SARGENT & LUNDY ENGINEERS CHICAGO	Calc. For Establishing Required Raceway/Cable Separation Distances	Calc.No. 19-BDA-1
		Rev.3 Date 2-11-86
		Page 1 of 22
	(x) Safety-Related ( ) Non-Safety-Related	

Client: Illinois Power Company		Prepared by	Date
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Revision 0, dated 10-18-85	Pages: 21
Revision 1, dated 10-25-85	Revised Pages: 5, 6, 7, 14, 15, 17 per NRC comments.
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Revision 3, dated 2-11-86	Revised Pages: 5, 6, 9, 11, 12, 13, 18, 19

Review Method:

Revision 0 - Detailed Review of entire analysis.

Revision 1 - Detailed Review of revised sections.

Revision 2 - Detailed Review of revised sections.

Revision 3 - Detailed Review of revised sections.

References:

1. Wyle Laboratories Test Report 17769-2, Dated 10-3-85.
2. Wyle Laboratories Test Report 17769-1, Dated 8-23-85.
3. IEEE 384-1974.
4. USNRC Regulatory Guide 1.75, Revision 2.

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PURPOSE:

The purpose of this analysis is to establish minimum acceptable raceway to raceway, raceway to cable, and cable to cable separation distances between redundant safety-related raceways/cables and between safety and non-safety-related raceways/cables. This analysis, in conjunction with the test program conducted at Wyle Laboratories (References 1 and 2) has been developed in accordance with IEEE 384-1974, Section 5.1.1.2.

BASIS:

This analysis is based on a series of tests (References 1 and 2) which demonstrated that a representative cable when subjected to a conservatively high fault current, would not cause a loss of function in "target" cables mounted in various test configurations representative of typical plant installations.

ASSUMPTIONS:

The following assumptions were used as a basis in determining the specific fault parameters, selecting the test specimens used, and interpreting the test data complied in the Wyle test program.

1. The fault developed within a cable or equipment is assumed not to be cleared due to the failure of the primary protective device.

2. A fault is assumed to occur which would be significantly more severe than the worst credible fault which would be expected during actual plant operation. In achieving this level of severity, a "typically" high level of fault current cannot be assumed. Even though a very high fault current may produce the highest temperature, it would be for only a very brief duration due to rapid tripping of the backup breaker or fusing of the cable. Therefore, in an effort to achieve the highest level of conservatism, the fault current selected was one which would sustain a very high level of heat generation for a long time duration. Another significant parameter adding yet an additional level of conservatism is afforded by the test apparatus which generates a single phase current. The actual fault cable specimen had the three conductors connected in series and then connected to the test apparatus (see Figure 5, Reference 1, and Figure 6, Reference 2). This configuration results in an induced current in the conduit which adds significantly to the heat generated by the fault cable. This is demonstrated in the test results where the conduit actually exhibits a faster temperature rise than the fault cable jacket (see Figure I-2, Reference 2). This dual source of heat (fault current plus induced current in conduit) thereby significantly increases the conservatism of the test.

ASSUMPTIONS - Continued

3. The actual fault current selected was based on a typical locked rotor motor current. Locked rotor current would typically result in rapid breakdown of the motor insulation system, which in turn would result in a high level of fault current that would be cleared by the backup circuit breaker or would cause the cable to fuse open. For conservatism, it is assumed that the fault impedance would adjust itself automatically to maintain the initial fault current magnitude, thus extending the test duration. The fault current selected was 1300A based on a typical locked rotor current which would occur in a motor fed by a 500 MCM cable (see Assumption No. 6 for cable selection).

4. After a period of one hour, it is assumed that the fault impedance does decrease, but not to a point which would cause rapid fusing of the cable, or which would cause the backup breaker to trip. Additional conservatism is, therefore, added by increasing the fault current to 1700A and thereby increasing the heat generation for an additional two-hour duration or until the cable fused open.

5. The fault condition is conservatively assumed to remain undetected in the control room with no intervening operator action. The extreme amount of smoke observed during the test adds additional conservatism, since the fault condition could not credibly remain undetected by the fire alarm system and/or other plant personnel.

6. In order to encompass a maximum number of configurations, a 3/c 500 MCM cable is assumed to carry the fault current. All cables smaller than 500 MCM would be encompassed by the test due to their reduced I^2R heat generation. The small number of potential fault cables larger than 500 MCM are addressed where appropriate by extending the results of the tests on the 500 MCM cables. In order to conservatively apply these test results to configurations involving cables larger than 500 MCM, the following criteria has been applied:

   A. The same separation distances are assumed appropriate if an air gap was included (since an air gap provides an excellent insulating effect) in the test configuration and the target is not subject to flame exposure (see "C" below).

   B. When the fault specimen and the target specimen were tested in a "contact" configuration, a 1" air gap is added, which generally is in accordance with IEEE 384-1974.

   C. Based on the test results, the only configuration requiring consideration of flame exposure is Configuration No. 6 which had the fault cable at the top of a cable tray. It is apparent that the fault cable tends to ignite in this configuration due to greater heat retention (caused by the

ASSUMPTIONS - Continued

surrounding "fill" cables) and the unlimited free oxygen available for combustion. The 1" air gap as tested between a "target" conduit above a cable tray will, therefore, be increased to a minimum of 12" for both EPR/ HYPALON and TEFZEL target cables.

7. In order to encompass a maximum number of configurations, a 3/C 500 MCM (copper conductor) cable with a 600V/1000V insulation system is assumed to carry the fault current. Cables with higher insulation ratings would be encompassed by virtue of the fact that they have a more rugged insulating system and have more jacket surface area to dissipate heat.

8. In order to encompass all target cable types, instrument cable was more conservatively assumed since its insulation would be more vulnerable to damage. Both TEFZEL and EPR/HYPALON cables were tested in the Wyle Program, which represents the two types of insulation/jacket material used in the plant.

9. The actual test specimens selected were copper conductor cables taken from actual plant stock. The results of the test program are assumed applicable for the entire life of the plant based on the successful vendor qualification programs. These programs demonstrated that the cable characteristics remain within acceptable values subsequent to aging and LOCA environment simulation. Heat additionally appears to result in off-gasing of volatiles and, therefore, a "heat" aging program if applied to a fault test specimen may be less conservative than using actual plant stock.

10. It is assumed that all test configurations which included rigid steel conduit are also applicable to similar configurations utilizing "SERVICAIR" flexible, "LIQUIDTIGHT" flexible, or EMT conduit. In order to support this assumption, LIQUIDTIGHT flexible conduit was selected as the "least rugged" among "SERVICAIR," "LIQUIDTIGHT," or "EMT" and subsequently was tested in various configurations as discussed in Reference 1, Section III. The primary attribute necessary for a faulted cable conduit, is the ability to contain any flame which may occur. This attribute was successfully demonstrated as discussed in Section III of Reference 1.

11. Unless noted otherwise, separation distances are assumed applicable for both safety-related to redundant safety-related interactions and safety-related to non-safety-related interactions.

DISCUSSION

The results obtained through the test program conducted by Wyle Laboratories (References 1 and 2) have been analyzed and applied to specific configurations which may occur in actual plant installations. From this analysis, appropriate minimum separation distances have been developed and are summarized in Figure 1 of this calculation. A discussion of each test conducted follows, and includes results, interpretations, and appropriate minimum separation distances derived from each configuration tested. Separation distances in parentheses ( ) are applicable only to configurations involving a fault cable larger than 500 MCM (see Assumption 6).

Configuration No. 1 (Reference 2, Section 1)

This configuration included a fault cable in conduit, target cables in conduit, and target cables in free air. All target cables successfully passed the test. By direct application, the following separation distances represent acceptable installed configurations:

A. Conduit to conduit crossings (Figure 1-10)

Horizontal........0" (1")
Vertical..........0" (1")

B. Horizontal "fault" conduit to vertical free air target cable crossings (Figure 1-14)

R | Horizontal......>0" (1")

Parallel conduit to cable configurations and cable above conduit configurations were not directly tested, however, these distances have been established through interpretation of test data as follows:

1. A flame is not considered since the conduit would contain it.
2. Overall test results indicated that the most severe heat transfer results from direct contact, whereas an air gap precludes significant heat transfer.

The following separation distance, therefore, represents an acceptable installed configuration:

C. Horizontal "fault" conduit parallel to free air target cables (Figure 1-14)

Horizontal........1"
Vertical..........1"

DISCUSSION - Continued

Configuration No. 2 (Reference 2, Section 2)

This configuration included a fault cable in free air, target cables in free air and target cables in conduit. All target cables successfully passed the test. By direct application, the following separation distance represents an acceptable installed configuration.

A. Horizontal free air fault cable to horizontal free air target cables (Figure 1-15)

Horizontal........6"

B. Vertical free air fault cable to horizontal conduit (Figure 1-14)

R Horizontal.......>0" (1")

Parallel free air cable to free air cable configurations (separated vertically) and free air fault cable below a parallel target conduit were not directly tested, however, these distances have been established through interpretations of test data as follows:

1. A flame was not produced (other than a brief ignition at the cable ends which occurred when the cable fused open) and is, therefore, not considered.

2. Overall test results indicated that the most severe heat transfer results from direct contact, whereas an air gap precludes significant heat transfer.

The following separation distances, therefore, represent an acceptable installed configuration:

C. Horizontal free air fault cable to horizontal free air target cables (Figure 1-15)

Vertical..........6"

D. Horizontal free air fault cable parallel to target conduit (Figure 1-14)

Horizontal........1"
Vertical..........1"

DISCUSSION - Continued

Configuration No. 3 (Reference 1, Section 1)

This configuration included a fault cable in a tray and target cables in tray and conduit. A fire occurred in the faulted cable tray approximately 80 minutes into the test and continued throughout the remaining duration of the test. The flames impinged on the targets and the near proximity of the upper tray resulted in a high level of heat retention causing failure of all but one target cable. Subsequent to the fault cable fusing open, it was observed that the fault cable and adjacent cables self-extinguished. Although the fault criteria was significantly more extreme than would be expected during normal plant operation, it was decided for added conservatism to run new test configurations with increased separation rather than reduced fault criteria. Refer to Configuration Nos. 6 and 7 for the results of these tests.

Configuration No. 4 (Reference 1, Section II)

This configuration included a fault cable in conduit, target cables in conduit, and target cables in tray. All target cables passed the test with the exception of the TEFZEL cable in conduit. By direct application, the following separation distances represent acceptable installed configurations:

A. Non-safety-related conduit crossing above or below safety-related cable tray (Figure 1-6)

Vertical..........0" (1")
(Note: Separation between conduit above tray and cables in tray shall be 0").

B. Conduit to conduit parallel runs of 2' or less with safety-related cables having EPR/HYPALON insulation/jacket (Figure 1-11)

Vertical..........0" (1")

Non-safety-related conduit to the side of safety-related cable tray (in contact) and conduit to the side of conduit (in contact) were not directly tested. These distances have been established, however, through interpretation of test data as follows:

1. A fault conduit below a tray would be more severe than being to the side of the tray because heat would tend to rise into the tray versus heat rising to the side of the tray.

2. By similar analogy, a fault conduit below a target conduit would be more severe than being to the side of a target conduit.

DISCUSSION - Continued

The following separation distances, therefore, represent acceptable installed configurations:

C. Non-safety-related conduit to the side of safety-related cable tray (Figure 1-6)

Horizontal........0" (1")

D. Conduit to conduit parallel runs of 2' or less with safety-related cables having EPR/HYPALON insulation/jacket (Figure 1-11).

Horizontal........0" (1")

Separation distances less than 1" for conduit to conduit parallel runs in excess of 2' or which involve TEFZEL target cables generally do not occur (based on typical hanger design) and, therefore, were not tested. If this configuration would arise, separation would be in accordance with the general guidelines of IEEE 384-1974 as follows:

E. Conduit to conduit parallel runs in excess of 2' or which involve TEFZEL target cables (Figure 1-12)

Horizontal........1"
Vertical..........1"

Configuration No. 5 (Reference 1, Section III)

This configuration included a fault cable in flex conduit, in a box, and in rigid conduit, and target cables in flex conduit and rigid conduit. All target cables passed this test and demonstrated the equivalence of flex conduit versus rigid conduit as a barrier (see Assumption No. 9). By direct application, the test also demonstrated that the following separation distance represents an acceptable installed configuration:

A. Conduit over box with faulted cable (Figure 1-13)

Vertical..........0" (1")

Other configurations involving conduit and boxes were not directly tested, however, the temperatures of the box during the test indicate that due to the larger surface area of a box (versus conduit), a box will have a significantly reduced temperature below conduit when

DISCUSSION - Continued

subjected to similar heat sources. The ability of a box to disperse and reject heat better than conduit, therefore, demonstrates that a box can conservatively be assumed equivalent to conduit in any configuration involving conduit. The following separation distances, therefore, represents acceptable installed configurations.

B. Conduit to the side of a box with a faulted cable (Figure 1-13)

Horizontal........0" (1")

C. Conduit with a faulted cable to box (Figure 1-13)

Horizontal........0" (1")

Vertical..........0" (1")

Configuration No. 6 (Reference 1, Section IV)

This configuration included a fault cable in tray and conduits. Also included in this test configuration were thermocouple arrays above and to the side of the faulted cable tray. All targets passed the test with the exception of a TEFZEL cable in conduit crossing 1" above the faulted cable tray. By direct application, the following separation distances represent acceptable installed configurations:

A. Safety-related tray above and parallel to redundant safety-related or non-safety-related cable tray (Figure 1-1)

Vertical..........24"

The configuration involving a safety-related conduit above and parallel to redundant safety related or safety-related cable tray was not directly tested. However, the distance has been established through interpretation of the test data.

The maximum target cable temperature (thermocouples 21 through 23) plots in the conduit (CD-4) located at 22-1/2" above the top of the lower cable tray (T1) and immediately below the upper tray (at 24") were less than those target cables (C10 and C11, thermocouples 24 through 30) in the upper tray (T2) and well within the acceptable range. Therefore, since Configuration No. 6 is more severe than the one described, it can be conservatively assumed that the separation distance applicable to safety-related tray above and parallel to redundant safety related or non-safety-related cable tray (Figure 1-1) is also applicable for safety-related conduit above and parallel to redundant safety related or non-safety-related cable tray.

DISCUSSION - Continued

B. Safety-related conduit containing EPR/HYPALON cables crossing above redundant safety-related or non-safety-related tray (Figure 1-7)

Vertical..........1" (12")

C. Safety-related conduit containing TEFZEL cables crossing above redundant safety-related or non-safety-related cable tray (Figure 1-7)

Vertical..........12"

D. Safety-related conduit to the side of safety-related or non-safety-related cable tray (Figure 1-9)

Horizontal........ 0"
Vertical.......... 0"

Other configurations involving cable tray and conduit were not directly tested, however, these distances have been established through interpretation of the thermocouple array test data. It should also be noted that the cables surrounding the fault specimen in the tray were observed to be a contributing source of fuel while subjected to the heat generated by the fault cable. The ambient temperature measurements (from the thermocouple arrays) were, therefore, due to a heat source which was not limited to the middle of the tray but rather also extended toward the tray sides.

Figure 2 is a plot of maximum temperatures recorded from thermocouples 39 and 45. Also included on Figure 2 is a plot of maximum target cable temperatures which were in Conduit No. CD-5. This conduit was mounted at the same location monitored by thermocouples 39 and 45, and, therefore, provides a correlation between ambient versus target cable temperatures. The temperature plots generally indicate that the conduit provides a damping effect in transmitting heat from a fluctuating ambient. The target cable temperature tends to gradually rise to a level approximating the average ambient temperature.

Figure 3 is a plot of maximum temperatures recorded from thermocouples 41 and 47. These thermocouples recorded the highest temperatures of the arrays and will, therefore, be assumed to conservatively represent the ambient immediately to the side of the cable tray. Also included on Figure 3 is a plot of maximum credible target cable temperatures which could be expected based on the ambient versus cable temperature response characteristics plotted in Figure 2. This plot would be indicative of target cable temperatures in conduit, however, it would be appropriate to assume target cables in tray, or covered risers which would provide an even greater damping effect in heat transmission due to larger area

DISCUSSION - Continued

of steel involved (versus conduit). A gradual temperature rise to a level approximating the average ambient temperature can be expected. Note that a target tray would extend further past the fault tray (versus the conduit in Figure 2) and would experience a significant drop in average ambient temperature. Therefore, assuming that the target tray would reach the same average ambient as the conduit assumed in Figure 3 would add additional conservatism. Based on Figure 3, the maximum target cable temperature in tray, covered riser, or conduit above, and immediately to the side of a faulted cable tray would, therefore, be less than 300 F.

Throughout the entire test program, there were no target cable failures at temperatures below 300 F. Therefore, a target cable temperature of 300 F or less for a short period of time (based on Figure 3) represents an acceptable installed condition. Additional conservatism is afforded by virtue of the fact that cable failures did not occur even at temperatures in excess of 450 F.

Based on the preceding, the following separation distances, therefore, represent acceptable installed configurations:

E. Safety-related conduit, tray, or covered risers above or to the side of redundant safety-related or non-safety-related cable tray (Figures 1-1, 1-5 and 1-9)

R | Horizontal........>0"

A configuration involving an uncovered tray riser to the side of a cable tray may not include a metal barrier between the fault cable and the target cable. For conservatism, it will be assumed that the target cable temperature instantaneously equals the ambient temperature. Figure 4 is a plot of maximum temperatures recorded by thermocouples 42 and 44. These thermocouples recorded the highest temperatures of the arrays at a distance of 6" to the side of the cable tray. Also included on Figure 4 is a plot of temperatures of target cables (which passed the test) from Configuration No. 4. These temperatures are well in excess of the ambient temperatures recorded by thermocouples 42 and 44. The ambient temperatures are additionally assumed applicable to configurations involving a fault cable in a riser since the heat generated will tend to rise as with the fault cable in tray. Significant margin is also demonstrated in Figure 4.

Based on the preceding, the following separation distance, therefore, represents an acceptable installed configuration:

DISCUSSION - Continued

F. Safety-related open riser to the side of redundant safety-related or non-safety-related cable tray (Figure 1-5).

Horizontal........6"

Justification to reduce the 1" separation of safety-related conduits containing EPR/HYPALON cables above redundant safety-related or non-safety-related cable tray (as was demonstrated acceptable by this test) can be demonstrated as follows:

1. The target cable 1" above the cable tray prior to fault cable ignition was below 250 F and, therefore, well within an acceptable range.

2. The fault cable ignition would either be precluded or the flames would be contained by adding a solid steel tray cover. A similar analogy applies to conduit below a faulted tray which would actually be less severe since heat would rise from the tray.

Therefore, as long as an air gap exists, the following separation distance represents an appropriate installed configuration:

G. Safety-related conduit containing EPR/HYPALON cables above or below redundant safety-related or non-safety-related cable tray with a solid steel cover (Figures 1-8 and 1-9).

R Vertical..........>0"

Configuration No. 7 (Reference 1, Section V)

This configuration included a fault cable in cable tray and target cables in cable tray below the faulted tray. All target cables successfully passed the test. By direct application, the following separation distance represents an acceptable installed configuration:

A. Non-safety-related cable tray above safety-related cable tray (Figure 1-4).

Vertical..........(1")

The configuration involving a non-safety-related conduit above a safety-related cable tray was not directly tested. However, the distance has been established through interpretation of test data as follows:

R

1. An external flame is not considered since the conduit would contain it.

DISCUSSION - Continued

2. Throughout the entire test program configuration where external flame was not present, the temperatures were significantly less and well within the acceptable range.

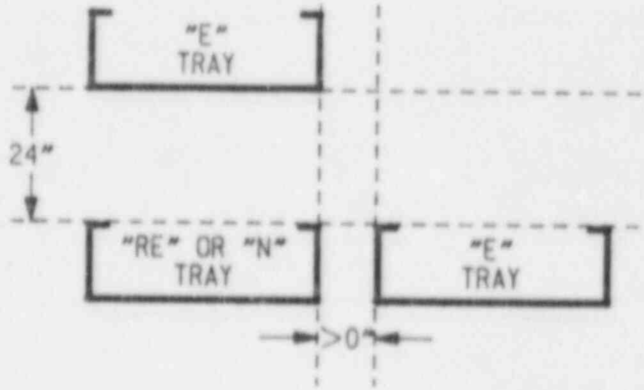
R 3. Overall test results indicate that the most severe heat transfer results from direct contact, whereas an air gap precludes significant heat transfer.

Therefore, since Configuration No. 7 is a more severe configuration than the one described, it can be conservatively assumed that the separation distance applicable to non-safety cable tray above safety-related cable tray (Figure 1-4) is also applicable for non-safety-related conduit above safety-related cable tray.

(1) SAFETY TRAY ABOVE OR TO THE SIDE OF REDUNDANT SAFETY OR NON-SAFETY TRAY

CLEARANCE REQUIRED:

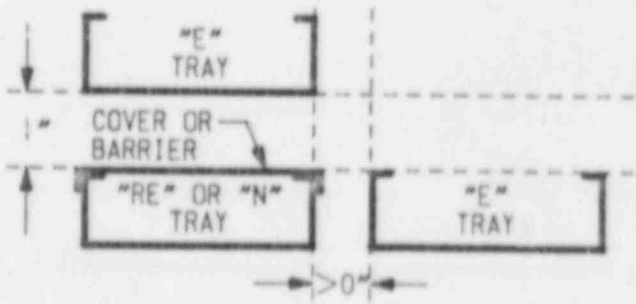
HORIZONTAL.......> 0"
OR
VERTICAL.........24"



(2) SAFETY TRAY ABOVE OR TO THE SIDE OF REDUNDANT SAFETY OR NON-SAFETY TRAY WITH COVER OR BARRIER

CLEARANCE REQUIRED:

HORIZONTAL.......> 0"
OR
VERTICAL.........1"



(3) SAFETY TRAY CROSSING ABOVE REDUNDANT SAFETY OR NON-SAFETY TRAY WITH COVER OR BARRIER

CLEARANCE REQUIRED:

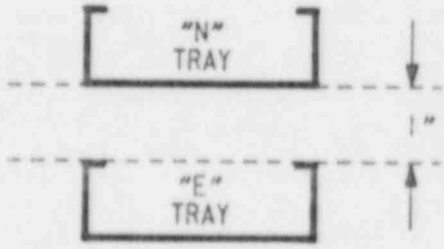
VERTICAL.........1"

FIGURE 1

(4) NON-SAFETY TRAY ABOVE OR TO THE SIDE OF SAFETY TRAY

CLEARANCE REQUIRED:

VERTICAL.........1"

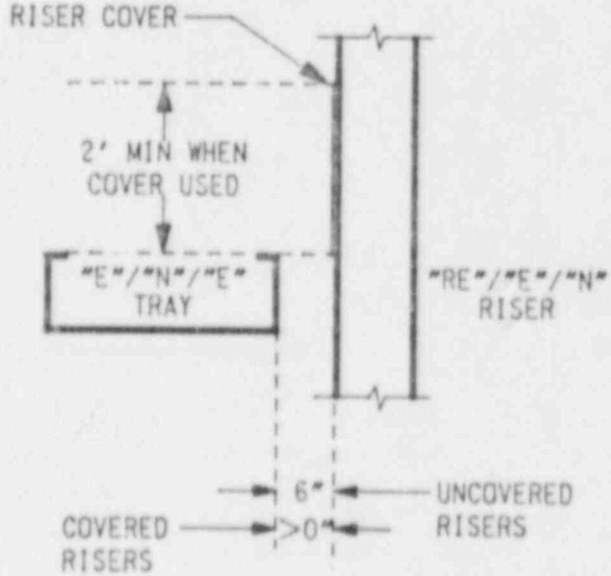


(5) SAFETY TO REDUNDANT SAFETY OR NON-SAFETY TRAY/RISER COMBINATIONS

CLEARANCE REQUIRED:

HORIZONTAL.......>0"
(COVERED RISER)

HORIZONTAL........ 6"
(UNCOVERED RISER)



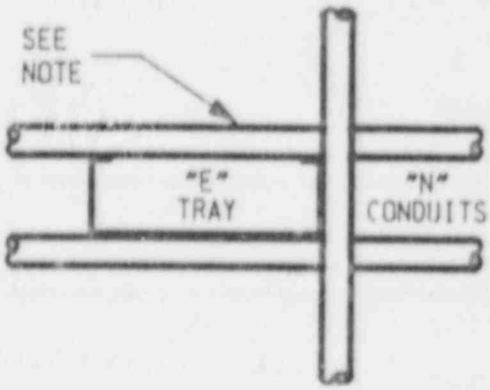
(6) NON-SAFETY CONDUIT CROSSING, ABOVF, BELOW OR TO THE SIDE OF SAFETY TRAY

CLEARANCE REQUIRED:

HORIZONTAL.......0" (1")

OR

VERTICAL.........0" (1")



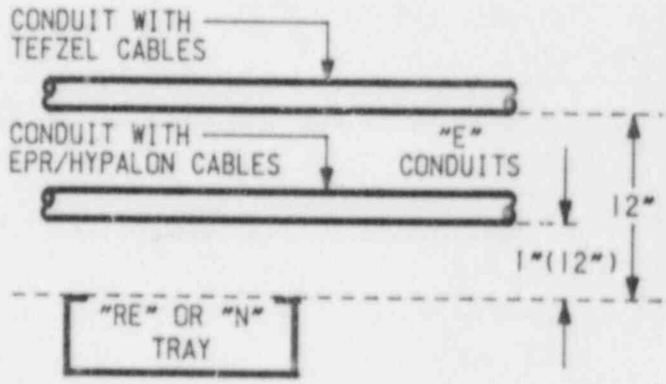
NOTE: SEPARATION BETWEEN CONDUIT ABOVE TRAY AND CABLES IN TRAY SHALL BE >0"

FIGURE I
(CONT.)

(7) SAFETY CONDUIT CROSSING ABOVE SAFETY OR NON-SAFETY TRAY

CLEARANCE REQUIRED:

VERTICAL (EPR/HYPALON) 1" (12")
VERTICAL (TEFZEL)..... 12"

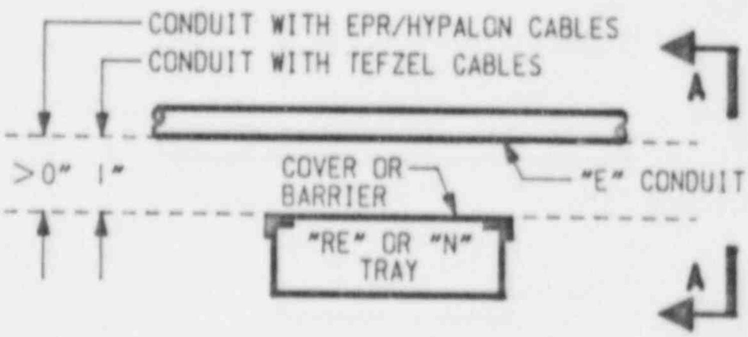


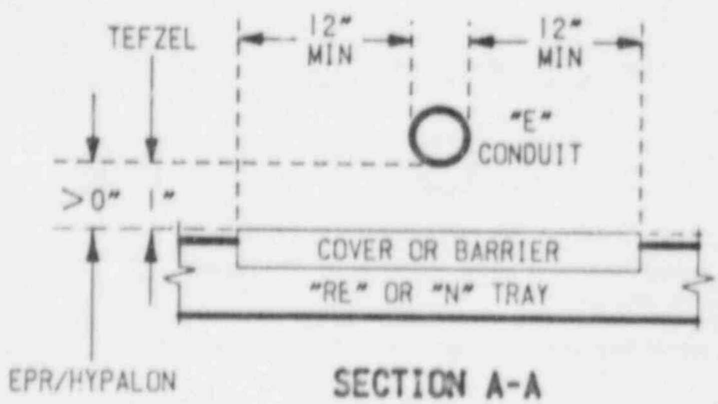
(8) SAFETY CONDUIT WITH TEFZEL CABLES ABOVE REDUNDANT SAFETY OR NON-SAFETY TRAY WITH COVER OR BARRIER

CLEARANCE REQUIRED:

VERTICAL (TEFZEL)...1"

VERTICAL (EPR/HYP)..>0"





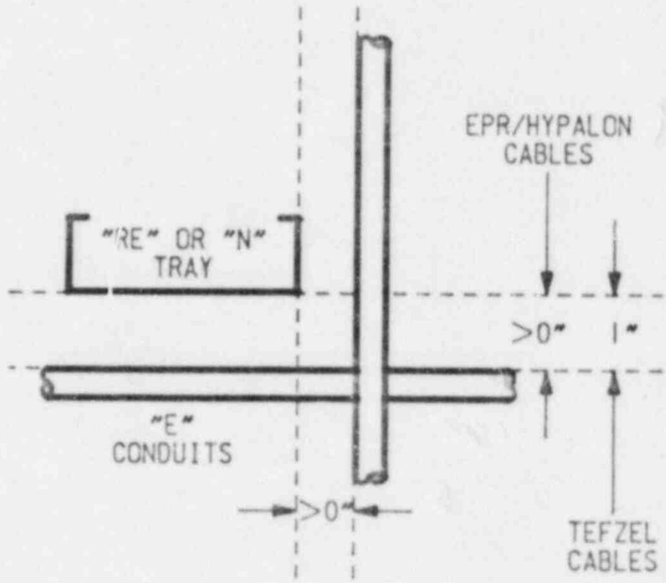
SECTION A-A

FIGURE I
(CONT.)

(9) SAFETY CONDUIT BELOW OR TO THE SIDE OF REDUNDANT SAFETY OR NON-SAFETY TRAY

CLEARANCE REQUIRED:

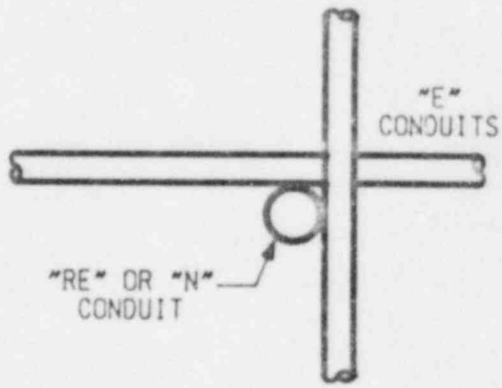
HORIZONTAL.......> 0"
OR
VERTICAL(EPR/HYP)...> 0"
VERTICAL(TEFZEL)..... 1"



(10) SAFETY CONDUIT TO REDUNDANT SAFETY OR NON-SAFETY CONDUIT CROSSINGS

CLEARANCE REQUIRED:

HORIZONTAL.......0" (1")
OR
VERTICAL.........0" (1")



(11) SAFETY CONDUIT WITH EPR/HYPALON CABLES PARALLEL TO REDUNDANT SAFETY OR NON-SAFETY CONDUITS

CLEARANCE REQUIRED:

HORIZONTAL.......0" (1")
OR
VERTICAL.........0" (1")

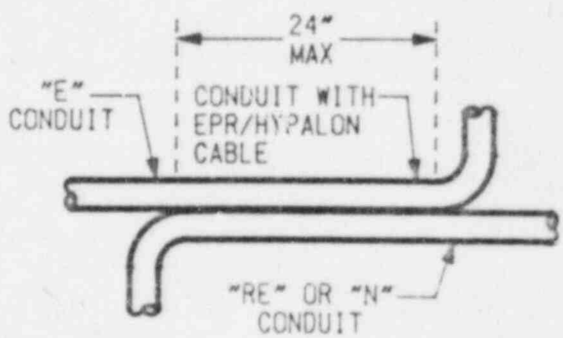
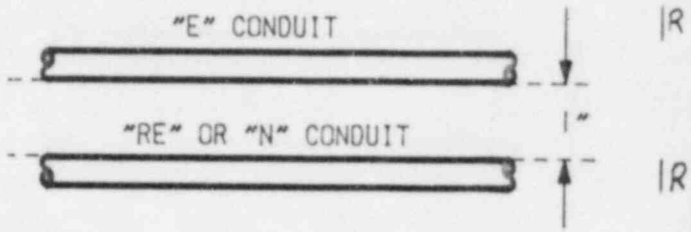


FIGURE I
(CONT.)

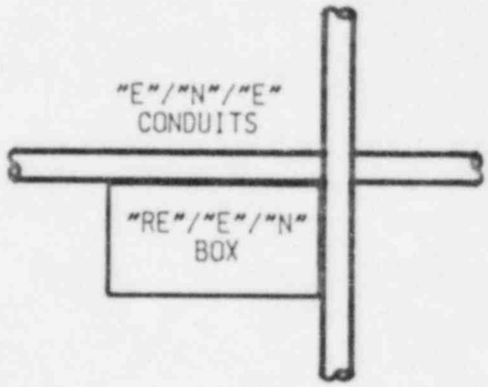
(12) SAFETY CONDUIT TO REDUNDANT SAFETY OR NON-SAFETY CONDUIT IN PARALLEL RUNS GREATER THAN 24" OR WHICH INVOLVED PARALLEL TEFZEL CABLE IN CONDUIT



CLEARANCE REQUIRED:

HORIZONTAL.......1"
OR
VERTICAL.........1"

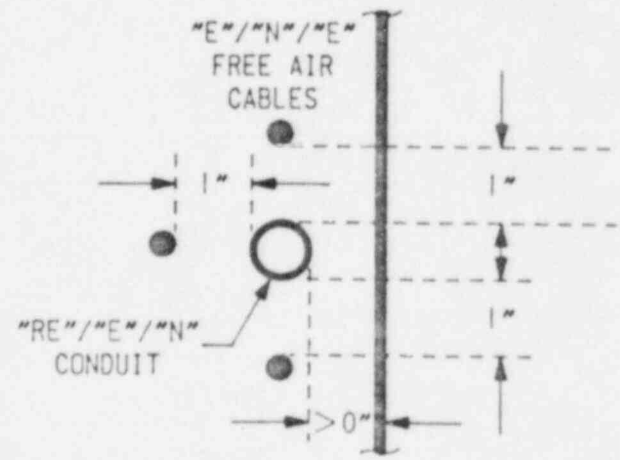
(13) SAFETY TO REDUNDANT SAFETY OR NON-SAFETY CONDUIT TO BOX COMBINATIONS



CLEARANCE REQUIRED:

HORIZONTAL.......0"(1")
OR
VERTICAL.........0"(1")

(14) SAFETY TO REDUNDANT SAFETY OR NON-SAFETY CABLE IN FREE AIR TO CONDUIT COMBINATIONS



CLEARANCE REQUIRED:

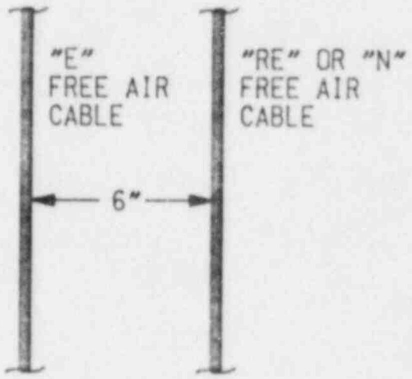
HORIZONTAL(CROSSING)...>0" (1")
HORIZONTAL(PARALLEL).....1"
OR
VERTICAL.................1"

FIGURE 1
(CONT.)

(15) SAFETY TO REDUNDANT SAFETY OR NON-SAFETY CABLE TO CABLE IN FREE AIR

CLEARANCE REQUIRED:

HORIZONTAL.......6"
OR
VERTICAL.........6"



CONFIGURATION KEY

ALL CABLE TRAYS IDENTIFIED IN THIS FIGURE ARE OPEN SOLID BOTTOM TYPE UNLESS OTHERWISE NOTED.

CONDUIT SEPARATION IDENTIFIED IN THIS FIGURE IS APPLICABLE TO EITHER RIGID STEEL, FLEXIBLE OR EMT.

RACEWAY SEGREGATION IDENTIFICATION IS AS FOLLOWS:

"E" SAFETY RELATED OR ASSOCIATED

"RE" REDUNDANT SAFETY RELATED OR ASSOCIATED

"N" NON-SAFETY RELATED

SEPARATION DISTANCES ABOVE OPEN CABLE TRAYS SHALL BE TAKEN FROM THE TOP OF THE TOPMOST CABLE IN THE TRAY OR FROM TOP OF THE TRAY SIDE RAILS (WHICHEVER IS HIGHER).

BARRIERS MAY BE UTILIZED IN LIEU OF THE SOLID TRAY COVERS ILLUSTRATED IN CONFIGURATIONS (2), (3) AND (8). WHEN UTILIZED, BARRIERS SHALL CONFORM TO THE REQUIREMENTS OF IEEE 384-1974, FIGURES 2, 3 AND 4.

SEPARATION DISTANCES FOR JUNCTION BOXES AND PULL BOXES NOT COVERED BY CONFIGURATION (13) SHALL BE THOSE SHOWN IN CONFIGURATIONS (6), (7), (8), (9) AND (14) BY ASSUMING THAT A BOX IS EQUIVALENT TO CONDUIT.

FOR THOSE DIMENSIONS NOTED IN PARENTHESIS THE FOLLOWING IS APPLICABLE:

1) SEPARATION BETWEEN REDUNDANT SAFETY RACEWAYS WHEN EITHER RACEWAY CONTAINS A CABLE LARGER THAN 500MCM.

2) SEPARATION BETWEEN SAFETY AND NON-SAFETY RACEWAYS WHEN THE NON-SAFETY RACEWAY CONTAINS A CABLE LARGER THAN 500MCM. R

THE VERTICAL CLEARANCE REQUIREMENTS PROVIDED IN CONFIGURATIONS (1) AND (4) ARE ALSO APPLICABLE FOR CONDUITS IN PARALLEL OVER TRAY.

FIGURE 1
(CONT.)

SARGENT & LUNDY
ENGINEERS
CHICAGO

Calcs. For		Calc. No. 19-FDA-1
X Safety-Related	Non-Safety-Related	Rev. 3 Date
		Page 20 of 22

Client ILLINOIS POWER COMPANY	Prepared by Date
Project CLINTON POWER STATION	Reviewed by Date
Proj. No. 4536-35 Equip. No. N A	Approved by Date

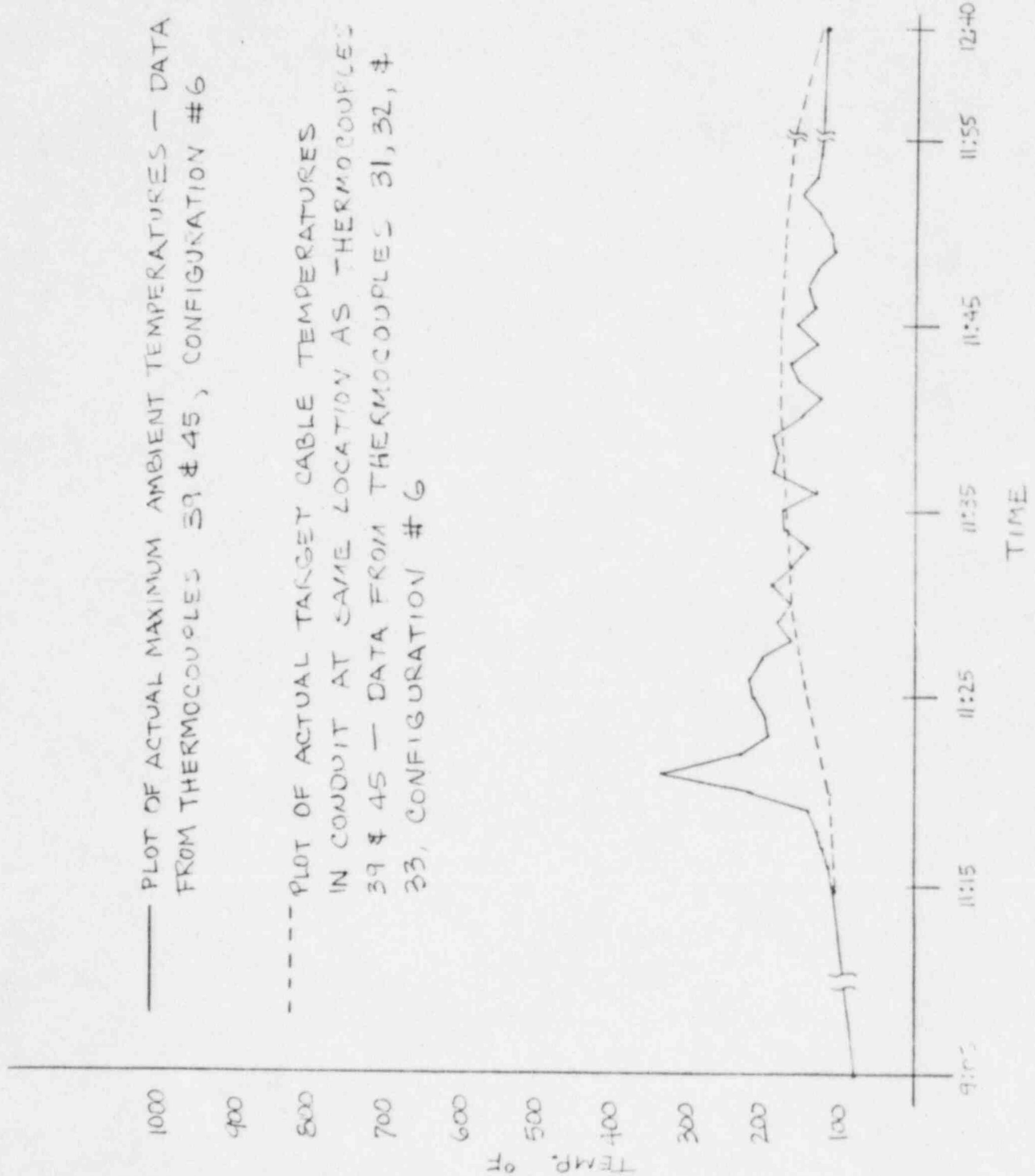


FIGURE 2

Form GQ-3.08.1 Rev. 2 SL-F647 04/84

Form GQ-3 08.1 Rev. 2 SL-F647 04/84

SARGENT LUNDY ENGINEERS	Calcs. For	Calc. No. 19-?DA-?
	☒ Safety-Related ☐ Non-Safety-Related	Rev. 3 Date
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Client ILLINOIS POWER COMPANY	Prepared by Date
Project CLINTON POWER STATION	Reviewed by Date
Proj. No. 4536-35 Equip. No. N/A	Approved by Date

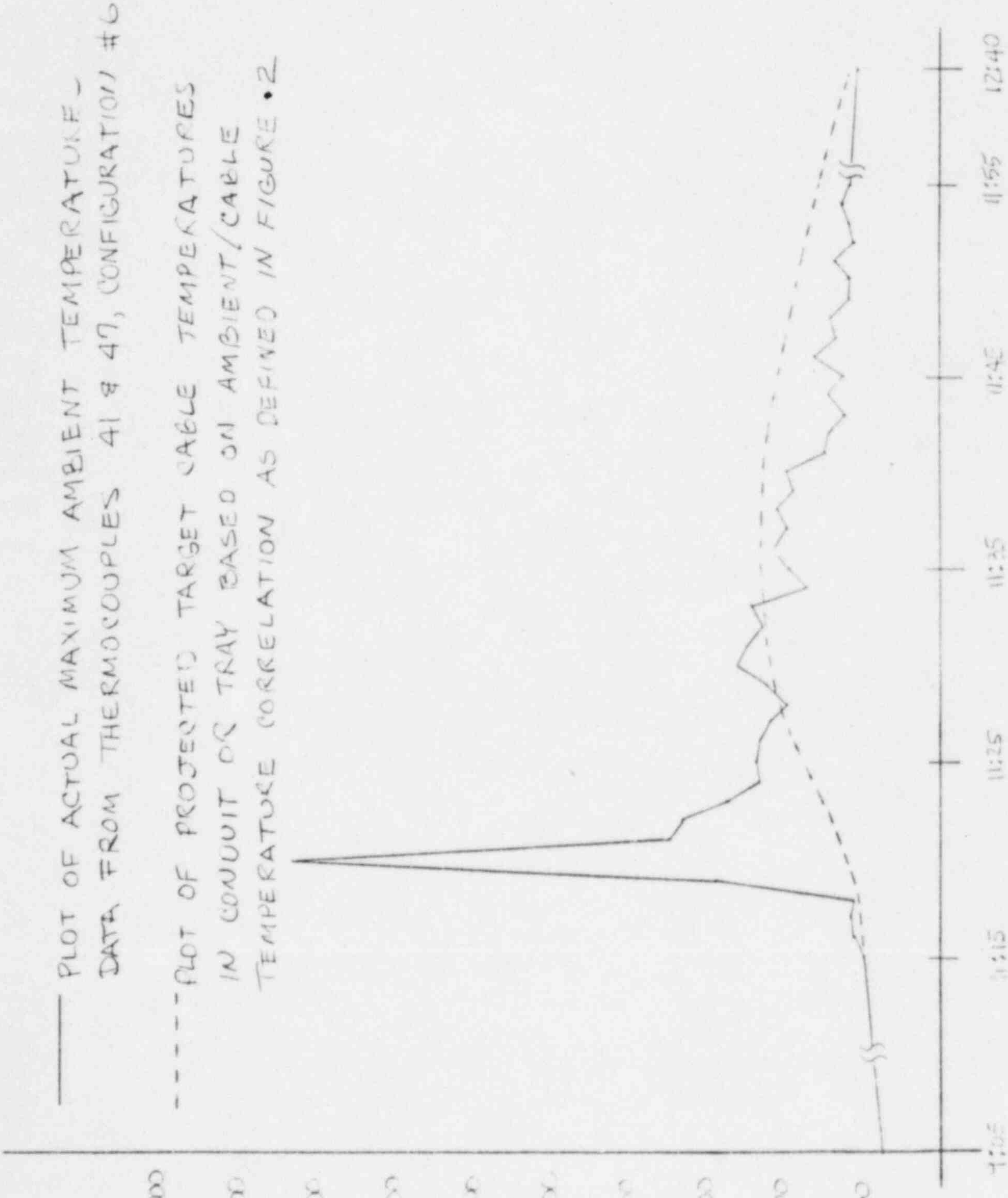

FIGURE 3

Form GQ-3.08.1 Rev. 2 SL-F647 04/84

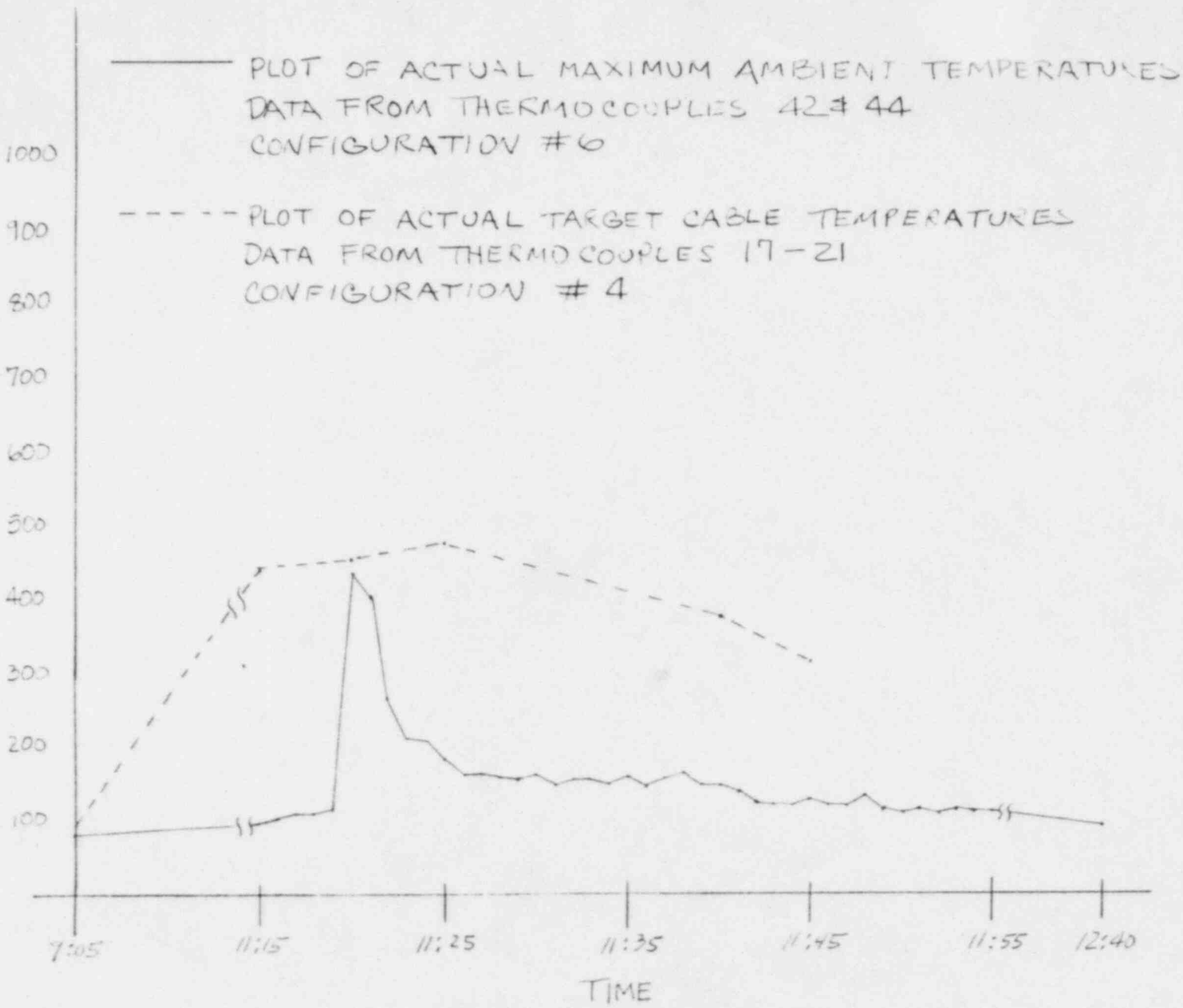

FIGURE 4

SARGENT & LUNDY ENGINEERS CHICAGO

Calcs. For

X Safety-Related

Non-Safety-Related

Calc. No. 19-[illegible]

Rev. 3 Date

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Project [illegible]

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