac safety-related motors. The response should include a motor feeder breaker curve and the upstream breaker curve.

SNC Response:

The Bechtel design criteria used to determine the long time overload relay settings for 600V motors is based on IEEE 588, which is now ANSI/IEEE C37.96-1988. Section 4.2.10.7.1 of ANSI/IEEE C37.96 - 1988 directs the user to multiply 125% X FLA (Full Load Current of Motor) X Service Factor. This is consistent with the criteria used for FNP. Since the

Westinghouse Amptector devices have a published tolerance of ±10%, an additional margin of +10% was added to prevent inadvertent motor tripping.

Application of the Bechtel criteria results in a relay setting of 160% for the Spent Fuel Pool pump motors. All other relays set in accordance with this criteria have lower settings. A review of the work histories for all safety-related 600V motors protected by relays set in accordance with this criteria indicates that no failures have occurred that are attributable to an overload operation of the motors. The time-current characteristic curves are not required for application of the Bechtel criteria for establishing the long time delay setting.

The settings established via the Bechtel criteria give preference to ensuring that motors will start and perform their safety related function with the risk of inadvertent tripping minimized. Experience confirms that this criteria has not resulted in any undesirable consequences or related damage to the safety-related 600V motors.

NRC requests:

Inspection Follow-up Item 348, 364/92-17-14, No periodic Testing to Verify Continued Capabilities of Most Safety-Related Molded Case Circuit Breakers (MCCBs).

Issue:

The licensee originally established a program for extensive testing of MCCBs but reduced the scope of the program based on a letter from the Nuclear Management and Resources Council (NUMARC). The NUMARC letter, dated October 17, 1990, noted that there had been problems with factory calibrations but that these problems could be identified and corrected through acceptance or pre/post maintenance testing. It concluded by stating that "it is not clear that the perceived benefits achieved by periodic testing of MCCBs are commensurate with the resources required to conduct such testing." The licensee currently tests MCCBs for safety-related use upon receipt or prior to use. However, once installed in the plant, the only routine testing of MCCBs is the testing required by Unit 2 TS for containment penetration MCCBs (Note: The Unit 1 TS do not require testing of containment penetration MCCBs.). The licensee plans no other preventive maintenance or testing of MCCBs over the life of the plant. Aging could cause the lubricant in the breaker to dry out or other degradation might occur which would affect breaker trip calibration. Region II finds that many other licensees perform periodic testing of their more important MCCBs and believes this is appropriate over the 40-year life of a plant.

Request for licensee:

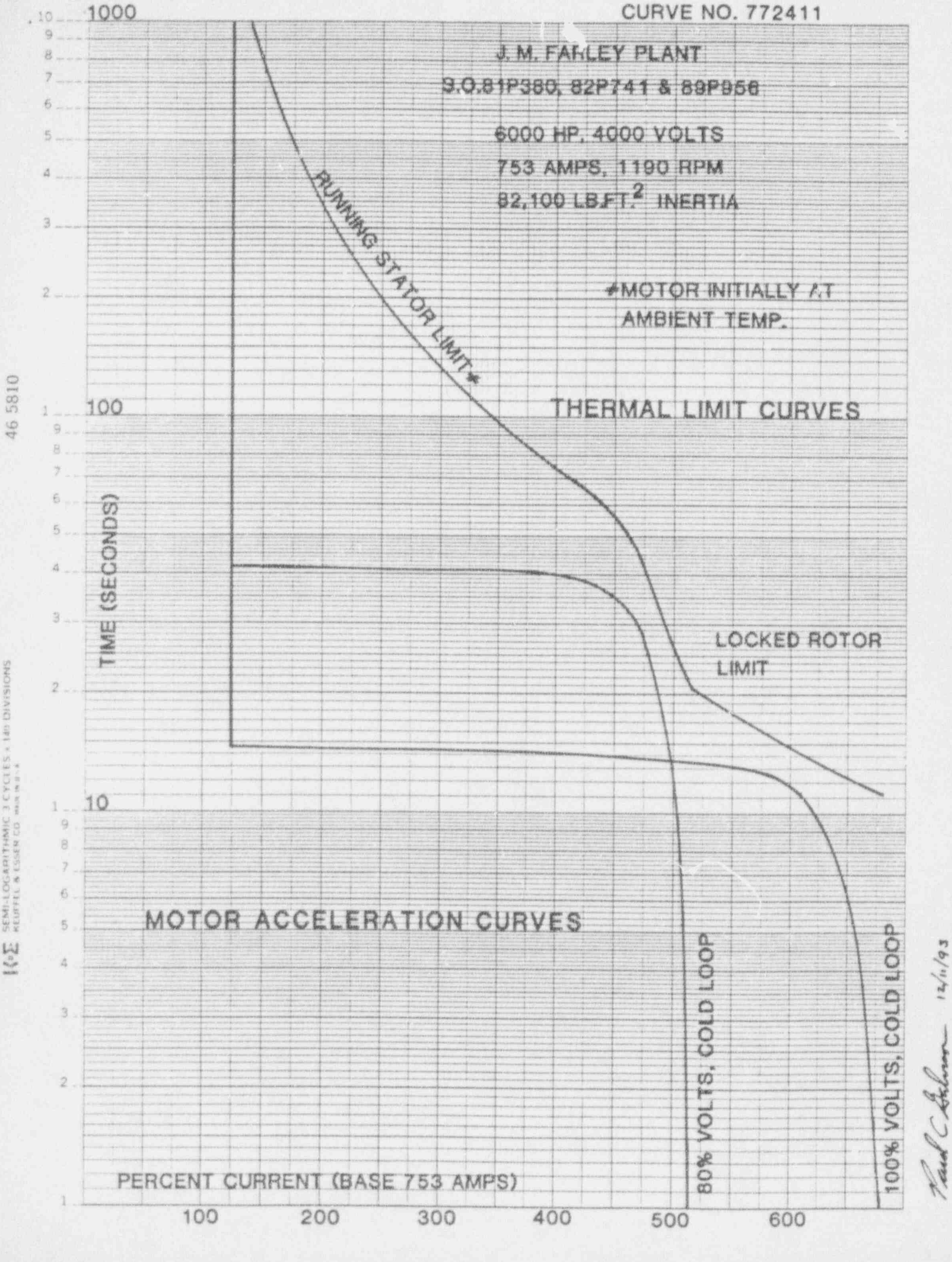
Identify safety-related and non-safety-related MCCBs that have been tested. In addition, provide detailed descriptive information explicitly addressing the number of MCCBs tested, the number of MCCB failures, and the types of MCCB failures that have been identified for these breakers as a result of this testing. Further, provide a description of any analysis of the testing results that has been used to determine actual failure rates include actual failure rates (include actual failure rates if available) for the MCCBs tested.

SNC Response:

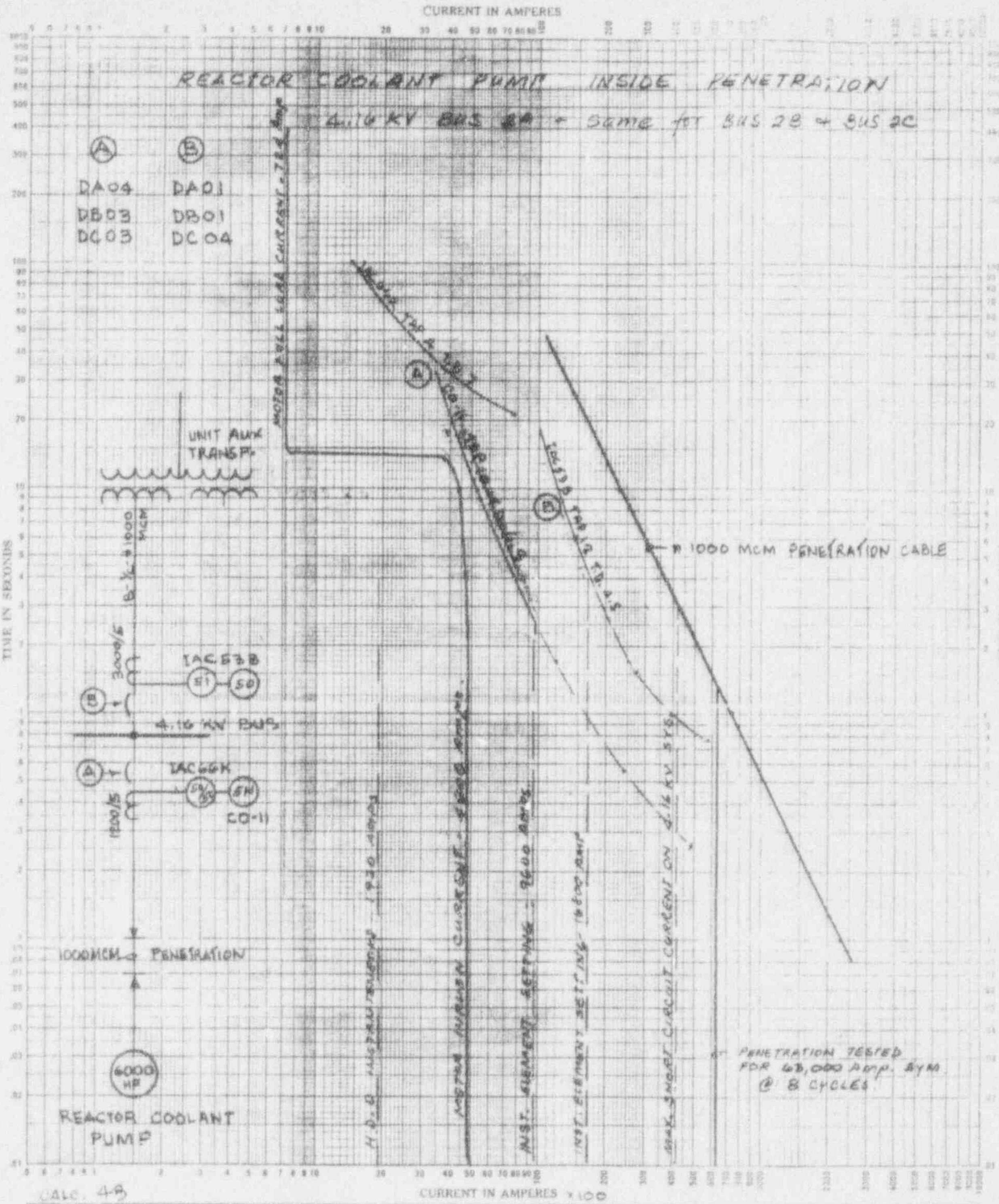
Periodic testing is performed for breakers protecting containment penetrations in accordance with the Unit 2 Technical Specifications. The results of approximately 425 tests performed to date indicate a total of 9 failures corresponding to a rate of (9/425X100) = 2.1%. It should be noted that 4 of these were failures to reset, indicating that the breakers would have successfully performed their protective function. Two additional failures were due to overcurrent actuation outside of the present FNP acceptance criteria; however, the breakers actually satisfied the most recent NEMA standards for breaker testing. On this basis it can be seen that less than 1% of the test performed in accordance with the Unit 2 Technical Specifications have indicated MCCB failures in a mode that would challenge overcurrent protection.

Absent vendor requirements for periodic MCCB testing or a history of MCCB failures, a program for periodic testing of MCCBs is not warranted at FNP.

ATTACHMENT



CURVE NO. 772411
J. M. FARLEY PLANT
S.O.81P380, 82P741 & 89P956
6000 HP, 4000 VOLTS
753 AMPS, 1190 RPM
82,100 LB.FT.2 INERTIA
RUNNING STATOR LIMIT*
*MOTOR INITIALLY AT AMBIENT TEMP.
THERMAL LIMIT CURVES
TIME (SECONDS)
LOCKED ROTOR LIMIT
MOTOR ACCELERATION CURVES
80% VOLTS, COLD LOOP
100% VOLTS, COLD LOOP
PERCENT CURRENT (BASE 753 AMPS)
1000
100
10
1
100
200
300
400
500
600
12/11/93



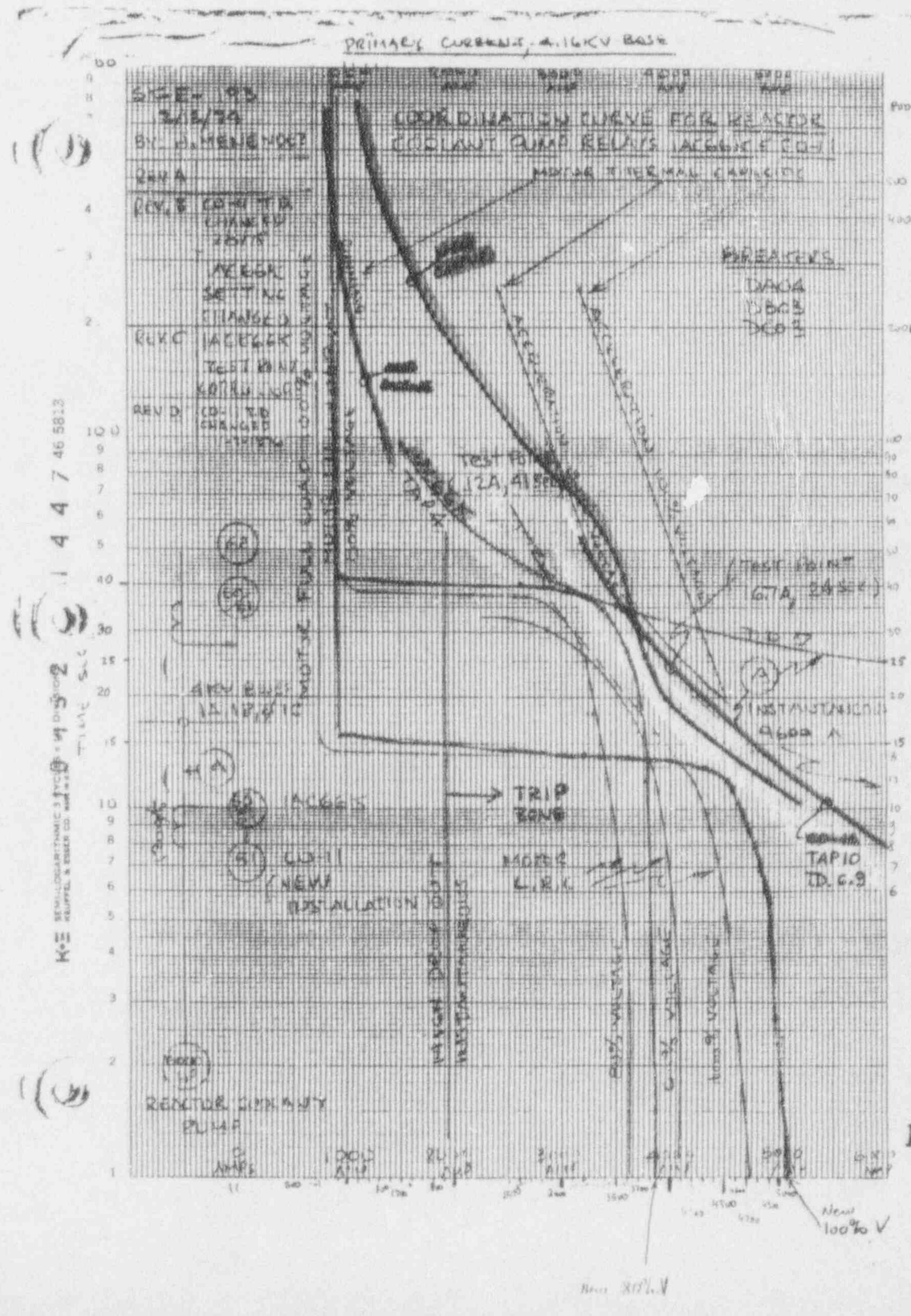
CALC. 48

#1000 MCM O/C TIME-CURRENT CHARACTERISTIC CURVES	
For MEDIUM VOLTAGE PENETRATION (4.16 KV) Fuse Links. In	
BASIS FOR DATA Standards .... Dated	
1. Tests made at .... Volts a-c at .... p.L. Starting at 25C with no initial load	No.
2. Curves are plotted to .... Test points so variations should be	Date

FIGURE 1

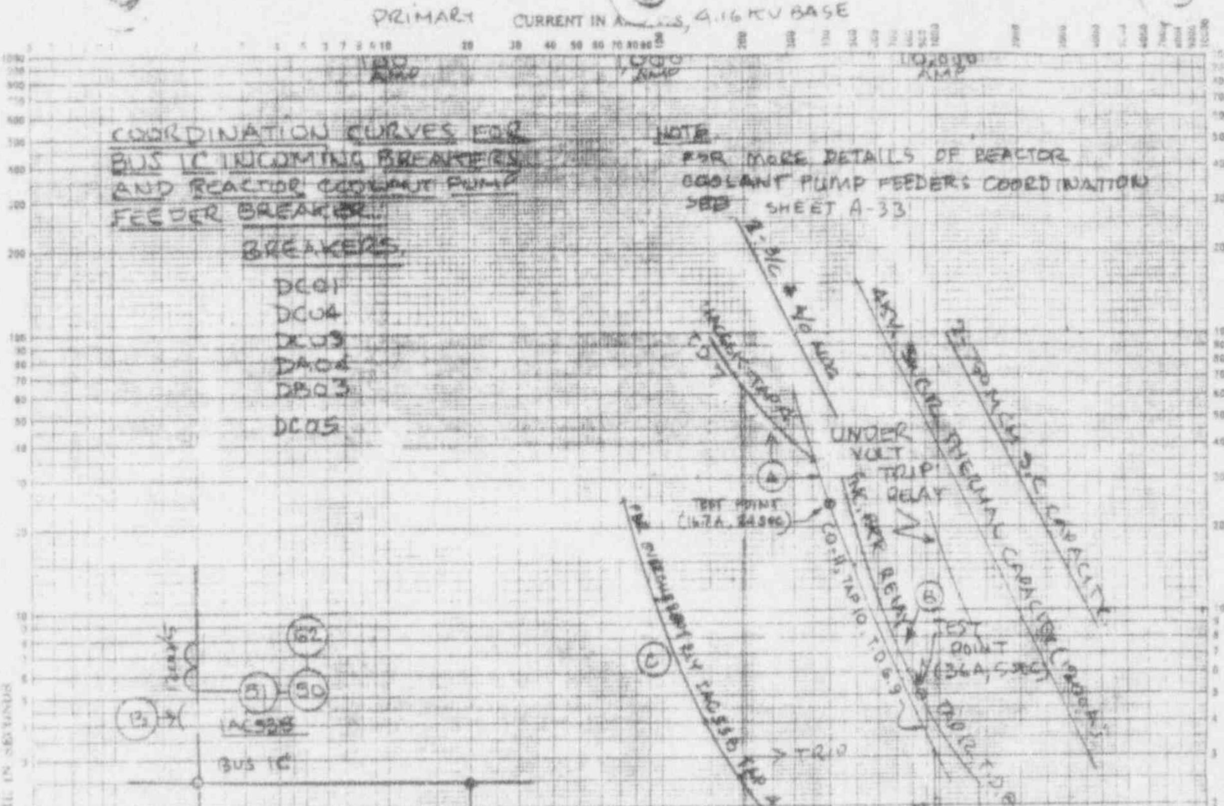
TIME-CURRENT CHARACTERISTIC 40 5257

Orig. ______ 3/26/93 Check. ______ 4-5-93



CALCULATION E-35.1.A APPENDIX A Sheet A-35 Rev. 0

Orig. DGB 3/24/93 Check. [illegible] 4-5-93



4KV SWITCHGEAR 1C TIME-CURRENT CHARACTERISTIC CURVES

For GE RELAYS IAC66K & IAC53B, & CO-11 JOSEPH M. FARLEY NUCLEAR PLANT, UNIT 1

BASIS FOR DATA Standards Dated

1. Tests made at Volts p.f. Starting at 25C with no initial load

2. Current in multiples of ... should be

No. SK-E-19B

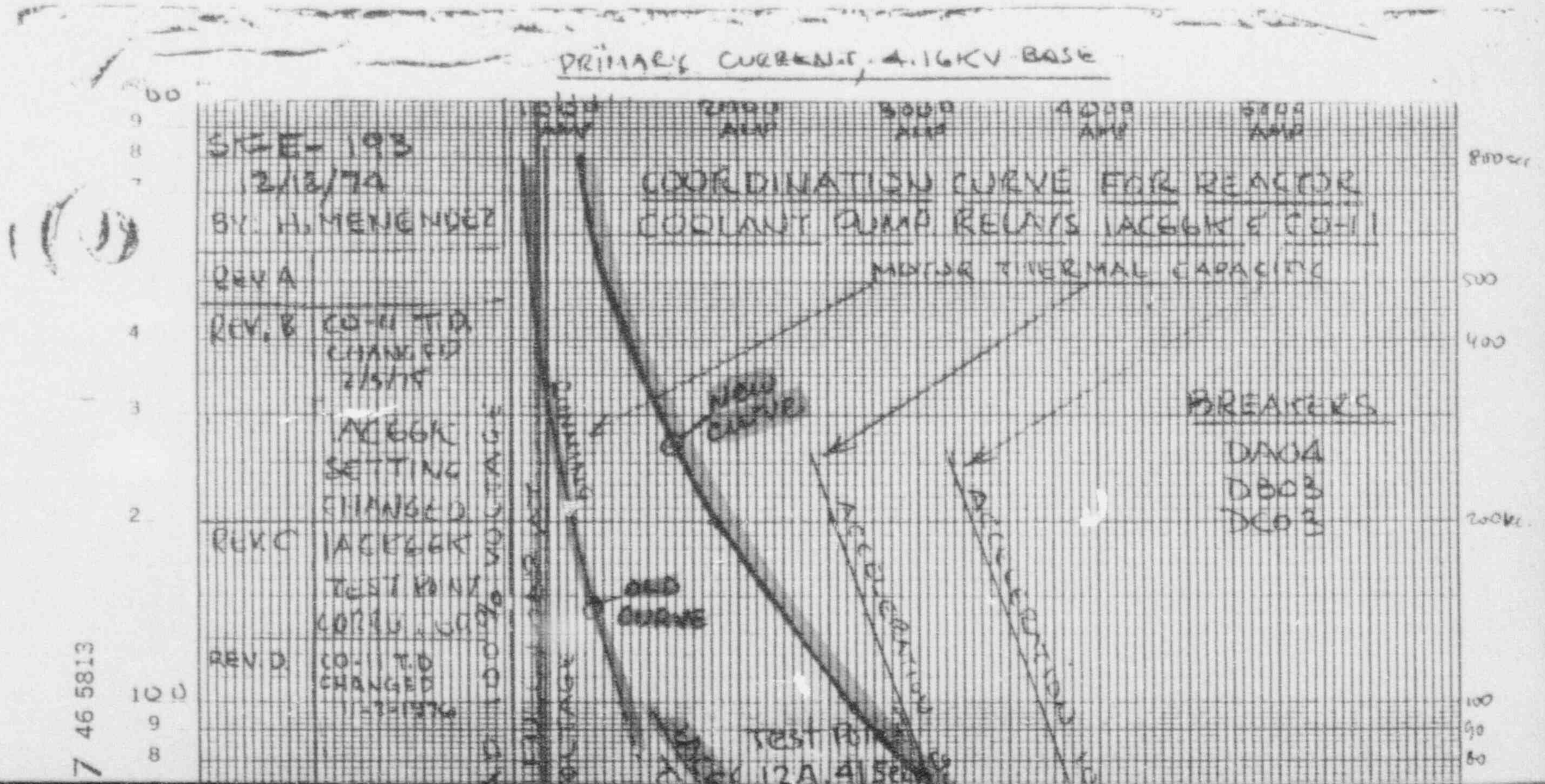
Date 12/17/74

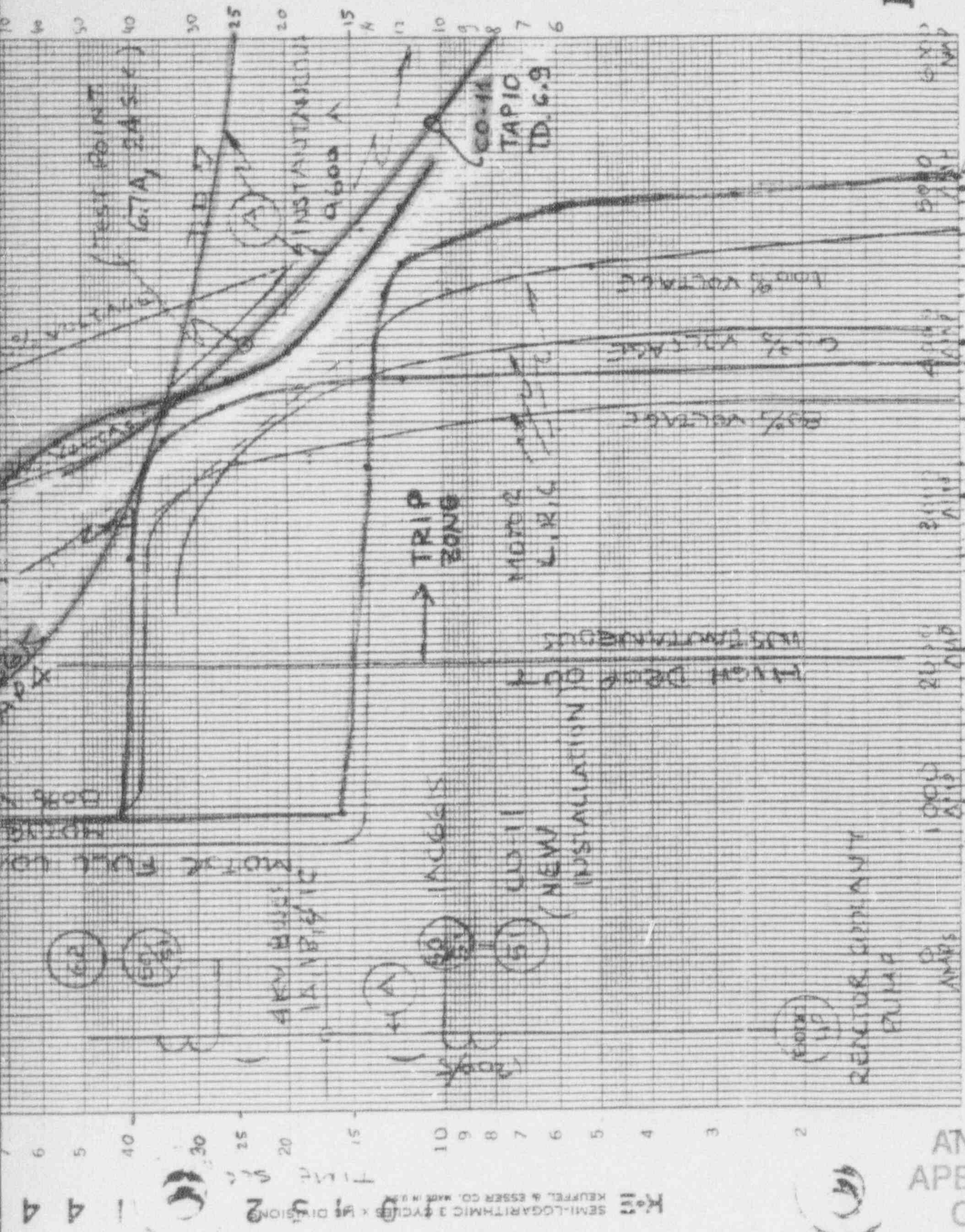
REV. E
ADDED DC05
5-2-81 IN REF. TO PCN 81-968

REV. F 7/1/81 RV
REV D CABLE SIZE

REV C	IAC66K RELAY SETTING MODIFIED 3/10/75	REV A	
		REV B	UNDERVOLT TRIP CURVE ADDED. CO-11 T.D. CHANGE TO 9.25 2/5/75
REV. D	CO-11 TD WAS 9.75 11-2-76		

Orig. ____ 3/26/93 Check. ____ 4-5-93





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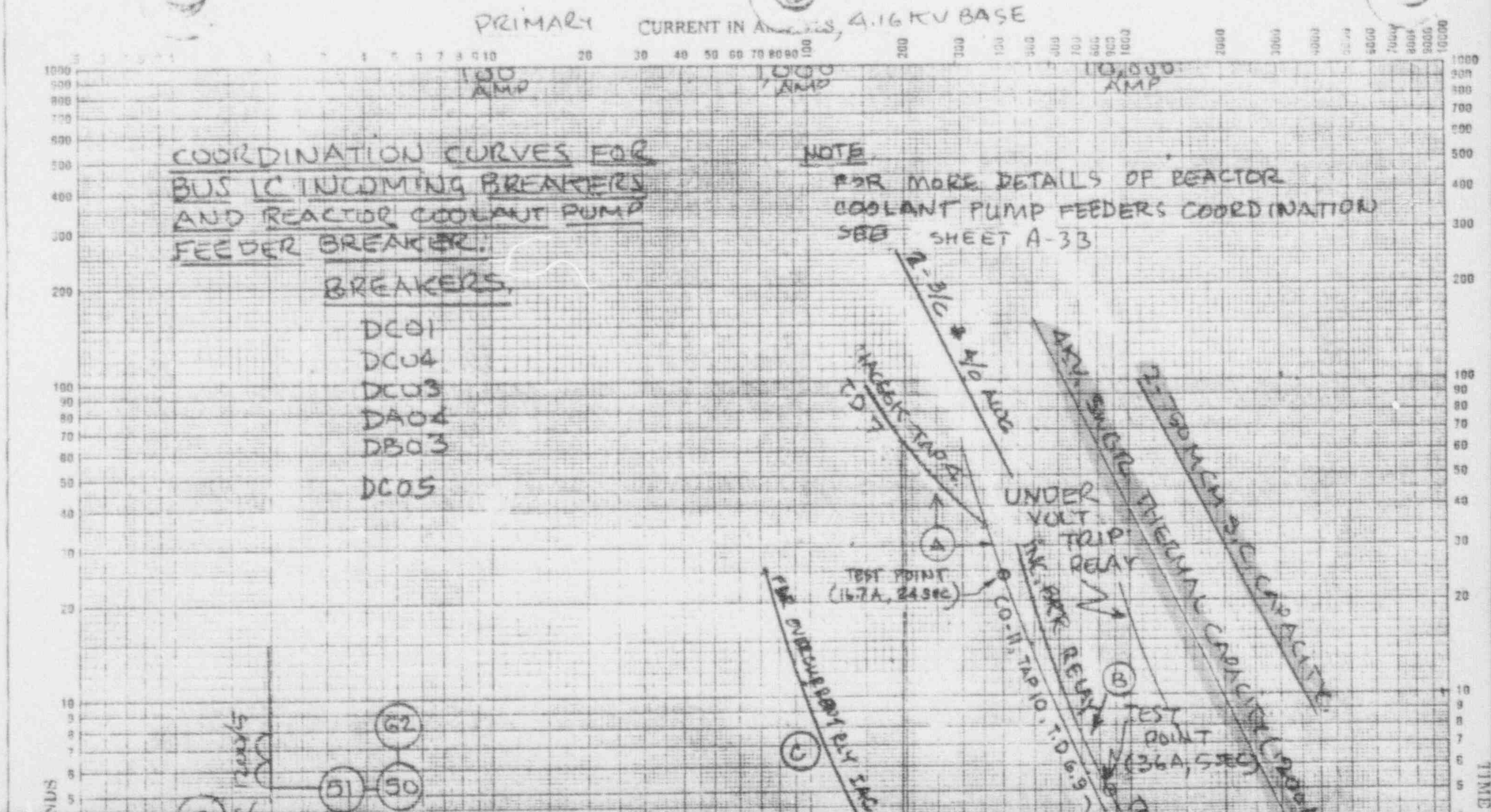
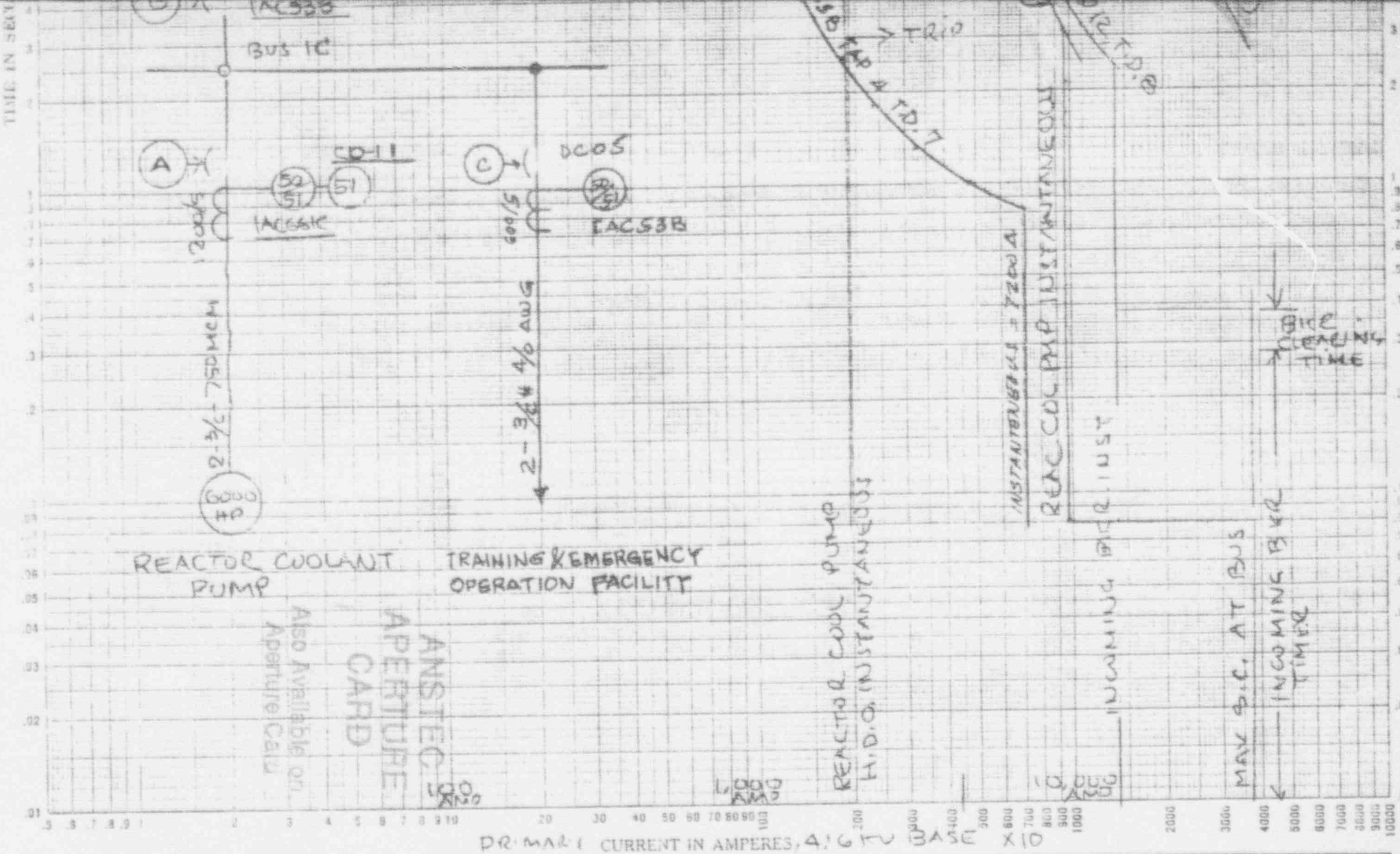
CALCULATION E-35.1.A APPENDIX A Sheet A-35 Rev. 0

Orig. ______ 3/24/93 Check. ______ 4-5-93





4KV SWITCHGEAR 1C TIME-CURRENT CHARACTERISTIC CURVES

For G.E. RELAYS IAC66K & IAC53B, W CO-11 ~~Fuse Links~~ In JOSEPH M. FARLEY NUCLEAR PLANT, UNIT 1

BASIS FOR DATA Standards .... Dated ....

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

... Curves are plotted to .... Test points .... variations should be ....

No. SK-E-198

Date 12/17/74

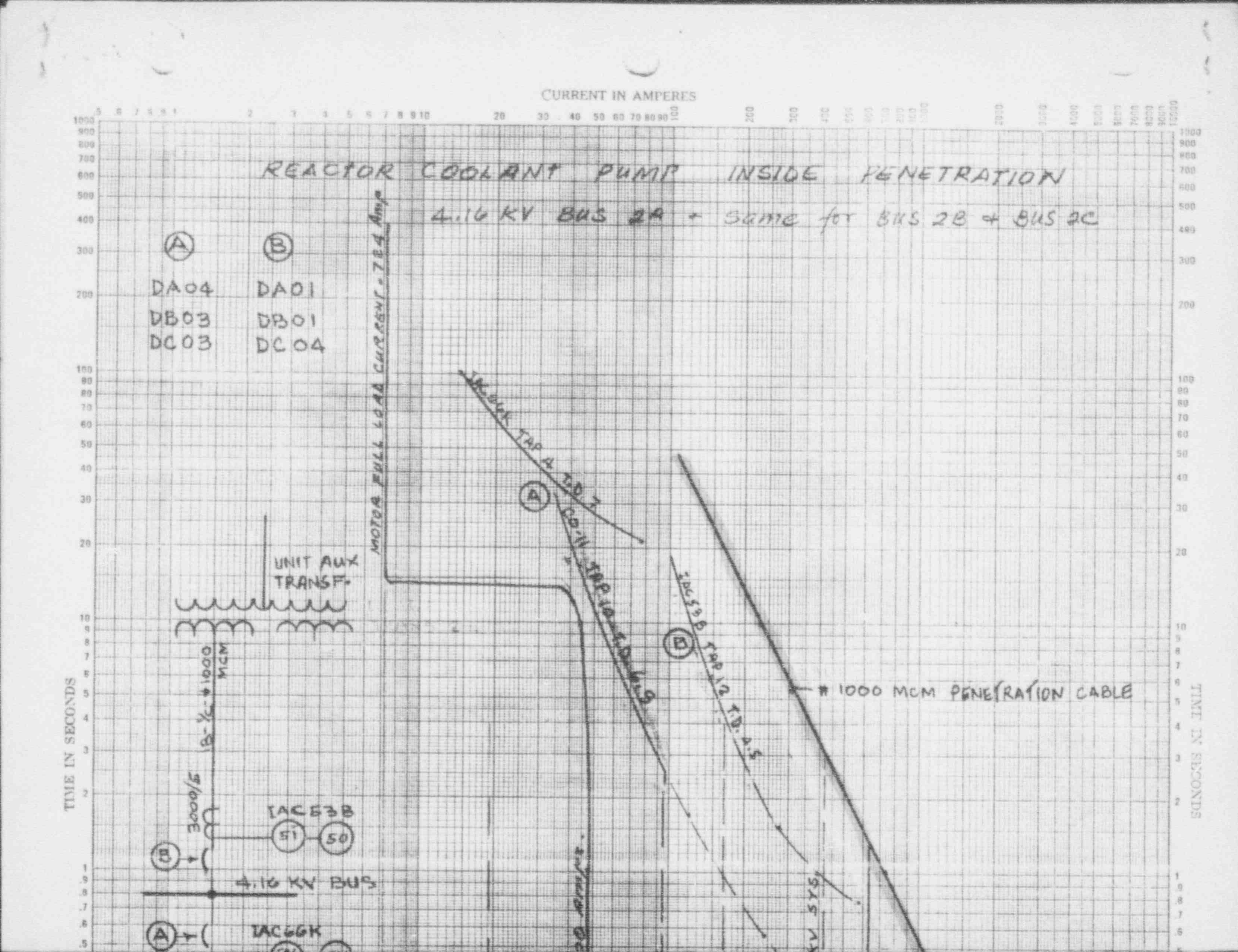
REV. C	IAC66K RELAY SETTING MODIFIED 3/10/75	REV A	
		REV B	UNDERVOLT TRIP CURVE ADDED. CO-11 T.D. CHANGED TO 5.25. 2/5/75
REV. D	CO-11 TD WAS 3.75 11-2-76		

REV. E
ADDED DC05
5-2-81 IN REF. TO PCN 81-968

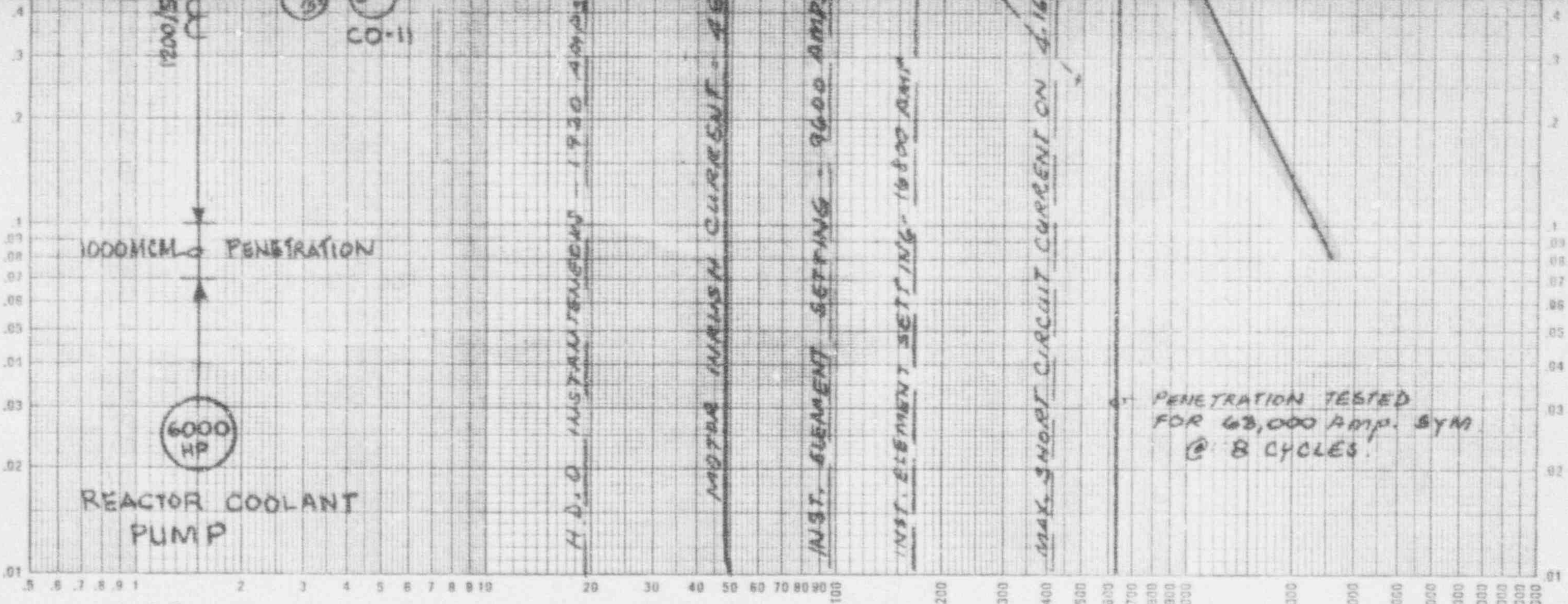
REV. F 7/1/81 ... REV'D CABLE 5136

TIME CURRENT CHARACTERISTICS 48 5257

9402040166-02



REACTOR COOLANT PUMP INSIDE PENETRATION
4.16 KV BUS 2A + Same for BUS 2B + BUS 2C
CURRENT IN AMPERES
TIME IN SECONDS
(A) DA04 DB03 DC03
(B) DA01 DB01 DC04
MOTOR FULL LOAD CURRENT - 78.4 Amp
IAC66K TAP 4 T.D. 7
CO-11 TAP 10 T.D. 6.9
IAC53B TAP 12 T.D. 4.5
#1000 MCM PENETRATION CABLE
UNIT AUX TRANSF.
18-1/c-#1000 MCM
3000/5
IAC53B
51
50
4.16 KV BUS
IAC66K



CALC. 48

#1000 MCM O/C TIME-CURRENT CHARACTERISTIC CURVES

For MEDIUM VOLTAGE PENETRATION (4.16KV) 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 1

9402040166-03