

TMI-1 EVALUATION OF THERMO-LAG FIRE BARRIERS

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REV. 1

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TMI-1 Evaluation of Thermo-Lag Fire Barriers

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1	A rewrite to address 3-hour fire barriers only.	<i>Fred P. Barber</i>	7/10/96

ABSTRACT

The purpose of this report is to provide the methodology for establishing the fire endurance rating of installed Thermo-Lag fire barrier raceway systems. This report summarizes the results of the evaluations which establish the aforementioned fire endurance ratings and identifies those Thermo-Lag fire barrier raceway systems which meet the requirements of Appendix R, Section IIIG, those barriers which do not meet Appendix R and will be modified or upgraded to meet Appendix R, and those barriers which do not meet Appendix R and for which an evaluation will be performed to justify the fire endurance rating in an exemption request.

This report also provides the methodology used to evaluate the hazards in each fire area or fire zone where Thermo-Lag fire barrier raceway systems are installed. These hazard evaluations will be documented in exemption requests and will serve as the basis for supporting such exemptions where the fire endurance rating of the Thermo-Lag fire barrier raceway system does not meet the requirements of Appendix R, Section IIIG.



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## 1.0 PURPOSE

The purpose of this report is to provide the methodology for establishing the fire endurance rating (equivalent rating by test comparison) of installed Thermo-lag fire barrier raceway systems at TMI-1. Fire endurance rating is established by identifying the "Actual Fire Rating" or the rating consistent with the fire endurance test acceptance criteria as defined in NRC Generic Letter 86-10 Supplement 1, "Fire Endurance Test Acceptance Criteria for Fire Barrier Systems Used to Separate Redundant Safe Shutdown Trains Within the Same Fire Area". Results of these evaluations are reported in Section 3.

This report also provides the methodology used to evaluate the hazards in each fire area or fire zone. The hazard evaluation will serve as the basis for supporting exemptions from Appendix R, Section IIIG. Figure 1 represents a logic chart for evaluating Thermo-lag and identifying a resolution path for restoring operability of cable raceway fire barriers. Attachment 1 includes typical fire barrier evaluations for all conduit sizes that are bounded by an accepted test configuration as well as all unique configurations such as boxes and penetrations that are bounded.

## 2.0 METHODOLOGY

### 2.1 Establishing Actual Fire Rating

To assess material performance and provide a basis for evaluation of installed Thermo-Lag fire barriers, an industry fire endurance test program was conducted by the Nuclear Energy Institute (NEI). To address issues with the fire endurance capability of installed barrier configurations, the industry test program:

- Assessed current industry configurations through the use of survey data,
- Conducted tests to establish performance of various baseline and upgraded fire barrier system assemblies, and
- Developed a guideline to assist utilities in evaluating installed barrier configurations

The guideline developed by NEI is known as the "NEI Application Guide for Evaluation of Thermo-Lag 330 Fire Barrier Systems" (Report no. 0784-00001-TR-02 Revision 2) or the "Application Guide". The Application Guide provides a process and data for evaluation of installed Thermo-Lag fire barrier configurations using information obtained from NEI and utility fire endurance test programs. GPU Nuclear has used this process to

- Establish the extent that installed barrier configurations can be bounded by previous tests,
- Determine the fire endurance capability (or "Actual Fire Rating") that installed barrier configurations, which are bounded by test, can be reasonably expected to provide, and
- Propose upgrades to installed barrier configurations where deemed necessary to achieve an acceptable fire rating.

In order to evaluate the extent that installed barrier conditions at TMI-1 can be bounded by test configurations and data in the Application Guide, GPU Nuclear performed the following:

- A walkdown of the fire areas/zones was conducted to document the installed barrier configurations with digitized computer images.
- The parameters identified by NEI during the industry fire endurance test program which pertain to fire endurance capability, as identified in the Application Guide, were included by GPU Nuclear in an electronic database. (Doc. No. TLDB-TMI-775-1)
- Each fire barrier system was separated into individual segments or elements for evaluation purposes. In general, individual elements are constituted by one or more of the following distinguishing characteristics:
  - 1) change in barrier construction technique;
  - 2) significant change in protected raceway or contents;
  - 3) variation from applicable barrier installation requirements;
  - 4) change in type of barrier material; or
  - 5) change in orientation of protected raceway or change which necessitates a change in barrier construction technique.
- Data collected during the walkdown and collected by a review of the original fire barrier construction details were entered into the database to permit detailed comparisons of relevant parameters from the NEI, Texas Utilities (TU), and TVA programs.
- Each of the test assemblies in the industry test programs was separated into individual segments or elements for evaluation purposes as were the installed fire barrier systems and entered into the data base in order to permit the detailed comparisons of relevant parameters with the installed fire barrier systems.
- The quality of the barrier installation was originally verified by installation process step sign-offs and final inspections performed by GPUN Quality Control and Fire Protection Engineers. No significant deviations from the original design/installation are expected or were noted. Plant repair procedures perform repairs to the same requirements as the initial installation. Repairs are performed either by or under the supervision of certified installers and are re-inspected by certified inspectors. Surveillance procedures ensure a refueling interval inspection to verify the integrity of the installed fire barrier envelopes.

A quality control program as described in the FHAR-Section 5 (and implemented by the TMI-1 QA Plan) was applied to the material, process and installation and inspection personnel. TMI-1 did not contract out the installation work to a third party licensed by TSI but rather contracted TSI to train and license GPUN personnel.

GPUN's initial experience with TSI's material shipments resulted in returning the initial shipment. Some of these problems are described as follows:

### Thickness

Material that was shipped excessively thick was a concern with hanger loading and cable derating. GPUN receipt inspectors verified thickness by taking many readings on each piece. If any piece had more than a few deviations that could not be economically repaired, it was shipped back to TSI.

### Voids and Porosity

Since the material was subject to considerable field work (cut and fit) voids were filled with TSI trowel grade material when exposed during installation. Material which had severe porosity was returned.

To insure receipt of consistent quality material from TSI, GPUN instituted 100% QC checks by GPUN at TSI's factory prior to release for shipment. Thorough receiving inspection checks were maintained.

### Density

Prior to and after assignment of the Manufacturing Assurance representative to the TSI factory, on site QC receipt inspection was relied upon to verify that material weight and density specifications were met.

### Detailed Examinations

GPU Nuclear performed detailed exams to confirm the accuracy of Quality Assurance records for important parameters which are not visible by walkdown. These exams, as committed to in GPU Nuclear letter C311-95-2265 dated July 7, 1995, were performed on 1 hour conduit barrier couplings. Additionally, GPU Nuclear performed work over and above that committed to in the aforementioned letter during the TMI-1 11R outage. As reported in GPU Nuclear letter C-311-95-2456 dated October 31, 1995, five fire barrier envelopes were dismantled to complete cable pulls and terminations for a modification installed during the outage. The Fire Protection Engineer and Quality Verification personnel witnessed the dismantlements and documented the as found important installation parameters, construction details and construction methodology. Items which were verified included the location of the stress skin, "v" rib orientation, joint design, gap widths, pre-buttering of joints and material inspection for voids. The results of these efforts confirmed conformance of Thermo-Lag with original installation and design requirements and provides a reasonable basis for reliance on Quality Assurance records and installation requirements for parameters which are not visible by walkdown.

In order to establish the actual fire rating of the installed fire barrier assemblies, the industry test data was evaluated. Actual fire rating is a term used to designate the fire endurance rating of the barrier consistent with the acceptance criteria contained in NFPA 251 (ASTM E-119), "Standard Fire Tests of Building Construction and Materials". NRC Generic Letter 86-10 Supplement 1, adapts the acceptance criteria of NFPA 251 to cable tray fire barrier wraps.

In 86-10, Supp.1, the staff bases acceptability of a fire endurance qualification test for fire barrier materials applied directly to a raceway or component if the "average" unexposed side temperature of the fire barrier system, as measured on the exterior surface of the raceway or component did not exceed 250 deg F above its initial temperature and a visual inspection of cables inside the raceway should show no signs of degraded conditions. Also, individual temperature readings should not exceed the 250 deg F temperature rise by more than 30 percent, or 325 deg F above the initial temperature.

To establish the barrier rating (ACTUAL RATING) of a test assembly, GPU Nuclear reviewed the temperature data for the test and identified that point in time when the first individual temperature reading on the unexposed side of the fire barrier for the entire raceway in the test assembly, as measured on the exterior surface of the raceway or component, exceeded 325 deg F above the initial temperature. Note that this method establishes a rating for all elements of a particular raceway size based upon the weakest link in the raceway. While it is possible to establish individual ratings in a test involving straight conduit, radial bends and condulets based upon thermocouple readings restricted to these elements in a test assembly, it is conservative to establish a common rating for all elements of a raceway based upon the single high reading for the entire raceway. For cable tray, the bare copper conductor temperature under the rungs of the tray exceeded 325 deg F before any other temperature reading and was therefore used to establish a conservative actual rating unless noted otherwise in the evaluation for that barrier.

To establish the actual rating for an installed configuration or element, the installed configuration's relevant parameters were compared with those of the industry tested configurations. If an acceptable match was found, it was selected and the installed configuration is considered bounded by an acceptable industry test configuration. The actual rating of the matching industry configuration becomes the actual rating of the installed configuration or element as documented by a detailed evaluation. The results of these detailed comparisons and evaluations are listed in section 3 of this report. These detailed comparisons and evaluations will be retained in the electronic database ( Doc. No. TLDB-TMI-775-1) and digitized computer image library mentioned previously.

## 2.2 Evaluating Fire Hazards

To evaluate the cable qualification ratings of the Thermo-Lag fire barriers which do not meet the requirements of Appendix R Section III.G (ie. less than 1 hour or 3 hour), the following method is employed:

A detailed description of the fire areas/zone where Thermolag is installed is provided. This describes:

- a. The location of the fire area/zone, the dimensions and fire rated construction of area/zone.
- b. Fire Protection Features in each fire area/zone.
- c. Combustible materials and locations.

An evaluation is then conducted which considers the location of the Thermo-Lag barrier, the location of combustibles in relation to the barrier, fuel geometry, and the expected nature of a fire. In addition, combustible or fire loading and calculated fire severity is provided for comparison to the rating of the barrier.



A comparison of the Actual Fire Rating (for 3 hour barriers) with the overall fire loading is performed using 80,000 BTU/Ft<sup>2</sup> as equivalent to a one hour fire. A combustible loading of 80,000 BTU/Ft<sup>2</sup> has been considered as equivalent to the heat release in an ASTM E-119 Test Oven for a one hour fire duration test. A source reference to support this assumption is Table 7-9b of the NFPA Fire Protection Handbook, Seventeenth Edition. This technique has served as one of the appropriate supporting bases for previous exemption requests. Combustible loading is an expression of the maximum heat that would be released in a fire area if all combustibles in a given fire area burned. Fire load is expressed in terms of the average fire load, which is the maximum heat release divided by the fire area in square feet. The comparison to E-119 as per Table 7-9b of the NFPA Fire Protection Handbook expresses heat potential in terms of energy released (BTU/FT<sup>2</sup>) and provides an equivalent fire severity approximately equivalent to that of the E-119 test for varying periods of time. It is a relationship of fuel loading (wood, paper and similar materials having calorific values of 7,000 to 8,000 BTU/lb ) that produces an exposure equivalent to the standard time temperature curve for approximate durations. This is empirically derived data developed for the industry to allow engineers to assess the needs for fire resistive construction where Class A combustibles constitute the primary fire hazard. While Class A combustibles are not the primary combustible in most areas in nuclear power plants, cable insulation, which is the primary combustible is slower burning in nature than Class A combustibles and has a commonly accepted heat release value of 10,000 BTU/lb. It is reasonable that the use of the NFPA method is applicable in assessing the fire severity potential in a power plant because the slower burning nature of a cable fire. This assumption is not supported by testing to precisely compare the potential differences in the relationship of Class A combustibles and cable insulation fuel load to fire severity. However, it is judged to be comparable for the reasons stated above and because the E-119 standard is the industry accepted standard for testing and qualifying fire barriers including tests performed by and for the NRC. Fire load is used as an approximate indicator of fire severity because it is considered conservative as long as fire conditions are not expected to be worse than the ASTM E-119 time-temperature curve. As stated above, the principal combustible in a nuclear plant is cable insulation which has a slightly higher heat release rate than ordinary Class A combustibles. However, fire conditions are not expected to be worse than the time temperature curve. It is for this reason that the NRC staff used the combustible loading concept and the combustible loading relationship to fire severity of Table 7-9b of the NFPA Handbook as an appropriate attribute for assessing fire severity potential when granting previous exemptions.

## 3.0 SUMMARY OF RESULTS

The results of applying the above methodology towards establishing an actual fire rating and a cable qualification rating for Thermo-Lag fire barriers are as follows:

## 3.1 Control Building Fire Area CB-FA-2b

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG	NEI TEST
1CCE-FB02	24" X 6" Cable Tray	1	85	2-10
1CCE-FB02	24" x 6" Cable Tray	1	85	2-10
1CCE-FB02	24" x 6" Radial bend tray	1	85	2-10
1CCE-FB03	Condulet	1	69	2-3
1CCE-FB03	1.25" Conduit	8	69	2-3
1CCE-FB03	1.25" Radial bend conduit	5	69	2-3
1CCE-FB03	9.5" x 5" x 6" condulet	1	69	2-3
1CCE-FB09	1" Conduit	1	69	2-3
1CCE-FB09	1" Radial bend conduit	1	69	2-3
1CCE-FB09	11.5"x5.5"x12" condulet	1	69	2-3
1CCE-FB10	Condulet	1	69	2-3
1CCE-FB10	1" Conduit	5	69	2-3
1CCE-FB10	1" Radial bend conduit	3	69	2-3
1CCE-FB10	8"x 5.5"x 4.5" condulet	1	69	2-3

The above envelopes (1CCE-FB02, 1CCE-FB03, 1CCE-FB09, 1CCE-FB10) will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-2b because they have an "ACTUAL FIRE RATING" of at least 60 minutes.

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG	NEI TEST
1CCE-FB02	Penetration	1	Indeterminate	Unbounded
1CCE-FB02	12" x 37" Penetration	1	Indeterminate	Unbounded
1CCE-FB09	17.5"x 15"x 6" Penetration	1	Indeterminate	Unbounded
1CCE-FB10	Penetration	1	Indeterminate	Unbounded

The fire endurance rating of the above penetration elements of envelopes 1CCE-FB02, 1CCE-FB09 and 1CCE-FB10 is indeterminate. These elements will be upgraded to provide a fire endurance rating of 60 minutes. As with the existing envelopes in this fire area which have a minimum rating of 60 minutes, these elements will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-2b because they have an "ACTUAL FIRE RATING" of at least 60 minutes.

## 3.2 Control Building Fire Area CB-FA-2c

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI Test
1CCE-FB03	Penetration	1	60	3-2
1CCE-FB03	1.25" Condulet	2	69	2-3
1CCE-FB03	1.25" Conduit	1	69	2-3
1CCE-FB09	Penetration	1	60	3-2
1CCE-FB09	1" Conduit	1	69	2-3
1CCE-FB09	1" Radial bend conduit	1	69	2-3
1CCE-FB09	1" Condulet	2	69	2-3
1CCE-FB09	17.5"x 15"x 6" Box	1	69	2-3
1CCE-FB10	1" Conduit	5	69	2-3
1CCE-FB10	1" Penetration	1	60	3-1
1CCE-FB10	1" Radial bend conduit	5	69	2-3

The above envelopes (1CCE-FB03, 1CCE-FB09, 1CCE-FB10) will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-2c because they have an "ACTUAL FIRE RATING" of at least 60 minutes.

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI Test
1CCE-FB09	Penetration	1	Indeterminate	Unbounded
1CCE-FB09	8" x 12" Penetration	1	Indeterminate	Unbounded

The fire endurance rating of the above penetration elements of envelope 1CCE-FB09 is indeterminate. These elements will be upgraded to provide a fire endurance rating of 60 minutes. As with the existing envelopes in this fire area which have a minimum rating of 60 minutes, these elements will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-2c because they have an "ACTUAL FIRE RATING" of at least 60 minutes.

## 3.3 Control Building Fire Area CB-FA-2d

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI TEST
1CCE-FB04	0.75 Conduit	5	69	2-3
1CCE-FB04	0.75 Radial bend conduit	3	69	2-3
1CCE-FB04	0.75 Condulet	2	69	2-3
1CCE-FB05	1.5" Conduit	4	69	2-3
1CCE-FB05	1.5" Penetration	1	60	3-2
1CCE-FB05	1.5" Radial bend conduit	1	69	2-3
1CCE-FB05	10.75"x7.5"x5.8 condulet	1	69	2-3
1CCE-FB05	14" x 6" x 6.5" condulet	1	69	2-3
1CCE-FB05	9.5"x 5.5"x5 condulet	1	69	2-3



ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI TEST
1CCE-FB06	1.5" Conduit	6	69	2-3
1CCE-FB06	1.5" Penetration	1	60	3-2
1CCE-FB06	1.5" Radial bend conduit	4	69	2-3
1CCE-FB06	1.5" conduit	1	69	2-3
1CCE-FB06	14" x 6" x 6" conduit	1	69	2-3

The above envelopes (1CCE-FB04, 1CCE-FB05, 1CCE-FB06) will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-2d because they have an "ACTUAL FIRE RATING" of at least 60 minutes.

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI Test
1CCE-FB04	0.75 Penetration	1	Indeterminate	Unbounded

The fire endurance rating of the above penetration element of envelope 1CCE-FB04 is indeterminate. This element will be upgraded to provide a fire endurance rating of 60 minutes. As with the existing envelopes in this fire area which have a minimum rating of 60 minutes, this element will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-2d because it has an "ACTUAL FIRE RATING" of at least 60 minutes.

#### 3.4 Control Building Fire Area CB-FA-2e

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI TEST
1CCE-FB07	2" Conduit	6	69	2-3
1CCE-FB07	2" Radial bend conduit	5	69	2-3
1CCE-FB07	2" Conduit	1	69	2-3

The above envelope (1CCE-FB07) will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-2e because it has an "ACTUAL FIRE RATING" of at least 60 minutes.

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI Test
1CCE-FB07	Penetration	2	Indeterminate	Unbounded

The fire endurance rating of the above penetration elements of envelope 1CCE-FB07 is indeterminate. These elements will be upgraded to provide a fire endurance rating of 60 minutes. As with the existing envelopes in this fire area which have a minimum rating of 60 minutes, these elements will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-2e because they have an "ACTUAL FIRE RATING" of at least 60 minutes.

## 3.5 Control Building Fire Area CB-FA-2f

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI TEST
1CCE-FB08	24" X 6" Cable Tray	1	85	2-10
1CCE-FB08	6" x 6" radial bend tray	1	86	2-10

The above envelope (1CCE-FB08) will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-2f because it has an "ACTUAL FIRE RATING" of at least 60 minutes.

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI Test
1CCE-FB08	30" X 36" X 12 Box	1	Indeterminate	Unbounded

The fire endurance rating of the above element of envelope 1CCE-FB08 is indeterminate. This element will be upgraded to provide a fire endurance rating of 60 minutes. As with the existing envelope in this fire area, which has a minimum rating of 60 minutes, this element will be subject of an exemption request from the requirement in Appendix R, Section III G..C for an automatic suppression system in fire area CB-FA-2f because it has an "ACTUAL FIRE RATING" of at least 60 minutes.

## 3.6 Control Building Fire Area CB-FA-2g

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI TEST
1CCE-FB07	19' x 5" x 5" conduit	1	69	2-3
1CCE-FB07	2" Conduit	3	69	2-3
1CCE-FB07	2" Penetration	1	60	3-1
1CCE-FB07	2" Radial bend conduit	1	69	2-3
1CCE-FB07	22" x 7" x 6" conduit	1	69	2-3

The above envelope (1CCE-FB07) will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-2g because it has an "ACTUAL FIRE RATING" of at least 60 minutes.

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI Test
1CCE-FB07	Penetration	1	Indeterminate	Unbounded

The fire endurance rating of the above penetration element of envelope 1CCE-FB07 is indeterminate. This element will be upgraded to provide a fire endurance rating of 60 minutes. As with the existing envelopes in this fire area which have a minimum rating of 60 minutes, this element will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-2g because it has an "ACTUAL FIRE RATING" of at least 60 minutes.

## 3.7 Control Building Fire Area CB-FA-3a

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI TEST
1CCG-FB01	12"x 15"x 13.5" Box	1	60	2-2
1CCG-FB01	2" Conduit	2	69	2-3
1CCG-FB01	2" Radial bend conduit	2	69	2-3

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI TEST
1CCG-FB05	13.5"x 6" x 6" conduit	1	69	2-3
1CCG-FB05	16"x 6" x 7.5" conduit	1	69	2-3
1CCG-FB05	2" Conduit	5	69	2-3
1CCG-FB05	2" Penetration	1	60	3-1
1CCG-FB05	2" Radial bend conduit	4	69	2-3

The above envelopes (1CCG-FB01, 1CCG-FB05) will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-2f because they have an "ACTUAL FIRE RATING" of at least 60 minutes.

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI Test
1CCG-FB01	Penetration	1	Indeterminate	Unbounded

The fire endurance rating of the above penetration element of envelope 1CCG-FB01 is indeterminate. This element will be upgraded to provide a fire endurance rating of 60 minutes. As with the existing envelopes in this fire area which have a minimum rating of 60 minutes, this element will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-3a because it has an "ACTUAL FIRE RATING" of at least 60 minutes.

## 3.8 Control Building Fire Area CB-FA-3b

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI TEST
1CCG-FB02	3" Conduit	2	91	2-3
1CCG-FB02	3" Radial bend conduit	1	91	2-3
1CCG-FB03	1" Conduit	1	69	2-3
1CCG-FB03	1" Radial bend conduit	1	69	2-3
1CCG-FB03	14.5"x 4" x 4" conduit	1	69	2-3
1CCG-FB03	7.5"x 6" x 5.5" conduit	1	69	2-3
1CCG-FB04	0.75" Conduit	1	69	2-3
1CCG-FB05	Penetration	1	60	3-1
1CCG-FB05	2" Conduit	5	69	2-3
1CCG-FB05	2" Radial bend conduit	3	69	2-3
1CCG-FB05	2" Conduit	1	69	2-3

The above envelopes (1CCG-FB02, 1CCG-FB03, 1CCG-FB04, 1CCG-FB05) will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-3b because they have an "ACTUAL FIRE RATING" of at least 60 minutes.

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI Test
1CCG-FB02	23"x 17"x 5" Penetration	1	Indeterminate	Unbounded
1CCG-FB03	13"x 16" x 5" Penetration	1	Indeterminate	Unbounded
1CCG-FB03	16"x 11.5" x 3" Penetration	1	Indeterminate	Unbounded
1CCG-FB05	15"x 7" x 7" Box	1	Indeterminate	Unbounded
1CCG-FB05	35"x 10.5" x 16" Box	1	Indeterminate	Unbounded

The fire endurance rating of the above penetration elements of envelopes 1CCG-FB02, 1CCG-FB03 and 1CCG-FB05 is indeterminate. These elements will be upgraded to provide a fire endurance rating of 60 minutes. As with the existing envelopes in this fire area which have a minimum rating of 60 minutes, these elements will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire area CB-FA-3b because they have an "ACTUAL FIRE RATING" of at least 60 minutes.

### 3.9 Control Building Fire Zone FH-FZ-5

ENVELOPE NO.	TYPE	NO. ELEMENTS	ACTUAL RTG.	NEI TEST
1CCE-FB01	14.5"x7.5"x7" Penetration	1	60	3-2
1CCE-FB01	2.5" Penetration	1	60	3-1
1CCE-FB01	14.5"x7.5"x7" conduit	1	69	2-3
1CCE-FB01	2.5" Conduit	8	69	2-3
1CCE-FB01	2.5" Radial bend conduit	7	69	2-3
1CCE-FB01	7.75"x18.5"x28" conduit	1	69	2-3

The above envelope (1CCE-FB01) will be the subject of an exemption request from the requirement in Appendix R, Section III.G.2.c for an automatic suppression system in fire zone FH-FZ-5 because it has an "ACTUAL FIRE RATING" of at least 60 minutes.

### 4.0 REFERENCES

- 4.1 NRC Generic Letter 86-10, Supplement 1, Enclosure 1, "FIRE ENDURANCE TEST ACCEPTANCE CRITERIA FOR FIRE BARRIER SYSTEMS USED TO SEPARATE REDUNDANT SAFE SHUTDOWN TRAINS WITHIN THE SAME FIRE AREA", dated March 25, 1994.
- 4.2 10 CFR Part 50 Appendix R, "FIRE PROTECTION PROGRAM FOR NUCLEAR POWER FACILITIES OPERATING PRIOR TO JANUARY 1, 1979".
- 4.3 NEI Report No. 0784-00001-TR-02, Revision 2, "NEI APPLICATION GUIDE FOR EVALUATION OF THERMO-LAG 330 FIRE BARRIER SYSTEMS".
- 4.4 GPU Nuclear Three Mile Island Unit No.1 Fire Hazards Analysis Report (FHAR) No. 990-1745, Revision 16.
- 4.5 NFPA 251 (ASTM E-119), "STANDARD FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS".
- 4.6 Gilbert Commonwealth Letter G/C/TMI-1CS/16503 Sept. 15, 1988, J. Brendlen to J.W. Langenbach, "TSI DERATING CHECK".
- 4.7 NFPA Fire Protection Handbook, Seventeenth Edition.
- 4.8 GPUN Document No. TLDB-TMI-775-1, "TMI THERMO-LAG DATA BASE".

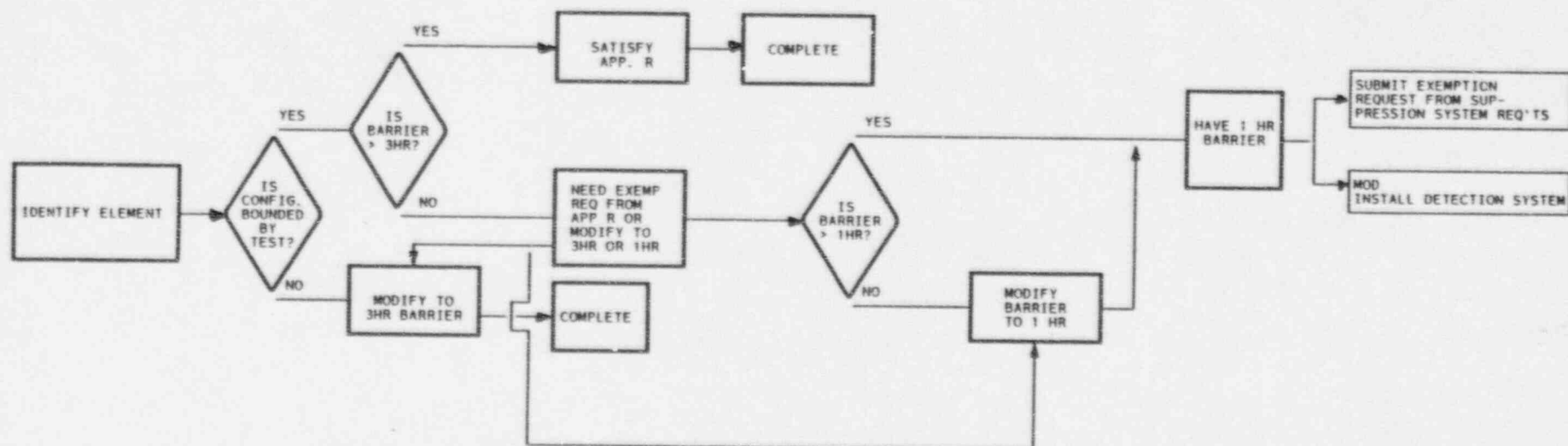


FIGURE 1  
THERMO-LAG RESOLUTION LOGIC CHART

ATTACHMENT 1  
FIRE BARRIER EVALUATIONS

This attachment provides the detailed evaluations of selected "3 hour" fire barrier configurations to demonstrate how specific elements are bounded with accepted test configurations and how fire endurance ratings or "Actual Fire Ratings" are established. In addition, the attachment includes assumptions used in performing these evaluations. Both evaluations and assumptions have been extracted from the electronic database which retains all the evaluations (Doc. No. TLDB-TMI-775-1). For conduits and tray, typical configurations are included. All unique configurations are included. Below is a listing of the selected evaluation by "element no."

SIZE	CONDUIT (STRAIGHT)	CONDUIT (RADIAL BEND)	CONDULET
.75"	544	543	542
1.00"	354	353	352
1.25"	31	302	300
1.50"	315	317	314
2.00"	334	333	34
2.50"	284	285	30
3.00"	381	382	NA

SIZE	TRAY	TRAY (RADIAL BEND)
24" X 6"	159	160
6" X 6"	350	

PENETRATIONS

573, 574, 582, 577, 578, 545, 605, 606



## EVALUATION ASSUMPTIONS FOR TMI

### 2. ASSUMPTIONS FOR IMPORTANT BARRIER PARAMETERS

THIS SECTION ADDRESSES THE RELEVANCE OF IMPORTANT PARAMETERS IDENTIFIED IN NRC LETTER OF DEC. 21, 1993. EACH OF THESE PARAMETERS WHICH ARE APPLICABLE TO TMI-1 IS CONSIDERED FOR COMPARISON TO TESTED CONFIGURATIONS DOCUMENTED IN THE NEI APPLICATION GUIDE. DETAILED EXAMINATIONS WERE CONDUCTED ON A REPRESENTATIVE NUMBER OF INSTALLED CONFIGURATIONS PRIMARILY TO DEMONSTRATE THE ACCURACY OF QUALITY VERIFICATION RECORDS FOR THE INSTALLATION OF THE THERMO-LAG FIRE BARRIER ENVELOPES FOR THOSE PARAMETERS WHICH CANNOT BE VERIFIED IN THE FIELD BY VISUAL EXAMINATION.

WHERE VERIFICATION OF PARAMETERS IS REQUIRED AND AVAILABLE BY VISUAL EXAMINATION, THOSE PARAMETERS WERE IDENTIFIED FOR EACH ELEMENT OF THE INSTALLED CONFIGURATION. DETAILED EXAMINATIONS DEMONSTRATE THE ACCURACY OF QUALITY VERIFICATION RECORDS AND INVESTIGATE PARAMETERS WHICH ARE IMPORTANT BUT NOT PART OF ORIGINAL INSTALLATION RECORDS. THIS WILL JUSTIFY RELIANCE ON DESIGN AND QUALITY VERIFICATION RECORDS AS WELL AS THE DETAILED EXAMINATIONS FOR PARAMETERS WHICH CANNOT BE VERIFIED IN THE FIELD BY VISUAL EXAMINATION. THIS SUPPORTS THE EFFORT TO COMPARE INSTALLED CONFIGURATIONS WITH TESTED CONFIGURATIONS USING DATA FROM THE NEI APPLICATION GUIDE. THIS COMPARISON IS REQUIRED TO ESTABLISH ACTUAL FIRE ENDURANCE RATINGS FOR INSTALLED THERMO-LAG CONFIGURATIONS.

#### A. RACEWAY ORIENTATION (HORIZONTAL, VERTICAL, RADIAL BENDS)

RACEWAY ORIENTATION IS RELEVANT. VERIFICATION IS BY VISUAL EXAM.

NOTE THAT FIRE ENDURANCE RATINGS FOR ENVELOPE DESIGNS ON CONDUIT ROUTINGS ARE ESTABLISHED BY USING THE FIRST THERMOCOUPLE READING IN A TEST ASSEMBLY THAT EXCEEDS A SPECIFIC TEMPERATURE IRRESPECTIVE OF THE ORIENTATION. THIS METHOD IGNORES WHERE IN THE ASSEMBLY THE HIGHEST TEMPERATURE OCCURS FIRST. THIS FIRST READING IS THEN USED AS THE BASIS FOR THE ENTIRE ASSEMBLY FIRE ENDURANCE RATING. SOURCE OF THE THERMOCOUPLE READINGS IS A TEST REPORT REFERENCED IN THE NEI APPLICATION GUIDE. THEREFORE, FOR CONDUIT RUNS INCLUDING CONDULETS, THE ORIENTATION OF THE RACEWAY IS NOT CRITICAL TO ESTABLISHING THE FIRE ENDURANCE RATING.

#### B. CONDUIT

THIS PARAMETER IS RELEVANT. VERIFICATION IS BY VISUAL EXAM AND DESIGN DRAWINGS. QC RECORDS ALSO DOCUMENT THE TYPE OF RACEWAY AND ITS SIZE.

#### C. JUNCTION BOXES AND LATERAL BENDS.

THIS PARAMETER IS RELEVANT. VERIFICATION IS BY VISUAL EXAM AND DESIGN DRAWINGS. QC RECORDS ALSO DOCUMENT THE TYPE OF RACEWAY AND ITS SIZE.

#### D. LADDER-BACK CABLE TRAY WITH SINGLE LAYER CABLE FILL

THIS PARAMETER IS RELEVANT. VERIFICATION IS BY VISUAL EXAM AND DESIGN DRAWINGS. QC RECORDS ALSO DOCUMENT THE TYPE OF RACEWAY AND ITS SIZE.

#### E. CABLE TRAY WITH T-SECTION

THIS PARAMETER IS RELEVANT. VERIFICATION IS BY VISUAL EXAM AND DESIGN DRAWINGS. QC RECORDS ALSO DOCUMENT THE TYPE OF RACEWAY AND ITS SIZE.

## EVALUATION ASSUMPTIONS FOR TMI

### F. RACEWAY MATERIAL (ALUMINUM, STEEL)

RACEWAYS (CONDUITS, BOXES, ETC) AT TMI-1 ARE CONSTRUCTED OF STEEL AND ALUMINUM.

THIS PARAMETER IS NOT RELEVANT. THE BASIS FOR THIS IS THAT MOST NEI TESTING HAS BEEN CONDUCTED USING ALUMINUM RACEWAYS. ALTHOUGH ALUMINUM HAS A SLIGHTLY HIGHER HEAT CAPACITY (SPECIFIC HEAT) THAN STEEL, A GIVEN LENGTH OF STEEL CONTAINS SIGNIFICANTLY MORE MASS THAN ALUMINUM. THEREFORE, A GIVEN HEAT EXPOSURE WILL RESULT IN HIGHER TEMPERATURES FOR ALUMINUM RACEWAYS THAN FOR EQUIVALENT RACEWAYS CONSTRUCTED OF STEEL. THIS EFFECT HAS BEEN DEMONSTRATED BY NEI TEST 1-6 AND TVA TEST 6.1.4 WHICH EACH EVALUATED 1-HOUR THERMOLAG PRESHAPED SECTIONS ON 3" DIAMETER ALUMINUM AND STEEL CONDUITS. IN EACH TEST, THE AVERAGE AND MAXIMUM TEMPERATURES RECORDED ON THE SURFACE OF ALUMINUM CONDUITS SURPASSED THOSE RECORDED ON STEEL CONDUIT SURFACES. THE RESULTS ARE NOT SIGNIFICANTLY DIFFERENT. HOWEVER, THE RESULTS DO SUGGEST THAT IT IS LEGITIMATE TO APPLY TEST RESULTS FOR ALUMINUM RACEWAYS TO THERMOLAG CONFIGURATIONS CONSTRUCTED ON STEEL RACEWAYS BECAUSE FIRE TEST RESULTS FOR ALUMINUM RACEWAYS WILL MOST LIKELY BE CONSERVATIVE COMPARED TO STEEL RACEWAYS AND WILL PROBABLY NOT EXCEED TEST RESULTS FOR SIMILAR THERMOLAG CONSTRUCTION ON STEEL RACEWAYS.

THEREFORE, VERIFICATION OF ALUMINUM OR STEEL AS THE RACEWAY MATERIAL IS NOT RELEVANT SINCE THE MAJORITY OF NEI TEST DATA IS BASED UPON THERMOLAG CONFIGURATIONS CONSTRUCTED ON ALUMINUM RACEWAYS AND THIS DATA IS AVAILABLE FOR ESTABLISHING FIRE ENDURANCE RATINGS. AS STATED ABOVE THIS IS CONSIDERED LEGITIMATE BASED UPON COMPARATIVE TEST RESULTS FOR SIMILAR THERMOLAG CONSTRUCTIONS ON ALUMINUM AND STEEL RACEWAYS.

### G. SUPPORT PROTECTION, THERMAL SHORTS (PENETRATING ELEMENTS)

THIS PARAMETER IS RELEVANT. VERIFICATION IS BY VISUAL EXAM AND DESIGN DRAWINGS.

THE PURPOSE OF PROTECTING SUPPORT AND INTERVENING STEEL MEMBERS IS PRIMARILY TO PREVENT HEAT CONDUCTION THROUGH STEEL CONNECTED WITH THE PROTECTED RACEWAY.

1-HOUR CONDUIT AND CABLE TRAY ENVELOPES WITH SUPPORT MEMBERS WERE PROTECTED FOR AN 9" DISTANCE. 3-HOUR ENVELOPES TESTED WITH SUPPORT MEMBERS WERE PROTECTED FOR THE ENTIRE LENGTH AND INTERVENING STEEL MEMBERS WERE PROTECTED FOR AN 18" DISTANCE. NO JOINT REINFORCEMENT WAS PROVIDED ON EITHER OF THE ABOVE SUPPORT OR INTERVENING STEEL MEMBER CONFIGURATIONS.

THE TESTING DEMONSTRATED THAT SUPPORT AND INTERVENING STEEL MEMBERS PROTECTED AS DESCRIBED ABOVE ADEQUATELY PREVENT SIGNIFICANT HEAT CONDUCTION INTO PROTECTIVE ENVELOPES. UNPROTECTED STEEL DID NOT FAIL DURING THE TEST. NO FAILURES OF PROTECTIVE ENVELOPES HAVE BEEN ATTRIBUTED TO STRUCTURAL FAILURES OF MATERIAL INSTALLED ON SUPPORT AND INTERVENING STEEL MEMBERS.

THE CONFIGURATION OF THERMOLAG INSTALLED ON SUPPORTS IS NOT CONSIDERED CRITICAL AS LONG AS COVERAGE OF SUPPORT OR CONNECTING STEEL IS PROVIDED CONSISTENT WITH THE HOURLY RATING (1/2 IN. FOR 1-HOUR, 1 IN. FOR 3-HOUR) AND COMPARABLE OR GREATER DISTANCES AS AS PER THE NEI TESTS. NO SPECIFIC COMPARISONS WITH NEI TEST CONFIGURATIONS WILL BE MADE AS THE EXACT CONSTRUCTION DETAILS ARE



## EVALUATION ASSUMPTIONS FOR TMI

NOT CONSIDERED CRITICAL TO THE PERFORMANCE OF THE CABLE RACEWAY PROTECTIVE ENVELOPE.

### H. AIR DROPS

THIS PARAMETER IS RELEVANT. VERIFICATION IS BY VISUAL EXAM AND DESIGN DRAWINGS. QC RECORDS ALSO DOCUMENT THE INSTALLATION DETAILS.

### I. BASELINE FIRE BARRIER PANEL THICKNESS

THIS PARAMETER IS RELEVANT AND NOT AVAILABLE BY VISUAL EXAM. RELIANCE IS ON QUALITY VERIFICATION CHECKS PERFORMED AT TSI, RECEIPT INSPECTION AND INSTALLATION INSPECTION.

VERIFICATION OF THIS PARAMETER IS DOCUMENTED BY DETAILED EXAMINATION.

### J. PREFORMED CONDUIT PANELS

THIS PARAMETER IS RELEVANT. VERIFICATION IS BY VISUAL EXAM.

### K. PANEL RIB ORIENTATION (PARALLEL OR PERPENDICULAR TO THE RACEWAY)

VERIFICATION IS NOT AVAILABLE BY VISUAL EXAMINATION.

VERIFICATION OF THIS PARAMETER IS DOCUMENTED BY DETAILED EXAMINATION.

THIS PARAMETER IS NOT RELEVANT FOR PREFORMED CONDUIT. IT IS RELEVANT TO CONFIGURATIONS CONSTRUCTED USING PANELS, NOT PREFORMED CONDUIT SECTIONS.

MOST PANELS ARE FABRICATED WITH V-RIB STIFFENERS. THE STANDARD METHOD OF PANEL INSTALLATION RESULTS IN STIFFENERS BEING ORIENTED INWARD. THEREFORE, WHEN THE PANELS ARE INSTALLED, AN INHERENT AIR GAP OF APPROX. 1/2 IN. IS INTRODUCED BETWEEN THE UNEXPOSED SIDE OF THE PANEL AND THE SURFACE OF PROTECTED ASSEMBLIES. ALTHOUGH SPECIFIC COMPARATIVE TESTING HAS NOT BEEN PERFORMED, IT IS REASONABLE TO CONCLUDE THAT CONFIGURATIONS CONSTRUCTED USING THIS STANDARD METHOD WOULD BE THERMALLY BOUNDED BY CONFIGURATIONS WHICH HAVE NO INSULATING AIR GAP. CONFIGURATIONS USING FLAT PANELS ON LBD BOXES WERE TESTED BY TVA. NEI TESTS USED V-RIBS. TEST RESULTS FOR NEI SHOW THAT LBD'S ARE NOT LIMITING, IE. TEST 2-1 FOR 3/4 IN. LBD'S SHOW LBD SURFACE TEMPERATURE ACCEPTANCE CRITERIA EXCEEDED AT 50 MINUTES VS CONDUIT SURFACE ACCEPTANCE CRITERIA EXCEEDED AT 27 MINUTES. IT IS REASONABLE TO CONCLUDE THAT LACK OF AN AIR GAP WOULD NOT SIGNIFICANTLY AFFECT PERFORMANCE SUCH THAT TEMPERATURE ACCEPTANCE CRITERIA WOULD BE EXCEEDED IN LESS 27 MINUTES. AS DISCUSSED IN A ABOVE, THE FIRE ENDURANCE RATING IS BASED UPON THE FIRST THERMOCOUPLE READING IN THE ENTIRE ASSEMBLY TO EXCEED A SPECIFIC POINT. THIS IS THEN APPLIED TO THE ENTIRE ASSEMBLY. THEREFORE A 3/4 IN LBD IS CONSIDERED TO HAVE A FIRE ENDURANCE RATING OF 27 MIN., NOT 50 MIN. THEREFORE THE PRESENCE OR DIRECTION OF V-RIBS IS NOT A RELEVANT PARAMETER SINCE THE LBD RATING IS BASED UPON PREFORMED CONDUIT IN CONTACT WITH THE CONDUIT SURFACE.

TO FURTHER SUSTANTIATE THE ABOVE DISCUSSION, THE FOLLOWING IS PRESENTED:

A REVIEW OF NEI TEST 2-1 (1 HOUR BASELINE CONDUIT) AND NEI TEST

## EVALUATION ASSUMPTIONS FOR TMI

2-3 (3 HOUR BASELINE CONDUIT) TEMPERATURE DATA SHOWS THAT THE FACTORS WHICH DETERMINE SURFACE CONDUIT OR CONDULET TEMPERATURE ARE AS FOLLOWS:

- A) THICKNESS OF THERMOLAG
- B) PRESENCE OF AIR GAP BETWEEN THERMOLAG AND CONDUIT/CONDULET
- C) DIAMETER OF CONDUIT/CONDULET

GREATER THICKNESS OF THERMOLAG PROVIDES A LOWER TEMPERATURE. FOR A GIVEN THERMOLAG THICKNESS AND CONDUIT SIZE, THE PRESENCE OF AN AIR GAP RESULTS IN A LONGER TIME TO REACH AN UNACCEPTABLE TEMPERATURE. THE CONDUIT AND CONDULET ARE ENVELOPED WITH THE SAME THICKNESS AND HAVE ESSENTIALLY THE SAME DIAMETER. THE CONDULET IS ENVELOPED BY A "BOX" TYPE CONFIGURATION OF THERMOLAG BECAUSE OF ITS IRREGULAR SHAPE WHILE THE CONDUIT IS COVERED BY A CYLINDRICAL ENVELOPE. BASED UPON THIS DISCUSSION, A CONDULET OF THE SAME DIAMETER AND THERMOLAG THICKNESS WOULD BE EXPECTED TO RESULT IN THE SAME MAXIMUM TIME/TEMPERATURE CHARACTERISTICS AS A CONDUIT IF THERE WERE NO AIR GAP. THE FACT THAT A CONDULET IS COVERED BY A "BOX" WITH OR WITHOUT V-RIB STIFFENERS WILL CAUSE A VARIATION IN THE SIZE OF THE AIR GAP. A "BOX" WITHOUT V-RIBS WILL STILL HAVE AIR GAPS BETWEEN THE THERMOLAG AND THE CONDULET WHERE THE THERMOLAG IS NOT TANGENT TO THE CONDULET WALL. THIS MEANS THAT THE CONDULET TEMPERATURE RESPONSE WILL BE LESS THAN OR EQUAL TO, BUT NOT GREATER THAN, A CONDUIT OF THE SAME DIAMETER WRAPPED IN THE SAME THICKNESS OF THERMOLAG. THEREFORE THE USE OF TEMPERATURE RESULTS FOR PREFORMED CONDUIT IS APPROPRIATELY BOUNDING TO A "BOX" TYPE CONFIGURATION FOR THE SAME SIZE CONDULET EVEN IF THE V-RIB STIFFENERS ARE REMOVED FROM THE INSIDE FACE OF THE THERMOLAG PANELS USED TO CONSTRUCT THE "BOX".

WITH RESPECT TO STIFFENER ORIENTATION OVER LARGE UNSUPPORTED SPANS, ORIENTATION MAY HAVE AN IMPACT ON BARRIER PERFORMANCE. SPECIFICALLY, NEI TEST 1-1 EVALUATED UPGRADE METHODS APPLIED TO A LIMITING CASE 1-HOUR BARRIER DESIGN INSTALLED ON A 36 INCH WIDE CABLE TRAY. THE PANELS WERE INSTALLED ON CABLE TRAY TOP AND BOTTOM SURFACES WITH RIBS ORIENTED IN THE DIRECTION OF THE TRAY RUN, AND NO MECHANISMS SUCH AS INTERNAL BANDING WERE USED TO SUPPORT THE TOP PANELS. THE ORIENTATION OF THE STIFFENER RIBS WAS A CONTRIBUTING FACTOR TO BOTH THERMAL AND STRUCTURAL FAILURE OF THE ENVELOPE. A PRONOUNCED SAG EFFECT OF THE TOP PANELS ENABLED SIGNIFICANT HEAT CONDUCTION THROUGH THE TOP OF THE ENVELOPE. ULTIMATELY, THE STRESSES IMPOSED AT JOINTS ALONG THE TRAY SIDE RAILS WERE SUFFICIENT TO BREACH THE ENVELOPE. NEI TEST 2-7 EVALUATED 1-HOUR BASELINE BARRIERS INSTALLED ON 6 INCH AND 24 INCH WIDE CABLE TRAYS. THE STIFFENER RIBS WERE AGAIN ORIENTED IN THE DIRECTION OF THE TRAY RUN, AND NO MECHANISMS SUCH AS INTERNAL BANDING WERE USED TO SUPPORT THE TOP PANELS. FAILURE OF THE BARRIERS WAS NOT ATTRIBUTED TO SAG OF THE TOP PANELS OR EXCESSIVE HEAT CONDUCTION THROUGH THE TOP OF THE ENVELOPE. THEREFORE, FOR ONE HOUR FIRE BARRIER PANELS, THE ORIENTATION OF THE RIB STIFFENERS IS NOT CRITICAL AS LONG AS THE UNSUPPORTED OR UNSTIFFENED SPAN DOES NOT EXCEED 24 INCHES.

SIMILARLY, NEI TEST 2-10 EVALUATED 3 HOUR BASELINE BARRIERS INSTALLED ON 6 INCH AND 24 INCH WIDE CABLE TRAYS. THE RIBS WERE ORIENTED IN THE DIRECTION OF THE RUN OF THE TRAYS. FAILURE OF THE BARRIERS WAS NOT ATTRIBUTED TO SAG EFFECTS OF THE TOP PANELS OR EXCESSIVE HEAT CONDUCTION THROUGH THE TOP OF THE ENVELOPES. THEREFORE FOR 3 HOUR FIRE BARRIER PANELS, THE ORIENTATION OF THE RIB STIFFENERS IS NOT CRITICAL AS LONG AS THE UNSUPPORTED OR

## EVALUATION ASSUMPTIONS FOR TMI

UNSTIFFENED SPAN DOES NOT EXCEED 24 INCHES.

### L. UNSUPPORTED SPANS

VERIFICATION OF RACEWAY SUPPORT LOCATIONS IS BY VISUAL EXAM. VERIFICATION OF UNSUPPORTED THERMOLAG PANEL BARRIER SPANS IS NOT AVAILABLE BY VISUAL EXAM.

VERIFICATION OF THIS PARAMETER WITH RESPECT TO THERMOLAG PANEL BARRIER SPANS IS DOCUMENTED BY DETAILED EXAMINATION.

SUPPORT SPAN FOR CONDUITS IS NOT RELEVANT. PROPER BAND SPACING AND THE CONDUIT ITSELF PROVIDE ADEQUATE SUPPORT FOR PREFORMED CONDUIT BARRIERS. THIS PARAMETER IS RELEVANT TO CABLE TRAY ENVELOPES AND BOX ENCLOSURES. TESTING HAS DEMONSTRATED THAT LARGE UNSUPPORTED BARRIER SPANS GREATER THAN 24 INCHES CHALLENGE THE INTEGRITY OF BARRIER ENVELOPES AS GREATER STRESSES ARE IMPOSED ON JOINTS. (NEI APPLICATION GUIDE).

### M. STRESS SKIN ORIENTATION (INSIDE OR OUTSIDE)

VERIFICATION OF THIS PARAMETER IS NOT AVAILABLE BY VISUAL EXAM FOR 1-HOUR FIRE BARRIERS. RELIANCE IS ON QUALITY VERIFICATION RECORDS. VERIFICATION OF EXTERIOR STRESS SKIN ON 3 HOUR PREFORMED SHAPES IS BY VISUAL EXAM.

VERIFICATION OF THIS PARAMETER FOR 1-HOUR FIRE BARRIERS IS DOCUMENTED BY DETAILED EXAMINATION.

THIS PARAMETER IS RELEVANT. 1 HOUR PREFORMED CONDUIT SHAPES AND PANELS MUST HAVE STRESS SKIN INSTALLED ON THE INSIDE OF THE BARRIER. 3 HOUR PREFORMED CONDUIT SHAPES AND PANELS MUST HAVE STRESS SKIN INSTALLED ON BOTH SIDES OF THE PANEL.

### N. STRESS SKIN OVER JOINTS OR NO STRESS SKIN OVER JOINTS

INSTALLATION OF STRESS SKIN OVER JOINTS WAS NOT A DESIGN REQUIREMENT FOR TMI-1. THIS HAS BEEN VERIFIED BY REVIEW OF THE ORIGINAL DESIGN DOCUMENTS.

STRESS SKIN INSTALLED OVER JOINTS WOULD CONTRIBUTE TO IMPROVING BARRIER PERFORMANCE AS DEMONSTRATED BY TESTING WITH THIS PARAMETER BY NEI, TUEC AND TVA. SINCE TMI-1 DID NOT USE THIS DESIGN FEATURE IN ITS THERMOLAG INSTALLATIONS AND SINCE COMPARISONS OF TMI-1 CONFIGURATIONS ARE MADE TO TEST CONFIGURATIONS WITHOUT STRESS SKIN INSTALLED OVER JOINTS, NO VERIFICATION OF THIS PARAMETER IS REQUIRED.

### O. STRESS SKIN TIES OR NO STRESS SKIN TIES

INSTALLATION OF STRESS SKIN TIES WAS NOT A DESIGN REQUIREMENT FOR TMI-1. THIS HAS BEEN VERIFIED BY REVIEW OF THE ORIGINAL DESIGN DOCUMENTS.

STRESS SKIN TIES WOULD CONTRIBUTE TO IMPROVING BARRIER PERFORMANCE AS DEMONSTRATED BY TESTING WITH THIS PARAMETER BY NEI, TUEC AND TVA. SINCE TMI-1 DID NOT USE THIS DESIGN FEATURE IN ITS THERMOLAG INSTALLATIONS AND SINCE COMPARISONS OF TMI-1 CONFIGURATIONS ARE MADE TO TEST CONFIGURATIONS WITHOUT STRESS SKIN TIES, NO VERIFICATION OF THIS PARAMETER IS REQUIRED.

## EVALUATION ASSUMPTIONS FOR TMI

### P. DRY-FIT, POST-BUTTERED JOINTS OR PRE-BUTTERED JOINTS

THIS PARAMETER IS RELEVANT AND NOT AVAILABLE BY VISUAL EXAM. PRE-BUTTERED JOINTS WAS AN INSTALLATION REQUIREMENT AT TMI-1. RELIANCE IS ON QUALITY VERIFICATION CHECKS.

VERIFICATION OF THIS PARAMETER IS DOCUMENTED BY DETAILED EXAMINATION.

### Q. GAP WIDTH

VERIFICATION OF THIS PARAMETER TO LESS THAN OR EQUAL TO 1/4 INCH BETWEEN PREFABRICATED THERMOLAG PANELS OR CONDUIT SECTIONS AT A JOINT IS DOCUMENTED BY DETAILED EXAMINATION. WHERE IT WAS VERIFIABLE, JOINT GAP DID NOT EXCEED 1/4 INCH.

THIS PARAMETER IS RELEVANT ALTHOUGH A MAXIMUM ALLOWABLE GAP BETWEEN JOINTS OF GREATER THAN 1/4 INCH SHOULD BE POSSIBLE. THE CONCERN IS THAT THE LACK OF STRESS SKIN AT A TROVELED JOINT FOR A RACEWAY INCREASES AS THE GAP GETS LARGER. IT IS NOT APPARENT WHAT ROLE THE GAP SIZE PLAYS IN MAINTAINING JOINT INTEGRITY DURING FIRE TESTING. THERE WERE NO SPECIFIC REQUIREMENTS TO COMPLY WITH THIS PARAMETER DURING ORIGINAL THERMOLAG INSTALLATION.

NOTE THAT THE DATA FIELD ON THE BARRIER SCREEN FOR EACH ELEMENT WILL NOT INDICATE A DIMENSION. THE FIELD WILL BE FILLED IN WITH "NA" SINCE VERIFICATION OF JOINT GAPS BY DETAILED EXAMINATION VERIFIED GAPS, WHERE EXAMINED DID NOT EXCEED 1/4 INCH.

### R. BUTT JOINTS OR GROOVED AND SCORED JOINTS.

THIS PARAMETER IS VERIFIED BY VISUAL EXAM AND IS ALSO DOCUMENTED BY DETAILED EXAMINATION.

GROOVED AND SCORED JOINTS APPLIES TO PREFABRICATED PANELS AND TO A METHOD FOR APPLYING PREFORMED CONDUIT SECTIONS ON RADIAL BENDS. AN ALTERNATIVE TO GROOVING AND SCORING JOINTS IS BUTT JOINTS. NOTE THAT GROOVING AND SCORING JOINTS DOES NOT APPLY TO STRAIGHT SECTIONS OF PREFORMED CONDUIT.

NOTE THAT BUTT JOINTS ONLY WERE USED TO FABRICATE BOXES AROUND LBD'S FOR SIZES UP TO 4 INCH AND TO JOIN STRAIGHT SECTIONS OF PREFORMED CONDUIT.

NEI TEST 2-7 TESTED 24 INCH AND 6 INCH TRAYS WITH BUTT JOINTS ON ALL 4 PANELS AND USING THE GROOVE AND SCORE METHOD SUCH THAT SIDE AND BOTTOM PANELS WERE SCORED TO THE INTERNAL STRESS SKIN TO FORM AN OPEN TOPPED TROUGH HINGED AT THE BOTTOM OF THE SIDE PANELS. THE TEST DATA INDICATES COMPARATIVE RESULTS ALTHOUGH ACCEPTABLE TEMPERATURES WERE EXCEEDED IN A SLIGHTLY SHORTER TIME FRAME FOR CONSTRUCTION WITH THE GROOVE AND SCORE METHOD. BARRIER OPENINGS WERE NOTED ON ALL ENVELOPES (EXCEPT FOR THE ALL BUTT JOINT 6 INCH TRAY) AFTER THE HOSE STREAM TEST. A CONCLUSION CAN BE DRAWN HERE THAT THE JOINT METHOD DOES NOT FACTOR INTO TEST FAILURE AND THAT A CONSERVATIVE APPROACH WOULD BE TO APPLY THE RESULTS OF THE GROOVE AND SCORE METHOD FOR ESTABLISHING FIRE ENDURANCE RATINGS.

NEI TEST 2-2 TESTED FREE STANDING BOX ENCLOSURES WITH THE BOTTOM AND SIDE PANELS SCORED TO THE INTERNAL STRESS SKIN AS WAS THE CASE WITH THE CABLE TRAY ENVELOPES DISCUSSED ABOVE. THE REMAINING



## EVALUATION ASSUMPTIONS FOR TMI

JOINTS WERE BUTT JOINTS. THE TEST DATA INDICATES NO FAILURE OF EITHER JOINT EXCEPT THAT THE HOSE STREAM TEST APPARENTLY CAUSED AN OPENING IN ONE OF THE GROOVED AND SCORED JOINTS.

A REVIEW OF BOTH NEI TESTS 2-2 AND 2-7 INDICATES THAT THERE DOES NOT APPEAR TO BE AN APPRECIABLE DIFFERENCE IN PERFORMANCE OF BUTT JOINTS AND GROOVED AND SCORED JOINTS WITH RESPECT TO ESTABLISHING FIRE ENDURANCE RATINGS. FAILURES OF TESTS DO NOT APPEAR TO OCCUR BECAUSE OF ONE JOINT VS. THE OTHER ALTHOUGH USE OF TEMPERATURE DATA ASSUMING A GROOVED AND SCORED JOINT IS SLIGHTLY MORE CONSERVATIVE THAN DATA FROM AN ALL BUTT JOINT SYSTEM.

THEREFORE, USING TEST DATA FOR GROOVED AND SCORED JOINTS SHOULD PRECLUDE CONCERN OVER THE TYPE OF JOINT WHEN ESTABLISHING A FIRE ENDURANCE RATING.

THIS PARAMETER IS THEREFORE NOT CONSIDERED CRITICAL FOR FIELD VERIFICATION AS LONG AS TEST DATA FOR GROOVED AND SCORED JOINTS IS USED TO ESTABLISH A FIRE ENDURANCE RATING.

### S. STEEL BANDS VS. TIE WIRES

EITHER BANDS OR WIRES ARE ACCEPTABLE AND ARE CONSIDERED A RELEVANT PARAMETER. VERIFICATION IS BY VISUAL EXAM.

STAINLESS STEEL BAND FASTENERS BOUND STAINLESS STEEL TIE WIRES. TIE WIRES ALLOW FOR BETTER MATERIAL ACTIVATION. ALSO, PARTICULARLY DURING CONDUIT TESTS, BANDS HAVE BEEN OBSERVED TO RESULT IN LOCALIZED HEATING EFFECTS AS THEY TEND TO CONDUCT MORE HEAT THROUGH THE PROTECTIVE ENVELOPE THAN WIRES. (NEI APPLICATION GUIDE).

DUE TO BETTER MATERIAL ACTIVATION, THE EXPANDING CHAR LAYER TENDS TO PROTECT TIE WIRES MORE EFFECTIVELY THAN BANDS. LESS PRO-  
NOUNCED SAG EFFECTS AND BETTER OVERALL STRUCTURAL PERFORMANCE HAVE BEEN OBSERVED FOR TIE WIRE FASTENERS. (NEI APPLICATION GUIDE).

### T. BAND/WIRE SPACING

THIS PARAMETER IS RELEVANT AND CAN BE VERIFIED BY VISUAL EXAM.

### U. BAND/WIRE DISTANCE TO JOINTS

THIS PARAMETER IS RELEVANT, EXCEPT AS NOTED BELOW, AND CAN BE VERIFIED BY VISUAL EXAMINATION

NEI TESTS 2-1, 2-3, 2-7 and 2-10 HAVE DEMONSTRATED THAT CERTAIN BARRIER CONFIGURATIONS DO NOT TYPICALLY EXHIBIT STRUCTURAL FAILURES. THESE INCLUDE THERMO-LAG PRESHAPED SECTIONS INSTALLED ON CONDUITS OF ALL SIZES, "BOX" TYPE ENCLOSURES CONSTRUCTED AROUND CONDULET FITTINGS WITH PANELS, AND BARRIERS INSTALLED ON SMALL CABLE TRAYS. FOR THESE TYPES OF CONFIGURATIONS, THE PROTECTED RACEWAYS THEMSELVES GENERALLY PROVIDE A LARGE DEGREE OF STRUCTURAL SUPPORT TO THE BARRIER. FOR THE BARRIERS EVALUATED BY THE NEI TESTS LISTED ABOVE, BAND SPACING OF 12" (ON CENTERS) WAS UTILIZED AND BANDS WERE INSTALLED WITHIN 2"-3" OF BUTT JOINTS FORMED BETWEEN ADJACENT PANELS OR CONDUIT SECTIONS. NOTE THAT THE USE OF SMALL MITERED PRESHAPED SECTIONS TO ACCOMMODATE THE CURVATURE OF CONDUIT RADIAL BENDS NECESSITATES A MINIMUM OF ONE FASTENER FOR

## EVALUATION ASSUMPTIONS FOR TMI

EACH MITERED PIECE.

IN EVALUATING RADIAL BENDS, USE OF THE REQUIREMENT TO BE WITHIN 2" OF A BUTT JOINT WILL BE USED IN EVALUATING ACCEPTABILITY. THIS REQUIREMENT IS CONSERVATIVE BECAUSE AS THE ENVELOPE SIZE INCREASES, THE BAND PER MITERED SECTION ON SIZES BETWEEN 3/4 INCH AND 3 INCH ENVELOPES WILL EXCEED THE TESTED CONFIGURATION REQUIREMENT OF 1 BAND PER SECTION FOR A 3/4 INCH ENVELOPE. EVALUATION OF RADIAL BENDS ALSO CONSIDERS THE DISTANCE OF BANDS FROM THE MITERED SECTIONS ON THE ENDS OF THE RADIAL BENDS TO THE BANDS ON THE ADJACENT ELEMENT. THE MAXIMUM ALLOWABLE DISTANCE IN THIS CASE IS 12 INCHES.

NEI TESTS 3-1 AND 3-2 EVALUATED BASELINE CONFIGURATIONS OF 1-HOUR AND 3 HOUR PRESHAPED THERMO-LAG SECTIONS INSTALLED ON CONDUIT ASSEMBLIES WHICH UTILIZED STAINLESS STEEL BAND FASTENERS LOCATED 6" FROM BUTT JOINT LOCATIONS AND SPACED UP TO 14 INCHES ON CENTER. THE PERFORMANCE OF THESE BASELINE BARRIER SYSTEMS DEMONSTRATED THAT SUCH VARIATIONS IN FASTENER LOCATION (FROM PREVIOUS BASELINE TESTING WHERE FASTENERS WERE LOCATED 2" FROM BUTT JOINT LOCATIONS AND 12" ON CENTER) HAVE NO SIGNIFICANT EFFECT ON THE PERFORMANCE OF PRESHAPED STRAIGHT SECTIONS INSTALLED ON CONDUIT SYSTEMS.

BECAUSE VARIATIONS IN BAND SPACING WITH RESPECT TO BUTT JOINT LOCATION DO NOT HAVE AN EFFECT ON STRUCTURAL PERFORMANCE FOR STRAIGHT CONDUIT, THE CRITERIA FOR SPACING ON THESE CONFIGURATIONS WILL REMAIN AT 12 INCHES ON CENTER. THE REQUIREMENT FOR BANDS TO BE LOCATED WITHIN 2 INCHES OF A BUTT JOINT IS NOT APPLICABLE. THE CRITERIA FOR RADIAL BENDS IS AS DISCUSSED ABOVE.

EACH ELEMENT EVALUATION WILL IDENTIFY ADDITIONAL INSPECTION REQUIREMENTS AND/OR ADDITIONAL BANDING REQUIREMENTS IF NEEDED. IF ADDITIONAL BANDS ARE REQUIRED, THEY MUST BE INSTALLED IN ORDER FOR THE FIRE RATING ON THAT BARRIER, AS ESTABLISHED IN THE EVALUATION, TO BE VALID.

### V. NO INTERNAL BANDS ON TRAYS

THIS PARAMETER IS RELEVANT AND CANNOT BE VERIFIED BY VISUAL EXAM. RELIANCE IS ON QUALITY VERIFICATION CHECKS.

VERIFICATION OF THIS PARAMETER IS ALSO DOCUMENTED BY DETAILED EXAMINATION.

### W. NO ADDITIONAL TROWEL MATERIAL OVER SECTIONS AND JOINTS OR ADDITIONAL TROWEL MATERIAL APPLIED

SOME JOINTS AT TMI-1 WERE POST BUTTERED IN ADDITION TO PRE-BUTTERING; HOWEVER NO SPECIFIC THICKNESS WAS SPECIFIED. THEREFORE, INSTALLATION OF ADD'L TROWEL OVER SECTIONS AND JOINTS WAS NOT A DESIGN REQUIREMENT FOR TMI-1. ADD'L TROWEL INSTALLED OVER SECTIONS AND JOINTS CONTRIBUTE TO IMPROVING BARRIER PERFORMANCE AS DEMONSTRATED BY NEI UPGRADE TESTING. SINCE TMI-1 DID NOT USE THIS DESIGN FEATURE AND SINCE COMPARISONS ARE MADE TO TEST CONFIGURATIONS WITHOUT THIS FEATURE, NO VERIFICATION OF THIS PARAMETER IS REQUIRED.

### X. NO EDGE GUARDS OR EDGE GUARDS.

THIS PARAMETER IS NOT RELEVANT. THE USE OF EDGE GUARDS AS A CONSTRUCTION AID AS DESCRIBED BELOW IS NOT CONSIDERED A

## EVALUATION ASSUMPTIONS FOR TMI

PERFORMANCE PARAMETER ALTHOUGH IT CAN BE VERIFIED BY VISUAL EXAM.

FASTENER EDGE GUARDS ARE TYPICALLY USED AS A CONSTRUCTION AID ON CABLE TRAY AND BOX ENCLOSURES TO ENABLE FASTENERS TO BE SECURELY TIGHTENED WITHOUT GOUGING INTO THERMOLAG PANELS. IN THIS APPLICATION, A SMALL PIECE OF SHEET METAL IS TYPICALLY INSERTED ALONG THE EDGES OF A BARRIER ENCLOSURE, UNDER EACH FASTENER. EDGE GUARDS HAVE BEEN UTILIZED IN THE CONSTRUCTION OF A TEST BARRIER FOR TU ELECTRIC TEST SCHEME 3. THE BARRIER WAS A ONE HOUR ASSMBLY. THE FIRE ENDURANCE TEST RESULTED IN SATISFACTORY SIDE RAIL TEMPERATURES. THEREFORE, FOR SIDE RAIL TEMPERATURE CRITERIA TO BE SATISFIED, THE EDGE GUARDS COULD NOT HAVE ADVERSELY AFFECTED THE THERMAL PERFORMANCE OF THE BARRIER. SUBSEQUENT TU ELECTRIC CABLE TRAY TESTS (SCHEMES 13-1 AND 11-5) ALSO INCLUDED EDGE GUARDS ON UPGRADED 1-HOUR BARRIERS WITHOUT ADVERSE THERMAL OR STRUCTURAL EFFECTS.

NEI CABLE TRAY TESTING (TESTS 2-7 AND 2-10) WHICH DID NOT UTILIZE EDGE GUARDS, DEMONSTRATED THAT STRUCTURAL FAILURES OF CABLE TRAY ENVELOPES DO NOT TYPICALLY OCCUR IN AREAS WHERE EDGE GUARDS WOULD NORMALLY BE INSTALLED. RATHER, STRUCTURAL FAILURES OCCUR AT JOINT LOCATIONS ON THE UNDERSIDES OF TRAY BARRIERS AWAY FROM EDGE GUARD LOCATIONS.

AS STATED ABOVE, THE USE OF EDGE GUARDS AS A CONSTRUCTION AID AS DESCRIBED ABOVE IS NOT CONSIDERED A SIGNIFICANT BARRIER PERFORMANCE PARAMETER.

## EVALUATION FOR ELEMENT NO. 544

INSTALLEDINDUSTRY

Source...NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Conduit			3/4in conduit
Size.....0.75			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			N/A
Rib Location.....N/A			0 %
Fill.....92 %			NA ft.
Support Span.....NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.....Butt			No
Post buttered...No			Yes
Pre buttered...Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....Steel			12.0
Spacing (max)...10.0	0.0		N/A
dist to jt (max) 2.0			No
Add Trwl matl...No			No
Edgeguard.....No			69 min. Barr rating
Barr/CQ rating.... 69/ 0 min.			

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx

Ass2\_3h.pcx

Ass2\_3i.pcx

Ass2\_3j.pcx

for construction details.

Evaluation:

As shown through a parameter comparison NEI Test 2-3 (tested a 3/4" conduit) has been chosen as the bounding test for this element.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 92%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but 07/15/96



had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is acceptable as this dimension is not considered critical. The plant barrier does not require additional work.

This three hour barrier can be down graded to a one hour barrier with no additional work.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 3/4 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

satisfactory for the 60 minute test. Barrier condition was satisfactory after the hose stream test.

**Evaluation:**

As shown through a parameter comparison, the installed configuration is bounded by a test configuration.

For NEI Test Ass. 3-2, a 6" x 6" x 4" junction box was protected with 1 inch thick panel sections. The enclosure was abutted to the concrete and sealed with Thermo-Lag trowel grade material using post buttered techniques. During NEI Test 3-2, temperatures on the junction box surface for the 60 minutes was not recorded due to failure of the thermal couples. For this test, the Thermo-Lag to concrete interface joint did not fail the hose stream test. The thermocouple readings for the 6" x 6" x 4" junction box protected with 1/2" thick panel sections maximum temperature criterion (maximum temperature 402 deg F.) was reached in 54 minutes. It is reasonable to conclude that the junction box protected with 1 inch thick panel section will last for 60 minutes. In other words, this type of joint can be expected to maintain its thermal performance without failing the maximum temperature criterion for 60 minutes. It is therefore reasonable to use the results of NEI Test 3-2 to establish a fire endurance rating for this element as the construction techniques of this element are similar to those for NEI Test 3-2 except that this element has an additional panel section anchored to the concrete which is both pre and post buttered at the Thermo-Lag to concrete interface and Thermo-Lag to Thermo-Lag interface. NEI Test 3-2 demonstrates that a Thermo-Lag to concrete interface with trowel grade material will not cause the barrier to fail.

The thermal mass of the tested configuration was 1.80 lb/lin. ft. The plant barrier has a total thermal mass of 6.039 lb./lin. ft. (5.67 lb./lin. ft. conduit, 0.369 lb./lin. ft. cable(7/C-12 EK-9F)). The tested configuration used panels that were 1 inch thick. The plant configuration used 1 inch panel sections to protect the conduit and conduit.

Barrier condition was considered satisfactory after the hose stream test. There were no barrier openings present in the body of the protective envelope. No barrier openings to the conduits were present at the interface with the concrete slab either.

Band spacing is not considered relevant to this evaluation. The thermo-lag to concrete interface is the parameter being addressed here. This element is the thermo-lag to concrete interface for element no. 30.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 2 1/2 in. conduit envelope has a fire endurance rating of at least 60 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 543

INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Radial bend conduit			3/4in rad. bend
Size.....0.75			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			N/A
Rib Location.....N/A			0 %
Fill.....92 %			NA ft.
Support Span.....NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.....Butt			No
Post buttered...No			Yes
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			1band/sect
Banding.....Steel			0.0
Spacing (max)...11.0	0.0		
dist to jt (max) 3.5			
Add Trwl matl...No			No
Edgeguard.....No			No
Barr/CQ rating.... 69/ 0 min.			69 min. Barr rating

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx

Ass2\_3h.pcx

Ass2\_3i.pcx

Ass2\_3j.pcx

for construction details.

To allow for curvature, the sections installed on the radial bends were miter-cut into individual wedge shaped pieces and fit to the conduit radial bend.

Evaluation:

NEI Test 2-3, 3/4" conduit, tested a 90 degree radial bend in the horizontal to vertical orientation. The element is a 45 degree radial bend. Construction of this radial bend is similar to that used for a straight run conduit, ie: preshaped conduit sections, pre-buttered butt joints, and installation of banding material. The 3/4" conduit radial bend bounds the existing 3/4" plant conduit radial bend.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 92%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

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Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying steel skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is greater than that in the tested configuration. The plant barrier is required to have additional bands installed to maintain the required banding for a radial bend.

This three hour barrier can be down graded to a one hour barrier with minor rework on band placement.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 3/4 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 542

INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....condulet			3/4in condulet
Size.....0.75			1.000
Thickness.....1.000			No
Preform Conduit...No			Horizontal
Rib Location.....N/A			0 %
Fill.....92 %			NA ft.
Support Span..... NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...Yes			No
Joint type.....Butt			Butt
Post buttered...No			No
Pre buttered....Yes			Yes
Gap width.....NA			.25
Add trwl matl...Yes			No
Banding.....Steel			Steel
Spacing (max)... 2.0	0.0		12.0
dist to jt (max) 3.0			2.0
Add Trwl matl...Yes			No
Edgeguard.....No			No
Barr/CQ rating.... 69/ 0 min.			69 min. Barr rating

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3e.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

Evaluation:

As shown through a parameter comparison NEI Test 2-3 (tested a 3/4 in. conduit) has been chosen as the bounding test for this element.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 92%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but  
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had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is greater than that in the tested configuration. The plant barrier is required to have additional bands installed to maintain the 2" maximum spacing to a joint.

This three hour barrier can be down graded to a one hour barrier with minor rework on band placement.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 3/4 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 354

INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Conduit			3/4in conduit
Size.....1"			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			N/A
Rib Location.....N/A			0 %
Fill.....72 %			NA ft.
Support Span..... NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....No			No
Add trwl matl...No			Butt
Joint type.....Butt			No
Post buttered...No			Yes
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....Steel			12.0
Spacing (max)...11.5	0.0		N/A
dist to jt (max) 3.5			No
Add Trwl matl...Yes			No
Edgeguard.....No			69 min. Barr rating
Barr/CQ rating.... 69/ 0 min.			

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx

Ass2\_3h.pcx

Ass2\_3i.pcx

Ass2\_3j.pcx

for construction details.

Evaluation:

As shown through a parameter comparison NEI Test 2-3 (tested a 3/4" conduit) has been chosen as the bounding test for this element. Plant conduit is 1". The 3/4" conduit bounds the existing 1" plant conduit.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 72%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier

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installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 1 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 1 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is acceptable as this dimension is not considered critical. The plant barrier does not require additional work.

This three hour barrier can be down graded to a one hour barrier.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.



INSTALLEDINDUSTRY

Source...NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Radial bend conduit			
Size.....1"			3/4in rad. bend
Thickness.....1.000			1.000
Preform Conduit...Yes			Yes
Rib Location.....N/A			N/A
Fill.....72 %			0 %
Support Span..... NA ft.			NA ft.
Stress Skin.....Inside and outside			Inside and outside
Over joints.....Yes			No
Ties.....No			No
Staples.....No			No
Add trwl matl...No			No
Joint type.....Butt			Butt
Post buttered...No			No
Pre buttered....Yes			Yes
Gap width.....NA			.25
Add trwl matl...Yes			No
Banding.....Steel			1band/sect
Spacing (max)... 5.5	0.0		0.0
dist to jt (max) 2.0			
Add Trwl matl...Yes			No
Edgeguard..... 0			No
Barr/CQ rating.... 69/ 0 min.			69 min. Barr rating

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

To allow for curvature, the sections installed on the radial bends were miter-cut into individual wedge shaped pieces and fit to the conduit radial bend.

Evaluation:

NEI Test 2-3, 3/4" conduit, tested a 90 degree radial bend in the horizontal to vertical orientation. The element is a 45 degree radial bend. Construction of this radial bend is similar to that used for a straight run conduit, ie: preshaped conduit sections, pre-buttered butt joints, and installation of banding material. The 3/4" conduit radial bend bounds the existing 1" plant conduit radial bend.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 72%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

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Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 1 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 1 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is similar to the tested configuration. The plant barrier does not require additional work.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 352

INSTALLEDINDUSTRY

Source...NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....condulet		3/4in condulet
Size.....11.5"x5.5"x12"		1.000
Thickness.....1.000		No
Preform Conduit...No		Horizontal
Rib Location.....N/A		0 %
Fill.....72 %		NA ft.
Support Span..... NA ft.		Inside and outside
Stress Skin.....Inside and outside		No
Over joints.....Yes		No
Ties.....No		No
Staples.....No		No
Add trwl matl...No		No
Joint type.....Butt		Butt
Post buttered...No		No
Pre buttered....Yes		Yes
Gap width.....NA		.25
Add trwl matl...Yes		No
Banding.....Steel		Steel
Spacing (max)... 8.5	0.0	12.0
dist to jt (max) 2.5		2.0
Add Trwl matl...Yes		No
Edgeguard.....No		No
Barr/CQ rating.... 69/ 0 min.		69 min. Barr rating

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3e.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

Evaluation:

As shown through a parameter comparison NEI Test 2-3 (tested a 3/4" condulet) has been chosen as the bounding test for this element. Plant condulet is 1". The 3/4" condulet bounds the existing 1" plant condulet.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 72%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant

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fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 1 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 1 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. Install additional bands to insure that the 2 inch maximum distance to joints is maintained.

This three hour barrier can be down graded to a one hour barrier with minor rework on band placement.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.



INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Conduit			3/4in conduit
Size.....1.25"			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			N/A
Rib Location.....N/A			0 %
Fill.....79 %			NA ft.
Support Span..... NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.... Butt			No
Post buttered...No			Yes
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....Steel			12.0
Spacing (max)... 1.5	0.0		N/A
dist to jt (max) 1.5			No
Add Trwl matl...No			No
Edgeguard.....No			69 min. Barr rating
Barr/CQ rating.... 69/ 0 min.			

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx

Ass2\_3h.pcx

Ass2\_3i.pcx

Ass2\_3j.pcx

for construction details.

Evaluation:

As shown through a parameter comparison NEI Test 2-3 (tested a 3/4" conduit) has been chosen as the bounding test for this element. Plant conduit is 1.25". The 3/4" conduit bounds the existing 1.25" plant conduit.

This conduit is actually a penetration configuration which is similar to the tested 3/4" configuration in NEI Test Ass. 2-3 for a 3/4 in. conduit. The NEI assembly extended the barrier through the penetration and sealed around the fire barrier. Due to the similarities in construction, the aforementioned test has been chosen as the bounding test for this element.

While not instrumented as part of the test inside the penetration, conduit surface temperature inside the sealed penetration will be no higher since the construction of the barrier inside the penetration is the same as inside the test oven. Therefore the test results of Ass. 2-3 for 3/4 in. conduit can be applied to this element.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while

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the installed steel conduit has a percent fill of 79%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 1.25 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 1.25 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is acceptable as this dimension is not considered critical. The plant barrier does not require additional work.

This three hour barrier can be down graded to a one hour barrier with no additional work.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1.25 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Radial bend conduit			3/4in rad. bend
Size.....1.25"			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			N/A
Rib Location.....N/A			0 %
Fill.....79 %			NA ft.
Support Span..... NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.....Butt			No
Post buttered...No			Yes
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			1band/sect
Banding.....Steel			0.0
Spacing (max)... 6.0	0.0		
dist to jt (max) 2.0			
Add Trwl matl...No			No
Edgeguard.....No			No
Barr/CQ rating.... 69/ 0 min.			69 min. Barr rating

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

To allow for curvature, the sections installed on the radial bends were miter-cut into individual wedge shaped pieces and fit to the conduit radial bend.

Evaluation:

NEI Test 2-3, 3/4" conduit, tested a 90 degree radial bend in the horizontal to vertical orientation. The element is a 45 degree radial bend. Construction of this radial bend is similar to that used for a straight run conduit, ie: preshaped conduit sections, pre-buttered butt joints, and installation of banding material. The 3/4" conduit radial bend bounds the existing 1.25" plant conduit radial bend.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F above initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 79%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

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Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 1.25 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 1.25 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is similar to the tested configuration. The plant barrier does not require additional work.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1.25 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 300

INSTALLEDINDUSTRY

Source...NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....condulet		3/4in condulet
Size.....9.5" x 5" x 6"		1.000
Thickness.....1.000		No
Preform Conduit...No		Horizontal
Rib Location.....N/A		0 %
Fill.....79 %		NA ft.
Support Span..... NA ft.		Inside and outside
Stress Skin.....Inside and outside		No
Over joints.....Yes		No
Ties.....No		No
Staples.....Yes		No
Add trwl matl...No		No
Joint type.....Butt		Butt
Post buttered...No		No
Pre buttered...Yes		Yes
Gap width.....NA		.25
Add trwl matl...Yes		No
Banding.....Steel		Steel
Spacing (max)... 7.8	0.0	12.0
dist to jt (max) 1.3		2.0
Add Trwl matl...No		No
Edgeguard.....No		No
Barr/CQ rating.... 69/ 0 min.		69 min. Barr rating

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3e.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

Evaluation:

As shown through a parameter comparison NEI Test 2-3 (tested a 3/4 in. condulet) has been chosen as the bounding test for this element. The 3/4" condulet bounds the existing 1.25" plant condulet.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 79%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier

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installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 1.25 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 1.25 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is similar to that in the tested configuration. The plant barrier does not require additional work.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 3/4 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 350 deg F above initial ambient temperature.



INSTALLEDINDUSTRY

Source...NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Conduit			3/4in conduit
Size.....1.5"			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			N/A
Rib Location... ..N/A			0 %
Fill.....75 %			NA ft.
Support Span..... NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.....Butt			No
Post buttered...No			Yes
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....Steel			12.0
Spacing (max)...10.0	0.7		N/A
dist to jt (max) 4.5			No
Add Trwl matl...No			No
Edgeguard.....No			69 min. Barr rating
Barr/CQ rating.... 69/ 0 min.			

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

Evaluation:

As shown through a parameter comparison NEI Test 2-3 (tested a 3/4" conduit) has been chosen as the bounding test for this element. Plant conduit is 1.5". The 3/4" conduit bounds the existing 1.5" plant conduit.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 75%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant

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fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 1.5 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 1.5 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is acceptable as this dimension is not considered critical. The plant barrier does not require additional work.

This three hour barrier can be down graded to a one hour barrier.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1.5 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

INSTALLEDINDUSTRY

Source... NEI-Baseline-3hr  
Report No. 13890-96143 Ass. 2-3

Barr Component....Radial bend conduit			3/4in rad. bend
Size.....1.5"			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			N/A
Rib Location.....N/A			0 %
Fill.....75 %			NA ft.
Support Span.....NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			No
Joint type.....Butt			Butt
Post buttered...No			No
Pre buttered...Yes			Yes
Gap width.....NA			.25
Add trwl matl...Yes			No
Banding.....Steel			1band/sect
Spacing (max)... 4.5	0.0		0.0
dist to jt (max) 1.0			
Add Trwl matl...No			No
Edgeguard.....No			No
Barr/CQ rating.... 69/ 0 min.			69 min. Barr rating

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

To allow for curvature, the sections installed on the radial bends were miter-cut into individual wedge shaped pieces and fit to the conduit radial bend.

Evaluation:

NEI Test 2-3, 3/4" conduit, tested a 90 degree radial bend in the horizontal to vertical orientation. The element is a 45 degree radial bend. Construction of this radial bend is similar to that used for a straight run conduit, ie: preshaped conduit sections, pre-buttered butt joints, and installation of banding material. The 3/4" conduit radial bend bounds the existing 1.5" plant conduit radial bend.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 75%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

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Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 1.5 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 1.5 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is similar to the tested configuration. The plant barrier does not require additional work.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1.5 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.



## EVALUATION FOR ELEMENT NO. 314

INSTALLEDINDUSTRY

Source...NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....condulet			3/4in condulet
Size.....14" x 6" x 6.5"			1.000
Thickness.....1.000			No
Preform Conduit...No			Horizontal
Rib Location.....N/A			0 %
Fill.....75 %			NA ft.
Support Span..... NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			No
Joint type.....Butt			Butt
Post buttered...No			No
Pre buttered....Yes			Yes
Gap width.....NA			.25
Add trwl matl...Yes			No
Banding.....Steel			Steel
Spacing (max)... 3.0	0.0		12.0
dist to jt (max) 2.0			2.0
Add Trwl matl...No			No
Edgeguard.....No			No
Barr/CQ rating.... 69/ 0 min.			69 min. Barr rating

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3e.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

Evaluation:

As shown through a parameter comparison NEI Test 2-3 (tested a 3/4 in. conduit) has been chosen as the bounding test for this element. The 3/4" condulet bounds the existing 1.5" plant condulet.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 75%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier

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installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 1.5 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 1.5 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is similar to that in the tested configuration. The plant barrier does not require additional work.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1.5 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 334

INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Conduit			3/4in conduit
Size.....2"			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			N/A
Rib Location.....N/A			0 %
Fill.....73 %			NA ft.
Support Span.....NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.....Butt			No
Post buttered...No			Yes
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....Steel			12.0
Spacing (max)...10.5	0.0		N/A
dist to jt (max) 2.0			No
Add Trwl matl...No			No
Edgeguard.....No			69 min. Barr rating
Barr/CQ rating.... 69/ 0 min.			

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

Evaluation:

As shown through a parameter comparison NEI Test 2-3 (tested a 3/4" conduit) has been chosen as the bounding test for this element. Plant conduit is 2". The 3/4" conduit bounds the existing 2" plant conduit.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 73%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier

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installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 2 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 2 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is acceptable as this dimension is not considered critical. The plant barrier does not require additional work.

This three hour barrier can be down graded to a one hour barrier.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 2 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 333

INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Radial bend conduit			
Size.....2"			3/4in rad. bend
Thickness.....1.000			1.000
Preform Conduit...Yes			Yes
Rib Location.....N/A			N/A
Fill.....73 %			0 %
Support Span.....NA ft.			NA ft.
Stress Skin.....Inside and outside			Inside and outside
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			No
Joint type.....Butt			Butt
Post buttered...No			No
Pre buttered...Yes			Yes
Gap width.....NA			.25
Add trwl matl...Yes			No
Banding.....Steel			1band/sect
Spacing (max)... 1.5	0.0		0.0
dist to jt (max) 1.5			
Add Trwl matl...No			No
Edgeguard.....No			No
Barr/CQ rating.... 69/ 0 min.			69 min. Barr rating

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

To allow for curvature, the sections installed on the radial bends were miter-cut into individual wedge shaped pieces and fit to the conduit radial bend.

Evaluation:

NEI Test 2-3, 3/4" conduit, tested a 90 degree radial bend in the horizontal to vertical orientation. The element is a 45 degree radial bend. Construction of this radial bend is similar to that used for a straight run conduit, ie: preshaped conduit sections, pre-buttered butt joints, and installation of banding material. The 3/4" conduit radial bend bounds the existing 2" plant conduit radial bend.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while installed steel conduit has a percent fill of 73%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

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Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 2 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 2 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is similar to the tested configuration. The plant barrier does not require additional work.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 2 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.



INSTALLEDINDUSTRY

Source...NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....condulet			3/4in condulet
Size.....2"			1.000
Thickness.....1.000			No
Preform Conduit...No			Horizontal
Rib Location.....N/A			0 %
Fill.....73 %			NA ft.
Support Span..... NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.....Butt			No
Post buttered...No			Yes
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....Steel			12.0
Spacing (max)... 7.0	0.0		2.0
dist to jt (max) 2.5			No
Add Trwl matl...No			No
Edgeguard.....No			69 min. Barr rating
Barr/CQ rating.... 69/ 0 min.			

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3e.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

Evaluation:

NEI Test 2-3, 3/4" conduit, tested a condulet in the horizontal to vertical orientation. The element is a condulet. The 3/4" condulet bounds the existing 2" plant condulet.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F above initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 73%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier

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installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 2 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 2 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configurations. The plant band spacing from a joint is greater than that in the tested configuration. The plant barrier is required to have additional bands installed to maintain the 2" maximum spacing to a joint.

This three hour barrier can be down graded to a one hour barrier with minor rework on band placement.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 2 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Conduit			3/4in conduit
Size.....2.5"			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			N/A
Rib Location.....N/A			0 %
Fill.....89 %			NA ft.
Support Span..... NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...Yes			Butt
Joint type.....Butt			No
Post buttered...No			Yes
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....Steel			12.0
Spacing (max)... 8.0	0.0		N/A
dist to jt (max) 2.0			No
Add Trwl matl...No			No
Edgeguard.....No			69 min. Barr rating
Barr/CQ rating.... 69/ 0 min.			

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

Evaluation:

As shown through a parameter comparison NEI Test 2-3 (tested a 3/4 in. conduit) has been chosen as the bounding test for this element.

For NEI Test Ass. 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 89%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 2.5 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 2.5 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

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Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is acceptable as this dimension is not considered critical. The plant barrier does not require additional work.

This three hour barrier can be down graded to a one hour barrier.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 2.5 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.



## EVALUATION FOR ELEMENT NO. 285

INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Radial bend conduit			
Size.....2.5"			3/4in rad. bend
Thickness.....1.000			1.000
Preform Conduit...Yes			Yes
Rib Location.....N/A			N/A
Fill.....89 %			0 %
Support Span..... NA ft.			NA ft.
Stress Skin.....Inside and outside			Inside and outside
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...Yes			No
Joint type.....Butt			Butt
Post buttered...No			No
Pre buttered....Yes			Yes
Gap width.....NA			.25
Add trwl matl...Yes			No
Banding.....Steel			1band/sect
Spacing (max)... 4.5	0.0		0.0
dist to jt (max) 1.5			
Add Trwl matl...No			No
Edgeguard.....No			No
Barr/CQ rating.... 69/ 0 min.			69 min. Barr rating

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

To allow for curvature, the sections installed on the radial bends were miter-cut into individual wedge shaped pieces and fit to the conduit radial bend.

Evaluation:

NEI Test 2-3, 3/4" conduit, tested a 90 degree radial bend in the horizontal to vertical orientation. The element is a double 45 degree radial bend. Construction of this radial bend is similar to that used for a straight run conduit, ie: preshaped conduit sections, pre-buttered butt joints, and installation of banding material. The 3/4" conduit radial bend bounds the existing 2.5" plant conduit radial bend.

For NEI Test 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg. F above initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 89%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable

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internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 2.5 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 2.5 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configurations. The plant band spacing from a joint is similar to the tested configuration and does not require additional work.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 2.5 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....condulet			3/4in condulet
Size.....14.5"x7.5"x7"			1.000
Thickness.....1.000			No
Preform Conduit...No			Horizontal
Rib Location.....N/A			0 %
Fill.....89 %			NA ft.
Support Span..... NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...Yes			Butt
Joint type.....Butt			No
Post buttered...No			Yes
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....Steel			12.0
Spacing (max)... 7.8	0.0		2.0
dist to jt (max) 3.5			No
Add Trwl matl...No			No
Edgeguard.....No			69 min. Barr rating
Barr/CQ rating.... 69/ 0 min.			

Element Comments:

Industry Comments:

Ref. Ass2\_3a.pcx  
Ass2\_3e.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

Evaluation:

As shown through a parameter comparison, the installed configuration is bounded by a test configuration.

For NEI Test Ass. 2-3, the 3/4 in. aluminum conduit maximum temperature criterion (325 deg F over initial ambient) conduit surface temperature was exceeded at 69 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 89%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Note that the comparable test configuration to the installed configuration is 3/4 in. vs. 2.5 in. respectively. Using the results of the smaller test configuration as a comparison is necessary since no baseline 2.5 in. conduit 3 hr. fire barrier envelope was tested. Use of the smaller configuration as a comparison is conservative since the results of testing of multiple size raceways in Ass. 2-3 show the smaller the raceway, the faster acceptable internal temperatures are reached.

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Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3/4 in conduit had pronounced areas of burnthrough but had been subjected to an additional 33 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3/4 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3/4 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configurations. The plant band spacing from a joint is required to have additional bands installed to maintain the 2" maximum spacing to a joint..

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 2.5 in. conduit envelope has a fire endurance rating of at least 69 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 381

INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Conduit			3in conduit
Size.....3"			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			N/A
Rib Location.....N/A			0 %
Fill.....37 %			NA ft.
Support Span.....NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.....Butt			No
Post buttered...No			Yes
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....Steel			12.0
Spacing (max)...11.0	0.0		N/A
dist to jt (max) 8.5			No
Add Trwl matl...No			No
Edgeguard.....No			91 min. Barr rating
Barr/CQ rating.... 91/ 0 min.			

Element Comments:

Industry Comments:

Ref. Ass2\_3c.pcx

Ass2\_3h.pcx

Ass2\_3i.pcx

Ass2\_3j.pcx

for construction details.

Evaluation:

As shown through a parameter comparison NEI Test 2-3 (tested a 3" conduit) has been chosen as the bounding test for this element. Plant conduit is 3".

For NEI Test 2-3, the 3 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 91 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 37%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3 in conduit had localized area of burnthrough but had

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been subjected to an additional 11 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is acceptable as this dimension is not considered critical. The plant barrier does not require additional work.

This three hour barrier can be down graded to a one hour barrier.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 3 in. conduit envelope has a fire endurance rating of at least 91 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.



INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-96143 Ass. 2-3

Barr Component....Radial bend conduit			3in rad. bend
Size.....3"			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			N/A
Rib Location.....N/A			0 %
Fill.....37 %			NA ft.
Support Span.....NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.....Butt			No
Post buttered...No			Yes
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			2band/sect
Banding.....Steel			0.0
Spacing (max)... 6.0	0.0		
dist to jt (max) 3.0			
Add Trwl matl...No			No
Edgeguard.....No			No
Barr/CQ rating.... 91/ 0 min.			91 min. Barr rating

Element Comments:

Industry Comments:

Ref. Ass2\_3c.pcx  
Ass2\_3h.pcx  
Ass2\_3i.pcx  
Ass2\_3j.pcx

for construction details.

To allow for curvature, the sections installed on the radial bends were miter-cut into individual wedge shaped pieces and fit to the conduit radial bend.

Evaluation:

NEI Test 2-3, 3" conduit, tested a 90 degree radial bend in the horizontal to vertical orientation. The element is a double 45 degree radial bend. Construction of this radial bend is similar to that used for a straight run conduit, ie: preshaped conduit sections, pre-buttered butt joints, and installation of banding material.

For NEI Test 2-3, the 3 in. aluminum conduit maximum temperature criterion (325 deg. F over initial ambient) conduit surface temperature was exceeded at 91 minutes. The conduit surface temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum conduit had a percent fill of 0%, while the installed steel conduit has a percent fill of 37%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would a similar assembly constructed of aluminum. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

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Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. The barrier installed on the 3 in conduit had localized area of burnthrough but had been subjected to an additional 11 minutes of exposure beyond the point where the surface temperature exceeded the acceptance temperature criteria. Based on temperature profile data recorded during the test, no structural failure, such as joints opening, occurred for the 3 in. conduit barrier during fire exposure. Rather the openings were considered as "burnthrough" where the Thermo-lag material had been consumed to the underlying stress skin. It is reasonable to conclude that this burnthrough occurred following exceedance of acceptance temperature criteria, and that the 3 in. conduit and conduit barrier would have been capable of providing an adequate level of protection to the enclosed raceway had the hose stream been applied when the acceptance temperature criteria was initially exceeded.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is greater than that in the tested configuration. The plant barrier is required to have additional bands installed to maintain the required banding for a radial bend.

This three hour barrier can be down graded to a one hour barrier with minor rework on band placement.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 3 in. conduit envelope has a fire endurance rating of at least 91 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

INSTALLEDINDUSTRY

Source....NEI-Base-Tray-3hr  
Report No.13890-96150 Ass.2-10

Barr Component....Cable Tray			24x4 Tray A
Size.....24" X 6"			1.000
Thickness.....1.000			No
Preform Conduit...No			Inside/Parallel
Rib Location.....Unknown			15 %
Fill.....27 %			3.0 ft.
Support Span.....2.7 ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...Yes			Butt
Joint type.....Butt			No
Post buttered...No			Yes
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....Steel			12.0
Spacing (max)... 0.0	0.0		2.0
dist to jt (max)			No
Add Trwl matl...No			No
Edgeguard.....No			85 min. Barr rating
Barr/CQ rating.... 85/ 0 min.			

Element Comments:

Industry Comments:

Ref. Ass2\_10a.pcx  
Ass2\_10e.pcx  
Ass2\_10f.pcx  
Ass2\_10g.pcx

for construction details.

The support span relates to the single support in the test assembly. The total unsupported span is no greater than 3 feet.

Support members were covered using V-ribbed panel material to achieve coverage for the entire support. The support member envelopes were secured with steel bands, within 2in. of a panel butt joint or the end of a panel and a 12in. intervals thereafter.

All seams between joints between individual panels were postbuttered with trowel grade material.

Evaluation:

As shown through a parameter comparison, NEI Test 2-10 (tested a 24" x 4" cable tray - Tray A) has been chosen as the bounding test for this element. The plant cable tray is 24" x 6". The tested cable tray fire barrier bounds the existing 24" x 6" plant cable tray.

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For NEI Test 2-10, Tray A (24" x 4") aluminum ladder back cable tray maximum temperature criterion (325 deg. F over initial ambient) under cable tray rungs temperature was not exceeded at 86 minutes which is when the test was terminated. However, the cable tray right rail temperature exceeded maximum criterion at 85 minutes. The cable tray under rungs area temperature is the basis for establishing the actual rating of the installed configuration as this is the cold side temperature of the fire barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum cable tray had a percent fill of 15%, while the installed steel cable tray has a percent fill of 27%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would the tested assembly. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The cable tray itself will protect the circuits from in plant fire fighting and falling external objects during a fire due to the cable tray being installed high in the overhead. The barrier installed on the 24" x 4" cable tray had openings occur on the undersides of the barriers where damage to enclosed raceways induced by falling external objects would be unlikely.

Note that the comparable test configuration cable tray to the installed cable tray is 24" x 4" vs. 24" x 6" respectively. Using the results of the cable tray test configuration as a comparison is necessary since no baseline 24" x 6" cable tray 3 hr. fire barrier was tested. Use of the tested cable tray configuration as a comparison is acceptable since the depth of the cable tray does not effect the out come of the test as the width of the cable tray does.

The plant barrier spacing between bands is unknown. The plant band spacing from a joint is unknown. Additional inspection is required to determine the band spacing to a joint and spacing between bands.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 24" x 6" cable tray envelope has a fire endurance rating of at least 85 minutes when considering a maximum thermal acceptance criteria of 325 deg. F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 160

INSTALLEDINDUSTRY

Source....NEI-Base-Tray-3hr  
Report No.13890-96150 Ass.2-10

Barr Component....Radial bend tray			24x4Tray A bend
Size.....24" x 6"			1.000
Thickness.....1.000			No
Preform Conduit...No			Inside/Parallel
Rib Location.....Unknown			15 %
Fill.....27 %			3.0 ft.
Support Span.....2.8 ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.....Butt			Yes
Post buttered...No			No
Pre buttered....Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			2band/sect
Banding.....Steel			0.0
Spacing (max)... 5.5	0.0		No
dist to jt (max) 2.5			No
Add Trwl matl...No			85 min. Barr rating
Edgeguard.....No			
Barr/CQ rating.... 85/ 0 min.			

Element Comments:

Industry Comments:

Ref. Ass2\_10a.pcx  
Ass2\_10e.pcx  
Ass2\_10f.pcx  
Ass2\_10g.pcx

for construction details.

The support span relates to the single support in the test assembly. The total unsupported span is no greater than 3 feet.

To allow for curvature, the panels installed on the inside and outside surfaces of the radial bends were miter cut into individual horizontal slats, 3-7/8in. wide and 5-1/2 to 5-3/4in. wide respectively. The side rail panel materials were similarly miter cut such that an inner surface panel section, an outer surface panel section, and two tray side rail sections would form a single circumferential band around the radial bend.

Evaluation:

As shown through a parameter comparison, NEI Test 2-10 (tested a 24" x 4" cable tray radial bend - Tray A) has been chosen as the bounding test for this element. The plant cable tray radial bend is 24" x 6". The tested cable tray radial bend fire barrier bounds the existing 24" x 6" plant cable tray radial bend.

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For NEI Test 2-10, Tray A (24" x 4") aluminum ladder back cable tray maximum temperature criterion (325 deg. F over initial ambient) under cable tray rungs temperature was not exceeded at 86 minutes which is when the test was terminated. However, the cable tray right rail temperature exceeded the maximum criterion at 85 minutes. This will serve as the basis for the fire endurance rating for the barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum cable tray had a percent fill of 15%, while the installed steel cable tray has a percent fill of 27%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would the tested assembly. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Barrier condition was not considered satisfactory after the hose stream test. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The cable tray itself will protect the circuits from in plant fire fighting and falling external objects during a fire due to the cable tray being installed high in the overhead. The barrier installed on the 24" x 4" cable tray had openings occur on the undersides of the barriers where damage to enclosed raceways induced by falling external objects would be unlikely.

Note that the comparable test configuration cable tray to the installed cable tray is 24" x 4" vs. 24" x 6" respectively. Using the results of the cable tray test configuration as a comparison is necessary since no baseline 24" x 6" cable tray 3 hr. fire barrier was tested. Use of the tested cable tray configuration as a comparison is acceptable since the depth of the cable tray does not effect the out come of the test as the width of the cable tray does.

The plant barrier spacing between bands is less than the 12" spacing between bands for the tested configuration. The plant band spacing from a joint is greater than that in the tested configuration. The plant barrier is required to have additional bands installed to maintain the 2" maximum spacing to a joint.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 24" x 6" cable tray radial bend envelope has a fire endurance rating of at least 85 minutes when considering a maximum thermal acceptance criteria of 325 deg. F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 350

INSTALLEDINDUSTRY

Source....NEI-Base-Tray-3hr  
Report No.13890-96150 Ass.2-10

Parr Component....radial bend tray			6x4 Tray B bend
Size.....6" x 6"			1.000
Thickness.....1.000			No
Preform Conduit...No			Inside/Parallel
Rib Location.....N/A			16 %
Fill.....90 %			3.0 ft.
Support Span.....1.8 ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			NA
Add trwl matl...Yes			Butt
Joint type.....Butt			Yes
Post buttered...No			No
Pre buttered...Yes			.25
Gap width.....NA			No
Add trwl matl...Yes			2band/sect
Banding.....Steel			0.0
Spacing (max)... 0.0	0.0		
dist to jt (max)			
Add Trwl matl...No			No
Edgeguard.....No			86 min. Barr rating
Barr/CQ rating.... 86/ 0 min.			

## Element Comments:

## Industry Comments:

Ref. Ass2\_10b.pcx  
Ass2\_10e.pcx  
Ass2\_10f.pcx  
Ass2\_10g.pcx

for construction details.

The support span relates to the single support in the test assembly. The total unsupported span is no greater than 3 feet.

To allow for curvature, the panels installed on the inside and outside surfaces of the radial bends were miter cut into individual horizontal slats, 3-7/8in. wide and 5-1/2 to 5-3/4in wide respectively. The side rail panel materials were similarly miter cut such that an inner surface panel section, an outer surface panel section, and two tray side rail sections would form a single circumferential band around the radial bend.

Evaluation:

As shown through a parameter comparison, NEI Test 2-10 (tested a 6" x 4" cable tray radial bend - Tray B) has been chosen as the bounding test for this element. The plant cable tray radial bend is 6" x 6". The tested cable tray radial bend fire barrier bounds the existing 6" x 6" plant cable tray radial bend.

For NEI Test 2-10, Tray B (6" x 4") aluminum ladder back cable tray  
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maximum temperature criterion (325 deg. F over initial ambient) under cable tray rungs was not exceeded at 86 minutes which is when the test was terminated. No temperatures at any location exceeded the maximum temperature criterion. Therefore, 86 minutes will be the basis for establishing a fire endurance rating for the barrier. The installed configuration's raceway is constructed of steel vs. the tested aluminum. The tested aluminum cable tray had a percent fill of 16%, while the installed steel cable tray has a percent fill of 90%. The installed configuration therefore has a higher thermal capacity which would result in lower internal temperatures at a given time than would the tested assembly. It is therefore reasonable to conclude that the installed configuration would not exceed allowable internal temperatures faster than the tested configuration.

Note that the comparable test configuration cable tray to the installed cable tray is 6" x 4" vs. 6" x 6" respectively. Using the results of the cable tray test configuration as a comparison is necessary since the only other cable tray configuration tested was a 24" x 4" cable tray. Use of the 6" x 4" tested cable tray configuration as a comparison is conservative since the plant cable tray is more closely represented by the 6" x 4" tested cable tray.

Barrier condition was considered satisfactory after the hose stream test.

The plant barrier spacing between bands is unknown. The plant band spacing from a joint is unknown. Additional inspection is required to determine the band spacing measurements.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 6" x 6" cable tray radial bend envelope has a fire endurance rating of at least 86 minutes when considering a maximum thermal acceptance criteria of 325 deg. F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 573

INSTALLEDINDUSTRY

Source...NEI-Baseline-JB-3hr  
Report No.13890-98757 Ass. 3-2

Barr Component....Penetration			6"x6"x4 JB
Size.....1.25			1.000
Thickness.....1.000			No
Preform Conduit...No			No ribs/flat
Rib Location.....N/A			0 %
Fill.....0 %			NA ft.
Support Span.....NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.....Butt			Yes
Post buttered...No			No
Pre buttered....Yes			.125
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....Steel			0.0
Spacing (max)...0.0	0.0		2.0
dist to jt (max)			No
Add Trwl matl...No			No
Edgeguard.....0			60 min. Barr rating
Barr/CQ rating....60/ 0 min.			

## Element Comments:

## Industry Comments:

Panels were installed on the junction boxes first, with the side panels in compression between the bottom enclosure panel and the concrete slab. The V-rib stiffeners were hammered flat for the panels used to cover the junction box assembly. Support coverage was installed following junction box coverage using the butt joint method with post buttered joints. Protruding item coverage on the 1 inch steel conduits was provided with 1/2 inch preshaped conduit sections for a distance of 9 inches. An additional overlay of 3/8 inch thick sections was then installed. Stainless steel tie wires were pre-installed to secure support coverage and bands oriented perpendicular to the protruding conduit were installed through the material such that they were in contact with the top of the box.

A fillet of trowel grade material was placed at the interface between the box coverage and the concrete slab and at the interface between the box coverage and the protruding item coverage.

Surface temperatures were

satisfactory for the 60 minute test. Barrier condition was satisfactory after the hose stream test.

**Evaluation:**

As shown through a parameter comparison, the installed configuration is bounded by a test configuration.

For NEI Test Ass. 3-2, a 6" x 6" x 4" junction box was protected with 1 inch thick panel sections. The enclosure was abutted to the concrete and sealed with Thermo-Lag trowel grade material using post buttered techniques. During NEI Test 3-2, temperatures on the junction box surface for the 60 minutes was not recorded due to failure of the thermal couples. For this test, the Thermo-Lag to concrete interface joint did not fail the hose stream test. The thermocouple readings for the 6" x 6" x 4" junction box protected with 1/2" thick panel sections maximum temperature criterion (maximum temperature 402 deg F.) was reached in 54 minutes. It is reasonable to conclude that the junction box protected with 1 inch thick panel section will last for 60 minutes. In other words, this type of joint can be expected to maintain its thermal performance without failing the maximum temperature criterion for 60 minutes. It is therefore reasonable to use the results of NEI Test 3-2 to establish a fire endurance rating for this element as the construction techniques of this element are similar to those for NEI Test 3-2 except that this element has an additional panel section anchored to the concrete which is both pre and post buttered at the Thermo-Lag to concrete interface and Thermo-Lag to Thermo-Lag interface. NEI Test 3-2 demonstrates that a Thermo-Lag to concrete interface with trowel grade material will not cause the barrier to fail.

The thermal mass of the tested configuration was 1.80 lb/lin. ft. The plant barrier has a total thermal mass of 2.2173 lb./lin. ft. (2.15 lb./lin. ft. conduit, 0.0673 lb./lin. ft. cable(1Pr-16 EK-15A)). The tested configuration used panels that were 1 inch thick. The plant configuration used 1 inch panel sections to protect the conduit and conduit.

Barrier condition was considered satisfactory after the hose stream test. There were no barrier openings present in the body of the protective envelope. No barrier openings to the conduits were present at the interface with the concrete slab either.

Band spacing is not considered relevant to this evaluation. The thermo-lag to concrete interface is the parameter being addressed here. This element is the thermo-lag to concrete interface for element no. 175.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1-1/4 in. conduit envelope has a fire endurance rating of at least 60 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.



INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-98756 Ass. 3-1

Barr Component....	Penetration		2in mult. cond.
Size.....	1"		1.000
Thickness.....	1.000		Yes
Preform Conduit...	Yes		No ribs/flat
Rib Location.....	N/A		0 %
Fill.....	72 %		NA ft.
Support Span.....	NA ft.		Inside and outside
Stress Skin.....	Inside and outside		No
Over joints.....	Yes		No
Ties.....	No		No
Staples.....	Yes		No
Add trwl matl...	No		Butt
Joint type.....	Butt		Yes
Post buttered...	No		No
Pre buttered....	Yes		.125
Gap width.....	NA		No
Add trwl matl...	Yes		Steel
Banding.....	Steel		13.0
Spacing (max)...	4.0	0.0	6.0
dist to jt (max)	2.0		No
Add Trwl matl...	No		No
Edgeguard.....	No		60 min. Barr rating
Barr/CQ rating....	60/ 0 min.		

Element Comments:

Industry Comments:

After V-Rib panels were flattened, the panels were oriented, as if the ribs still existed, parallel to the conduits.

One preshaped conduit section was installed on the outside edge of each 2 inch conduit along the entire length. Top and bottom panels were then installed between the conduit sections forming an enclosure that is rounded on each side, flat on top and bottom and abutting the concrete slab on each end.

The interface between the barrier envelope and the concrete slab was post buttered with a fillet of trowel grade material.

Conduit surface temperatures were satisfactory for the 60 minute test duration. During the hose stream test, openings were developed in the barrier at the barrier/concrete interface area.

Evaluation:

As shown through a parameter comparison, the installed configuration is bounded by a test configuration.

For NEI Test Ass. 3-1, a pair of 2 inch conduits were mounted in a  
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"U-shaped" conduit loop configuration. The enclosure was constructed using 1 inch thick pre-shaped conduit sections and pre-fabricated V-rib panels covering the conduits. The enclosure was abutted to the concrete and sealed with Thermo-Lag trowel grade material using post buttered techniques. During NEI Test 3-1, temperature acceptance limits were not exceeded on the conduit surface for the 60 minutes. For this test, the Thermo-Lag to concrete interface joint failed the hose stream test. The thermocouple readings in the area of the Thermo-Lag to concrete interface were well below the maximum temperature criterion (maximum temperature 393 deg F.). The maximum thermocouple readings in this area ranged from 211 deg F to 229 deg F. In other words, this type of joint can be expected to maintain its thermal performance without failing the maximum temperature criterion for 60 minutes. It is therefore reasonable to use the results of NEI Test 3-1 to establish a fire endurance rating for this element as the construction techniques of this element are the same as those for NEI Test 2-3 except that this element is both pre and post buttered at the Thermo-Lag to concrete interface. NEI Test 3-1 demonstrates that a Thermo-Lag to concrete interface with trowel grade material will not cause the barrier to fail.

The thermal mass of the tested configuration was 2.32 lb/lin. ft. The plant barrier has a total thermal mass of 2.20 lb./lin. ft. (1.65 lb./lin. ft. conduit, 0.208 lb./lin. ft. cable (2/C-10 EK-8B), 0.34 lb./lin. ft. conduit coupling). The tested configuration used 2 inch preformed conduit sections and panels that were 1 inch thick. The plant configuration is as follows: 1" conduit, 1" preformed conduit sections on conduit up to coupling, 3" preformed conduit sections installed over the 1" sections, remaining conduit run (-2") has an air gap between the conduit and the preformed conduit section to the ceiling. Even though the thermal mass of the tested configuration is slightly more the air gap of the plant configuration will compensate for the slightly lower thermal mass (0.12 lb./lin. ft.). The tested configuration had trowel grade material applied at the preformed and concrete interface (post buttered). The plant configuration used both pre and post buttered trowel grade material for this joint. The fillet of trowel grade is also protected with the overlay of structural steel fire proofing. This provides additional protection to this joint.

Barrier condition was not considered satisfactory after the hose stream test. There were no barrier openings present in the body of the protective envelope. Openings to the conduits were present at the interface with the concrete slab. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. This element is located at the ceiling of the fire area and is located over the Technical Support center roof. Note that this test was terminated at 60 minutes.

Band spacing is not considered relevant to this evaluation. The thermo-lag to concrete interface is the parameter being addressed here. This element is the thermo-lag to concrete interface for element no. 375.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1 in. conduit envelope has a fire endurance rating of at least 60 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 582

INSTALLEDINDUSTRY

Source....NEI-Baseline-JB-3hr  
Report No.13890-98757 Ass. 3-2

Barr Component....Penetration			6"x6"x4 JB
Size.....			1.000
Thickness.....1.000			No
Preform Conduit...Yes			No ribs/flat
Rib Location.....N/A			0 %
Fill.....0 %			NA ft.
Support Span.....NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.....Butt			Yes
Post buttered...No			No
Pre buttered....Yes			.125
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....None			0.0
Spacing (max)...0.0	0.0		2.0
dist to jt (max)			No
Add Trwl matl...Yes			No
Edgeguard.....0			60 min. Barr rating
Barr/CQ rating....60/ 0 min.			

Element Comments:

Industry Comments:

Panels were installed on the junction boxes first, with the side panels in compression between the bottom enclosure panel and the concrete slab. The V-rib stiffeners were hammered flat for the panels used to cover the junction box assembly. Support coverage was installed following junction box coverage using the butt joint method with post buttered joints. Protruding item coverage on the 1 inch steel conduits was provided with 1/2 inch preshaped conduit sections for a distance of 9 inches. An additional overlay of 3/8 inch thick sections was then installed. Stainless steel tie wires were pre-installed to secure support coverage and bands oriented perpendicular to the protruding conduit were installed through the material such that they were in contact with the top of the box.

A fillet of trowel grade material was placed at the interface between the box coverage and the concrete slab and at the interface between the box coverage and the protruding item coverage.

Surface temperatures were

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satisfactory for the 60 minute test. Barrier condition was satisfactory after the hose stream test.

**Evaluation:**

As shown through a parameter comparison, the installed configuration is bounded by a test configuration.

For NEI Test Ass. 3-2, a 6" x 6" x 4" junction box was protected with 1 inch thick panel sections. The enclosure was abutted to the concrete and sealed with Thermo-Lag trowel grade material using post buttered techniques. During NEI Test 3-2, temperatures on the junction box surface for the 60 minutes was not recorded due to failure of the thermal couples. For this test, the Thermo-Lag to concrete interface joint did not fail the hose stream test. The thermocouple readings for the 6" x 6" x 4" junction box protected with 1/2" thick panel sections maximum temperature criterion (maximum temperature 402 deg F.) was reached in 54 minutes. It is reasonable to conclude that the junction box protected with 1 inch thick panel section will last for 60 minutes. In other words, this type of joint can be expected to maintain its thermal performance without failing the maximum temperature criterion for 60 minutes. It is therefore reasonable to use the results of NEI Test 3-2 to establish a fire endurance rating for this element as the construction techniques of this element are similar to those for NEI Test 3-2 except that this element has an additional panel section anchored to the concrete which is both pre and post buttered at the Thermo-Lag to concrete interface and Thermo-Lag to Thermo-Lag interface. NEI Test 3-2 demonstrates that a Thermo-Lag to concrete interface with trowel grade material will not cause the barrier to fail.

The thermal mass of the tested configuration was 1.80 lb/lin. ft. The plant barrier has a total thermal mass of 1.858 lb./lin. ft. (1.65 lb./lin. ft. conduit, 0.208 lb./lin. ft. cable(2/C-10 EK-8B)). The tested configuration used panels that were 1 inch thick. The plant configuration used 1 inch panel sections to protect the conduit and conduit.

Barrier condition was considered satisfactory after the hose stream test. There were no barrier openings present in the body of the protective envelope. No barrier openings to the conduits were present at the interface with the concrete slab either.

Band spacing is not considered relevant to this evaluation. The thermo-lag to concrete interface is the parameter being addressed here. This element is the thermo-lag to concrete interface for element no. 609.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed conduit envelope has a fire endurance rating of at least 60 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.



## EVALUATION FOR ELEMENT NO. 577

INSTALLEDINDUSTRY

Source...NEI-Baseline-JB-3hr  
Report No.13890-98757 Ass. 3-2

Barr Component....Penetration		6"x6"x4 JB
Size.....1.5"		1.000
Thickness.....1.000		No
Preform Conduit...Yes		No ribs/flat
Rib Location.....N/A		0 %
Fill.....75 %		NA ft.
Support Span..... NA ft.		Inside and outside
Stress Skin.....Inside and outside		No
Over joints.....Yes		No
Ties.....No		No
Staples.....Yes		No
Add trwl matl...No		No
Joint type.....Butt		Butt
Post buttered...No		Yes
Pre buttered....Yes		No
Gap width.....NA		.125
Add trwl matl...Yes		No
Banding.....Steel		Steel
Spacing (max)... 4.0	0.0	0.0
dist to jt (max) 2.0		2.0
Add Trwl matl...No		No
Edgeguard.....No		No
Barr/CQ rating.... 60/ 0 min.		60 min. Barr rating

## Element Comments:

## Industry Comments:

Panels were installed on the junction boxes first, with the side panels in compression between the bottom enclosure panel and the concrete slab. The V-rib stiffeners were hammered flat for the panels used to cover the junction box assembly. Support coverage was installed following junction box coverage using the butt joint method with post buttered joints. Protruding item coverage on the 1 inch steel conduits was provided with 1/2 inch preshaped conduit sections for a distance of 9 inches. An additional overlay of 3/8 inch thick sections was then installed. Stainless steel tie wires were pre-installed to secure support coverage and bands oriented perpendicular to the protruding conduit were installed through the material such that they were in contact with the top of the box.

A fillet of trowel grade material was placed at the interface between the box coverage and the concrete slab and at the interface between the box coverage and the protruding item coverage.

Surface temperatures were

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satisfactory for the 60 minute test. Barrier condition was satisfactory after the hose stream test.

**Evaluation:**

As shown through a parameter comparison, the installed configuration is bounded by a test configuration.

For NEI Test Ass. 3-2, a 6" x 6" x 4" junction box was protected with 1 inch thick panel sections. The enclosure was abutted to the concrete and sealed with Thermo-Lag trowel grade material using post buttered techniques. During NEI Test 3-2, temperatures on the junction box surface for the 60 minutes was not recorded due to failure of the thermal couples. For this test, the Thermo-Lag to concrete interface joint did not fail the hose stream test. The thermocouple readings for the 6" x 6" x 4" junction box protected with 1/2" thick panel sections maximum temperature criterion (maximum temperature 402 deg F.) was reached in 54 minutes. It is reasonable to conclude that the junction box protected with 1 inch thick panel section will last for 60 minutes. In other words, this type of joint can be expected to maintain its thermal performance without failing the maximum temperature criterion for 60 minutes. It is therefore reasonable to use the results of NEI Test 3-2 to establish a fire endurance rating for this element as the construction techniques of this element are similar to those for NEI Test 3-2 except that this element has an additional panel section anchored to the concrete which is both pre and post buttered at the Thermo-Lag to concrete interface and Thermo-Lag to Thermo-Lag interface. NEI Test 3-2 demonstrates that a Thermo-Lag to concrete interface with trowel grade material will not cause the barrier to fail.

The thermal mass of the tested configuration was 1.80 lb./lin. ft. The plant barrier has a total thermal mass of 2.727 lb./lin. ft. (2.58 lb./lin. ft. conduit, 0.1470 lb./lin. ft. cable(2/C-12 EK-9C). The tested configuration used panels that were 1 inch thick. The plant configuration used 1 inch panel sections to protect the conduit and conduit.

Barrier condition was considered satisfactory after the hose stream test. There were no barrier openings present in the body of the protective envelope. No barrier openings to the conduits were present at the interface with the concrete slab either.

Band spacing is considered acceptable for this configuration. No additional work is necessary.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1 1/2 in. conduit envelope has a fire endurance rating of at least 60 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 578

INSTALLEDINDUSTRY

Source....NEI-Baseline-JB-3hr  
Report No.13890-98757 Ass. 3-2

Barr Component....Penetration			6"x6"x4 JB
Size.....1.5"			1.000
Thickness.....1.000			No
Preform Conduit...No			No ribs/flat
Rib Location.....N/A			0 %
Fill.....90 %			NA ft.
Support Span..... NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....Yes			No
Staples.....No			No
Add trwl matl...No			Butt
Joint type.....Butt			Yes
Post buttered...No			No
Pre buttered....Yes			.125
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....None			0.0
Spacing (max)... 0.0	0.0		2.0
dist to jt (max)			No
Add Trwl matl...No			No
Edgeguard.....No			60 min. Barr rating
Barr/CQ rating.... 60/ 0 min.			

Element Comments:

Industry Comments:

Panels were installed on the junction boxes first, with the side panels in compression between the bottom enclosure panel and the concrete slab. The V-rib stiffeners were hammered flat for the panels used to cover the junction box assembly. Support coverage was installed following junction box coverage using the butt joint method with post buttered joints. Protruding item coverage on the 1 inch steel conduits was provided with 1/2 inch preshaped conduit sections for a distance of 9 inches. An additional overlay of 3/8 inch thick sections was then installed. Stainless steel tie wires were pre-installed to secure support coverage and bands oriented perpendicular to the protruding conduit were installed through the material such that they were in contact with the top of the box.

A fillet of trowel grade material was placed at the interface between the box coverage and the concrete slab and at the interface between the box coverage and the protruding item coverage.

Surface temperatures were

07/15/96

satisfactory for the 60 minute test. Barrier condition was satisfactory after the hose stream test.

**Evaluation:**

As shown through a parameter comparison, the installed configuration is bounded by a test configuration.

For NEI Test Ass. 3-2, a 6" x 6" x 4" junction box was protected with 1 inch thick panel sections. The enclosure was abutted to the concrete and sealed with Thermo-Lag trowel grade material using post buttered techniques. During NEI Test 3-2, temperatures on the junction box surface for the 60 minutes was not recorded due to failure of the thermal couples. For this test, the Thermo-Lag to concrete interface joint did not fail the hose stream test. The thermocouple readings for the 6" x 6" x 4" junction box protected with 1/2" thick panel sections maximum temperature criterion (maximum temperature 402 deg F.) was reached in 54 minutes. It is reasonable to conclude that the junction box protected with 1 inch thick panel section will last for 60 minutes. In other words, this type of joint can be expected to maintain its thermal performance without failing the maximum temperature criterion for 60 minutes. It is therefore reasonable to use the results of NEI Test 3-2 to establish a fire endurance rating for this element as the construction techniques of this element are similar to those for NEI Test 3-2 except that this element has an additional panel section anchored to the concrete which is both pre and post buttered at the Thermo-Lag to concrete interface and Thermo-Lag to Thermo-Lag interface. NEI Test 3-2 demonstrates that a Thermo-Lag to concrete interface with trowel grade material will not cause the barrier to fail.

The thermal mass of the tested configuration was 1.80 lb./lin. ft. The plant barrier has a total thermal mass of 2.994 lb./lin. ft. (2.58 lb./lin. ft. conduit, 0.207 lb./lin. ft. cable(3/C-12 EK-9D), 0.207 lb./lin. ft. cable(3/C-12 EK-9D). The tested configuration used panels that were 1 inch thick. The plant configuration used 1 inch panel sections to protect the conduit and conduit.

Barrier condition was considered satisfactory after the hose stream test. There were no barrier openings present in the body of the protective envelope. No barrier openings to the conduits were present at the interface with the concrete slab either.

The plant barrier spacing between bands is unknown. The plant band spacing from a joint is unknown. Additional inspection is required to determine band measurements.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1 1/2 in. conduit envelope has a fire endurance rating of at least 60 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 545

INSTALLEDINDUSTRY

Source....NEI-Baseline-3hr  
Report No.13890-98756 Ass. 3-1

Barr Component....Penetration			2in mult. cond.
Size.....2 inch			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			No ribs/flat
Rib Location.....N/A			0 %
Fill.....0 %			NA ft.
Support Span.....NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...No			Butt
Joint type.....Butt			Yes
Post buttered...No			No
Pre buttered....Yes			.125
Gap width.....NA			No
Add trwl matl...No			Steel
Banding.....Unknown			13.0
Spacing (max)... 0.0	0.0		6.0
dist to jt (max)			No
Add Trwl matl...No			No
Edgeguard.....0			60 min. Barr rating
Barr/CQ rating.... 60/ 0 min.			

Element Comments:

Industry Comments:

After V-Rib panels were flattened, the panels were oriented, as if the ribs still existed, parallel to the conduits.

One preshaped conduit section was installed on the outside edge of each 2 inch conduit along the entire length. Top and bottom panels were then installed between the conduit sections forming an enclosure that is rounded on each side, flat on top and bottom and abutting the concrete slab on each end.

The interface between the barrier envelope and the concrete slab was post buttered with a fillet of trowel grade material.

Conduit surface temperatures were satisfactory for the 60 minute test duration. During the hose stream test, openings were developed in the barrier at the barrier/concrete interface area.

Evaluation:

As shown through a parameter comparison, the installed configuration is bounded by a test configuration.

For NEI Test Ass. 3-1, a pair of 2 inch conduits were mounted in a  
07/15/96



"U-shaped" conduit loop configuration. The enclosure was constructed using 1 inch thick pre-shaped conduit sections and pre-fabricated V-rib panels covering the conduits. The enclosure was abutted to the concrete and sealed with Thermo-Lag trowel grade material using post buttered techniques. During NEI Test 3-1, temperature acceptance limits were not exceeded on the conduit surface for the 60 minutes. For this test, the Thermo-Lag to concrete interface joint failed the hose stream test. The thermocouple readings in the area of the Thermo-Lag to concrete interface were well below the maximum temperature criterion (maximum temperature 393 deg F.). The maximum thermocouple readings in this area ranged from 211 deg F to 229 deg F. In other words, this type of joint can be expected to maintain its thermal performance without failing the maximum temperature criterion for 60 minutes. It is therefore reasonable to use the results of NEI Test 3-1 to establish a fire endurance rating for this element as the construction techniques of this element are the same as those for NEI Test 3-1 except that this element is both pre and post buttered at the Thermo-Lag to concrete interface. NEI Test 3-1 demonstrates that a Thermo-Lag to concrete interface with trowel grade material will not cause the barrier to fail.

The thermal mass of the tested configuration was 2.32 lb./lin. ft. The plant barrier has a total thermal mass of 3.846 lb./lin. ft. (3.52 lb./lin. ft. conduit, 0.3260 lb./lin. ft. cable(5/C-12 EK-9E)). The tested configuration used 2 inch preformed conduit sections and panels that were 1 inch thick. The plant configuration used 2" preformed conduit sections that were 1 inch thick to the floor. The tested configuration had trowel grade material applied at the preformed and concrete interface (post buttered). The plant configuration used both pre and post buttered trowel grade material for the Thermo-Lag to Thermo-Lag and Thermo-Lag to concrete joint.

Barrier condition was not considered satisfactory after the hose stream test. There were no barrier openings present in the body of the protective envelope. Openings to the conduits were present at the interface with the concrete slab. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. Note that this test was terminated at 60 minutes.

Band spacing is not considered relevant to this evaluation. The thermo-lag to concrete interface is the parameter being addressed here. This element is the thermo-lag to concrete interface for element no. 45.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 2 in. conduit envelope has a fire endurance rating of at least 60 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.



## EVALUATION FOR ELEMENT NO. 605

INSTALLEDINDUSTRY

Source....NEI--Baseline-3hr  
Report No.13890-98756 Ass. 3-1

Barr Component....Penetration			2in mult. cond.
Size.....2.5"			1.000
Thickness.....1.000			Yes
Preform Conduit...Yes			No ribs/flat
Rib Location.....N/A			0 %
Fill.....89 %			NA ft.
Support Span.....NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...Yes			Butt
Joint type.....Butt			Yes
Post buttered...No			No
Pre buttered....Yes			.125
Gap width.....NA			No
Add trwl matl...Yes			Steel
Banding.....None			13.0
Spacing (max)...0.0	0.0		6.0
dist to jt (max)			No
Add Trwl matl...No			No
Edgeguard.....No			60 min. Barr rating
Barr/CQ rating....60/ 0 min.			

## Element Comments:

## Industry Comments:

After V-Rib panels were flattened, the panels were oriented, as if the ribs still existed, parallel to the conduits.

One preshaped conduit section was installed on the outside edge of each 2 inch conduit along the entire length. Top and bottom panels were then installed between the conduit sections forming an enclosure that is rounded on each side, flat on top and bottom and abutting the concrete slab on each end.

The interface between the barrier envelope and the concrete slab was post buttered with a fillet of trowel grade material.

Conduit surface temperatures were satisfactory for the 60 minute test duration. During the hose stream test, openings were developed in the barrier at the barrier/concrete interface area.

Evaluation:

As shown through a parameter comparison, the installed configuration is bounded by a test configuration.

For NEI Test Ass. 3-1, a pair of 2 inch conduits were mounted in a  
07/15/96

"U-shaped" conduit loop configuration. The enclosure was constructed using 1 inch thick pre-shaped conduit sections and pre-fabricated V-rib panels covering the conduits. The enclosure was abutted to the concrete and sealed with Thermo-Lag trowel grade material using post buttered techniques. During NEI Test 3-1, temperature acceptance limits were not exceeded on the conduit surface for the 60 minutes. For this test, the Thermo-Lag to concrete interface joint failed the hose stream test. The thermocouple readings in the area of the Thermo-Lag to concrete interface were well below the maximum temperature criterion (maximum temperature 393 deg F.). The maximum thermocouple readings in this area ranged from 211 deg F to 229 deg F. In other words, this type of joint can be expected to maintain its thermal performance without failing the maximum temperature criterion for 60 minutes. It is therefore reasonable to use the results of NEI Test 3-1 to establish a fire endurance rating for this element as the construction techniques of this element are the same as those for NEI Test 2-3 except that this element is both pre and post buttered at the Thermo-Lag to concrete interface. NEI Test 3-1 demonstrates that a Thermo-Lag to concrete interface with trowel grade material will not cause the barrier to fail.

The thermal mass of the tested configuration was 2.32 lb/lin. ft. The plant barrier has a total thermal mass of 6.039 lb./lin. ft. (5.67 lb./lin. ft. conduit, 0.369 lb./lin. ft. cable(7/C-12 EK-9F)). The tested configuration used 2 inch preformed conduit sections and panels that were 1 inch thick. The plant configuration used 2 1/2" preformed conduit sections on the conduit.

Barrier condition was not considered satisfactory after the hose stream test. There were no barrier openings present in the body of the protective envelope. Openings to the conduits were present at the interface with the concrete slab. The purpose of the hose stream test is to evaluate the structural integrity of the fire barrier and its ability to protect the enclosed raceway from damage caused by in plant fire fighting and falling external objects during a fire. The conduit itself without the fire barrier will protect the circuits inside the conduit from in plant fire fighting and falling external objects during a fire. Note that this test was terminated at 60 minutes.

Band spacing is not considered relevant to this evaluation. The thermo-lag to concrete interface is the parameter being addressed here. This element is the thermo-lag to concrete interface for element no. 298.

It is therefore concluded that the test data and parameter comparison to a tested configuration provides reasonable assurance that the installed 1 in. conduit envelope has a fire endurance rating of at least 60 minutes when considering a maximum thermal acceptance criteria of 325 deg F above initial ambient temperature.

## EVALUATION FOR ELEMENT NO. 606

INSTALLEDINDUSTRY

Source....NEI-Baseline-JB-3hr  
Report No.13890-98757 Ass. 3-2

Barr Component....Penetration			6"x6"x4 JB
Size.....14.5"x7.5"x7"			1.000
Thickness.....1.000			No
Preform Conduit...No			No ribs/flat
Rib Location.....N/A			0 %
Fill.....0 %			NA ft.
Support Span.....NA ft.			Inside and outside
Stress Skin.....Inside and outside			No
Over joints.....Yes			No
Ties.....No			No
Staples.....Yes			No
Add trwl matl...Yes			No
Joint type.....Butt			Butt
Post buttered...No			Yes
Pre buttered....Yes			No
Gap width.....NA			.125
Add trwl matl...Yes			No
Banding.....None			Steel
Spacing (max)...0.0	0.0		0.0
dist to jt (max)			2.0
Add Trwl matl...No			No
Edgeguard.....No			No
Barr/CQ rating....60/ 0 min.			60 min. Barr rating

## Element Comments:

## Industry Comments:

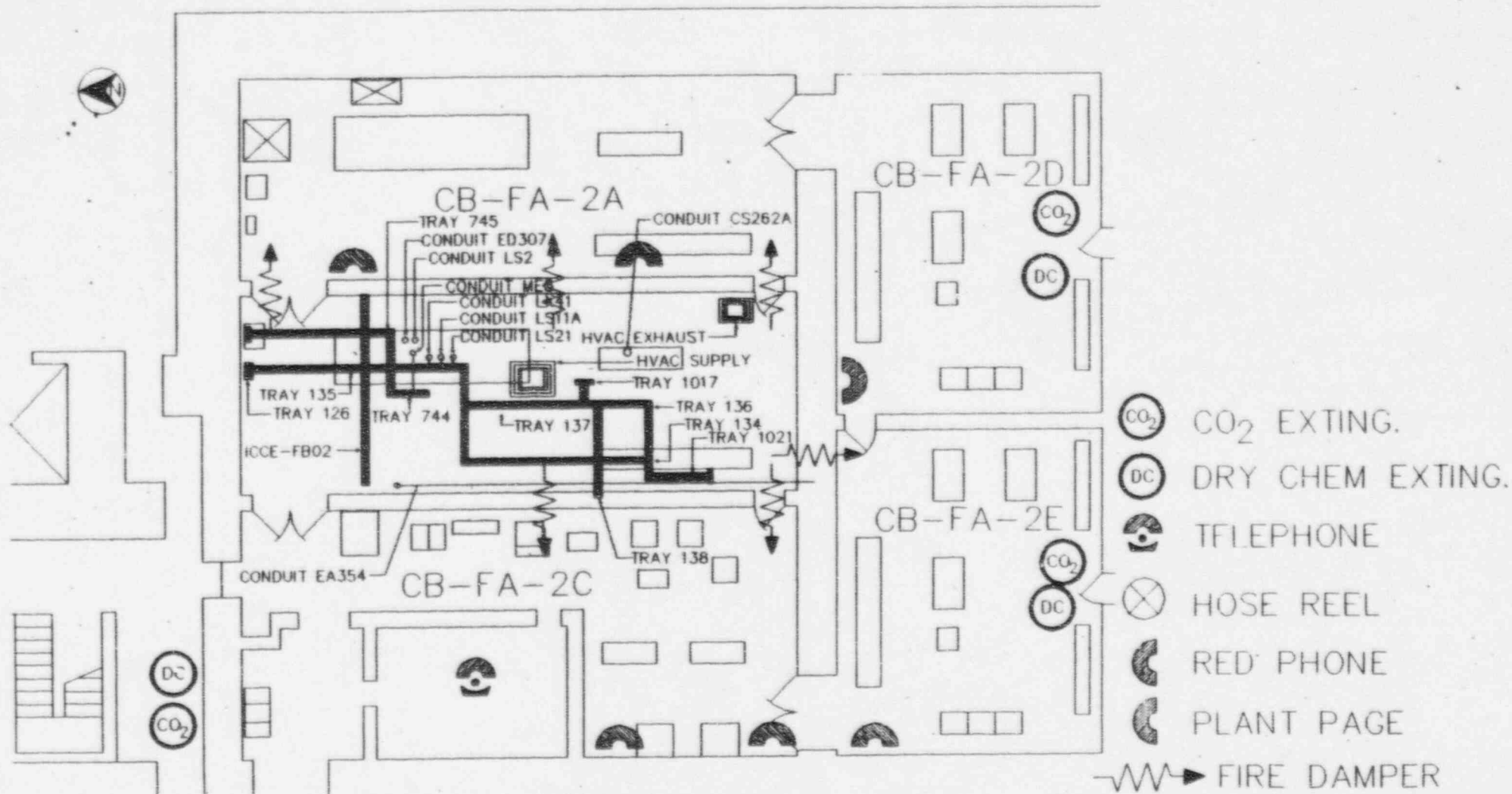
Panels were installed on the junction boxes first, with the side panels in compression between the bottom enclosure panel and the concrete slab. The V-rib stiffeners were hammered flat for the panels used to cover the junction box assembly. Support coverage was installed following junction box coverage using the butt joint method with post buttered joints. Protruding item coverage on the 1 inch steel conduits was provided with 1/2 inch preshaped conduit sections for a distance of 9 inches. An additional overlay of 3/8 inch thick sections was then installed. Stainless steel tie wires were pre-installed to secure support coverage and bands oriented perpendicular to the protruding conduit were installed through the material such that they were in contact with the top of the box.

A fillet of trowel grade material was placed at the interface between the box coverage and the concrete slab and at the interface between the box coverage and the protruding item coverage.

Surface temperatures were

07/15/96

**REORDERED SET OF  
FIRE AREA DRAWINGS  
AND  
DATA SHEETS**






CONTROL BUILDING ELEV. 322'

CB-FA-2B  
ICCE-FB02 / MISC

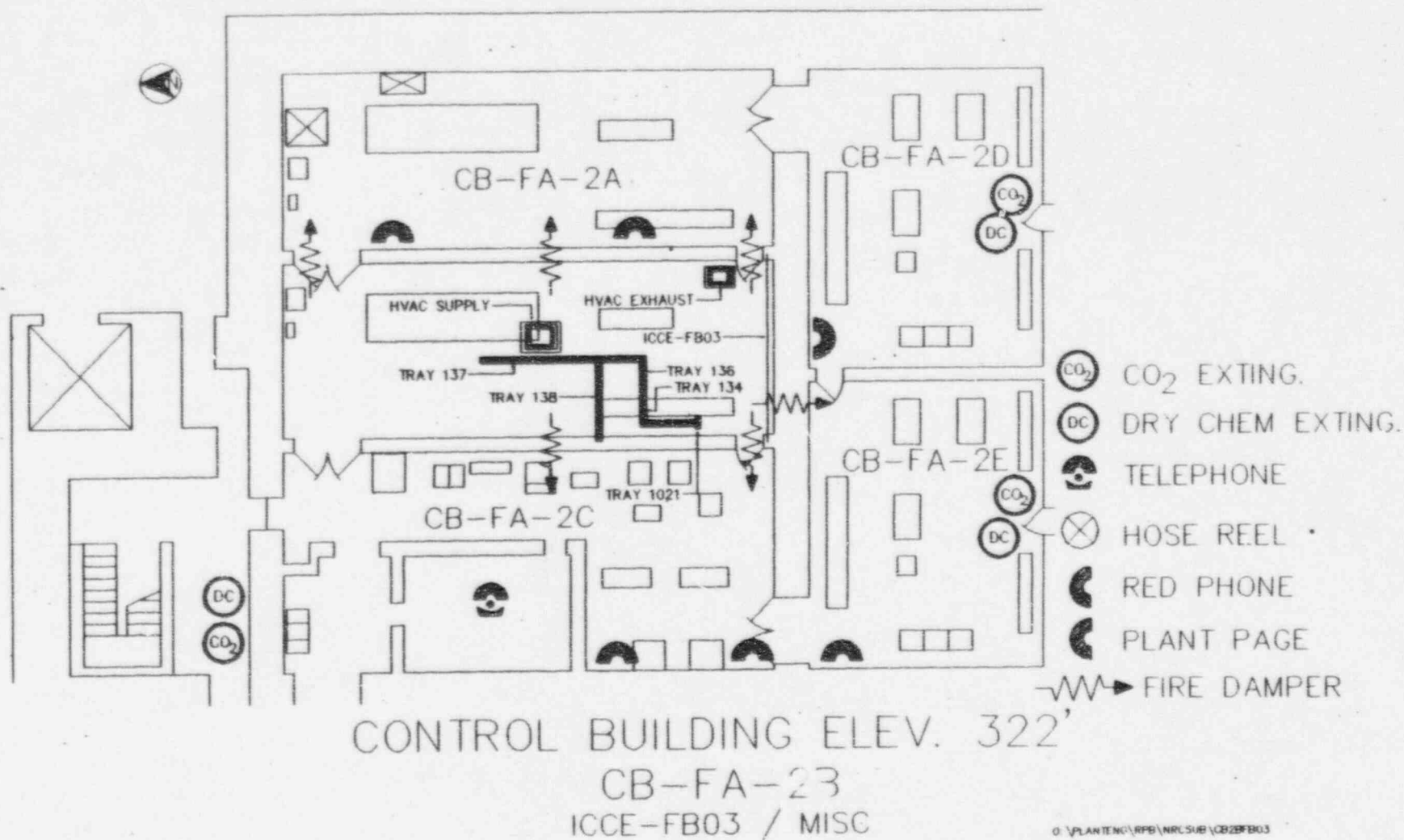


ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCE-FB02	TRAY 143 CIRCUIT	MAKEUP AND SUPPORT FUNCTIONS	TRAY 126 CIRCUIT	MAKEUP AND SUPPORT FUNCTIONS
	CG802 CG805 CQ313 CQ323 EA105 EA6822 ED523C LP23 LR23 LX32 MD68 RY4 RY23	RCS PRESSURE SOURCE RANGE MONITORING ELECTRICAL POWER SYSTEM	LS12 LX41 LX42 LX43 RZ1 RZ2 RZ3 RZ8 RZ13 RZ14 RZ15 RZ17 RZ21 RZ22 RZ23 RZ33 RZ34 RZ35 RZ53 RZ55	RCS PRESSURE SOURCE RANGE MONITORING ELECTRICAL POWER SYSTEM
			TRAY 134 CIRCUIT	CR322A LS11A LS21A LT21A
			TRAY 135 CIRCUIT	LS11A LS12 LS20 LS21 LX41 LX42 LX43 RZ17
THESE TABLES IDENTIFY ONLY THOSE CIRCUITS REDUNDANT TO A PROTECTED CIRCUIT IN A FIRE AREA/ZONE. WHEN A PROTECTED CIRCUIT HAS NO SPECIFIC REDUNDANT CIRCUIT IN A FIRE AREA, AS DESCRIBED IN THE EXEMPTION REQUEST, THEN THE PROTECTED CIRCUIT IS IDENTIFIED ON THE DRAWING ONLY.				
			CONT ON PAGE 2	

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCE-FB02	TRAY 143 CIRCUIT CG802 CG805 CQ313 CQ323 EA105 EA6822 ED523C LP23 LR23 LX32 MD68 RY4 RY23 	MAKEUP AND SUPPORT FUNCTIONS  RCS PRESSURE  SOURCE RANGE MONITORING  ELECTRICAL POWER SYSTEM	TRAY 136 CIRCUIT CR322A LS21A LT21A  TRAY 137 CIRCUIT CR302B CR305 CR306 CR312C CR314 CR315 CR322A CR322E CR324 CR325 CR336 LS20 LS21 LS21A LT30 ME44 RZ17 LT21A  TRAY 138 CIRCUIT CR302B CR305 CR306 CR312C CR314 CR315 CR322E CR324 CR325 CR336   	MAKEUP AND SUPPORT FUNCTIONS  RCS PRESSURE  SOURCE RANGE MONITORING  ELECTRICAL POWER SYSTEM
			CONT. ON PAGE 3	

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCE-FB02	TRAY 143 CIRCUIT CG802 CG805 CQ313 CQ323 EA105 EA6822 ED523C LP23 LR23 LX32 MD68 RY4 RY23	MAKEUP AND SUPPORT FUNCTIONS  RCS PRESSURE  SOURCE RANGE MONITORING  ELECTRICAL POWER SYSTEM	TRAY 138 CONT CIRCUIT LT30 ME44 RZ17  TRAY 744 CIRCUIT ME5 TRAY 745 CIRCUIT ME5 TRAY 1017 CIRCUIT CR302B CR305 CR306 CR312C CR314 CR315 CR322A CR322E CR324 CR325 CR336 LS20 LS21 LS21A LT21A LT30 ME44  TRAY 1021 CIRCUIT CR322A LS11A LS21A LT21A CONDUIT CS262A CIRCUIT CS262A  CONT ON PAGE 4	MAKEUP AND SUPPORT FUNCTIONS  RCS PRESSURE  SOURCE RANGE MONITORING  ELECTRICAL POWER SYSTEM

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCE-FB02	TRAY 143 CIRCUIT CG802 CG805 CQ313 CQ323 EA105 EA6822 ED523C LP23 LR23 LX32 MD68 RY4 RY23	MAKEUP AND SUPPORT FUNCTIONS  RCS PRESSURE  SOURCE RANGE MONITORING  ELECTRICAL POWER SYSTEM	CONDUIT EA354 CIRCUIT EA354 CONDUIT ED307A CIRCUIT ED307A CONDUIT LS2 CIRCUIT LS2 CONDUIT LSIHA CIRCUIT LSIHA ↓ LS12 CONDUIT LS21 CIRCUIT LS21 CONDUIT LX41 CIRCUIT LS20 ↓ LX41 LX42 LX43	MAKEUP AND SUPPORT FUNCTIONS  RCS PRESSURE  SOURCE RANGE MONITORING  ELECTRICAL POWER SYSTEM



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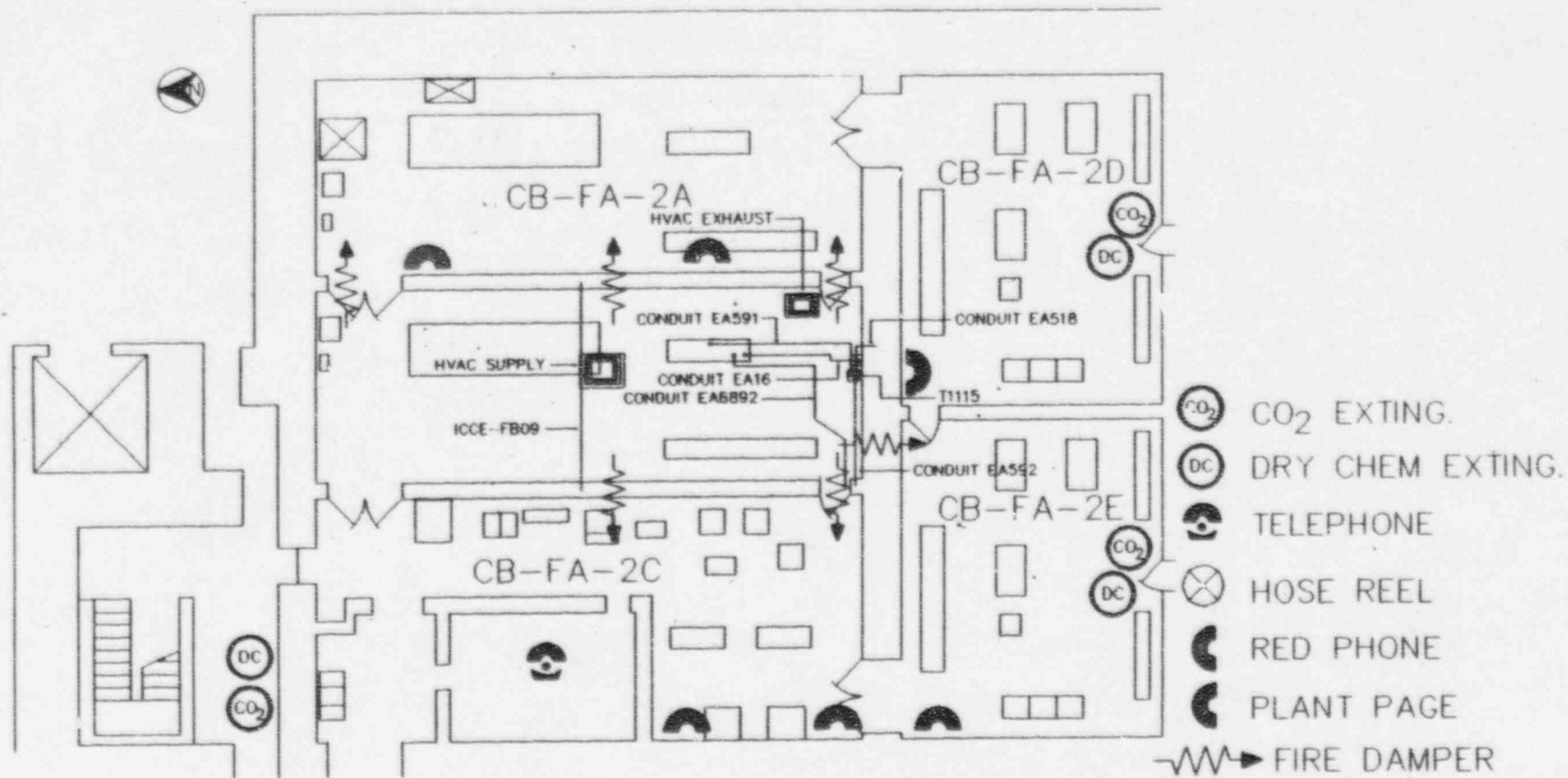


# CB-FA-2B

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCE-FB03	CONDUIT RE465 CIRCUIT RE465 ↓ RE473 RE510 ↓ RE514	STEAM GENERATOR PRESSURE AND LEVEL	TRAY 134 CIRCUIT EA6851A ↓ EA6854A TRAY 136 CIRCUIT EA6851A ↓ EA6854A TRAY 137 CIRCUIT EA6851A ↓ EA6854A TRAY 138 CIRCUIT EA6851A ↓ EA6854A TRAY 1021 CIRCUIT EA6851A ↓ EA6854A	STEAM GENERATOR PRESSURE AND LEVEL

# CB-FA-2B

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCE-FB09	CONDUIT EA6912 CIRCUIT EA6912	ELECTRICAL POWER SYSTEM	CONDUIT EA16 CIRCUIT EA16 CONDUIT EA518 CIRCUIT EA518 CONDUIT EA591 CIRCUIT EA591 CONDUIT EA592 CIRCUIT EA592 CONDUIT EA6892 CIRCUIT EA6892	ELECTRICAL POWER SYSTEM

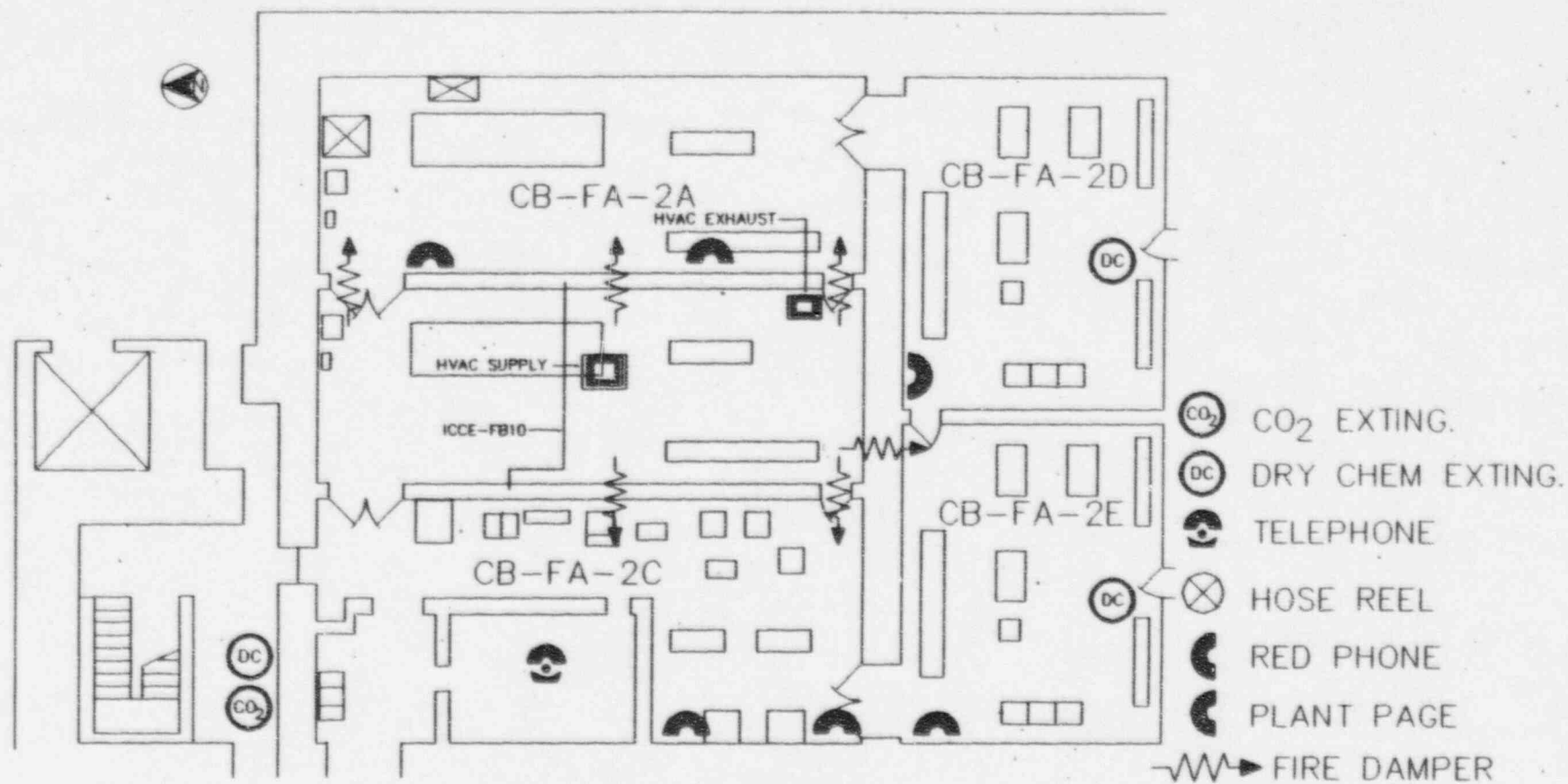


CONTROL BUILDING ELEV. 322

CB-FA-2B

ICCE-FB09 / EA6912

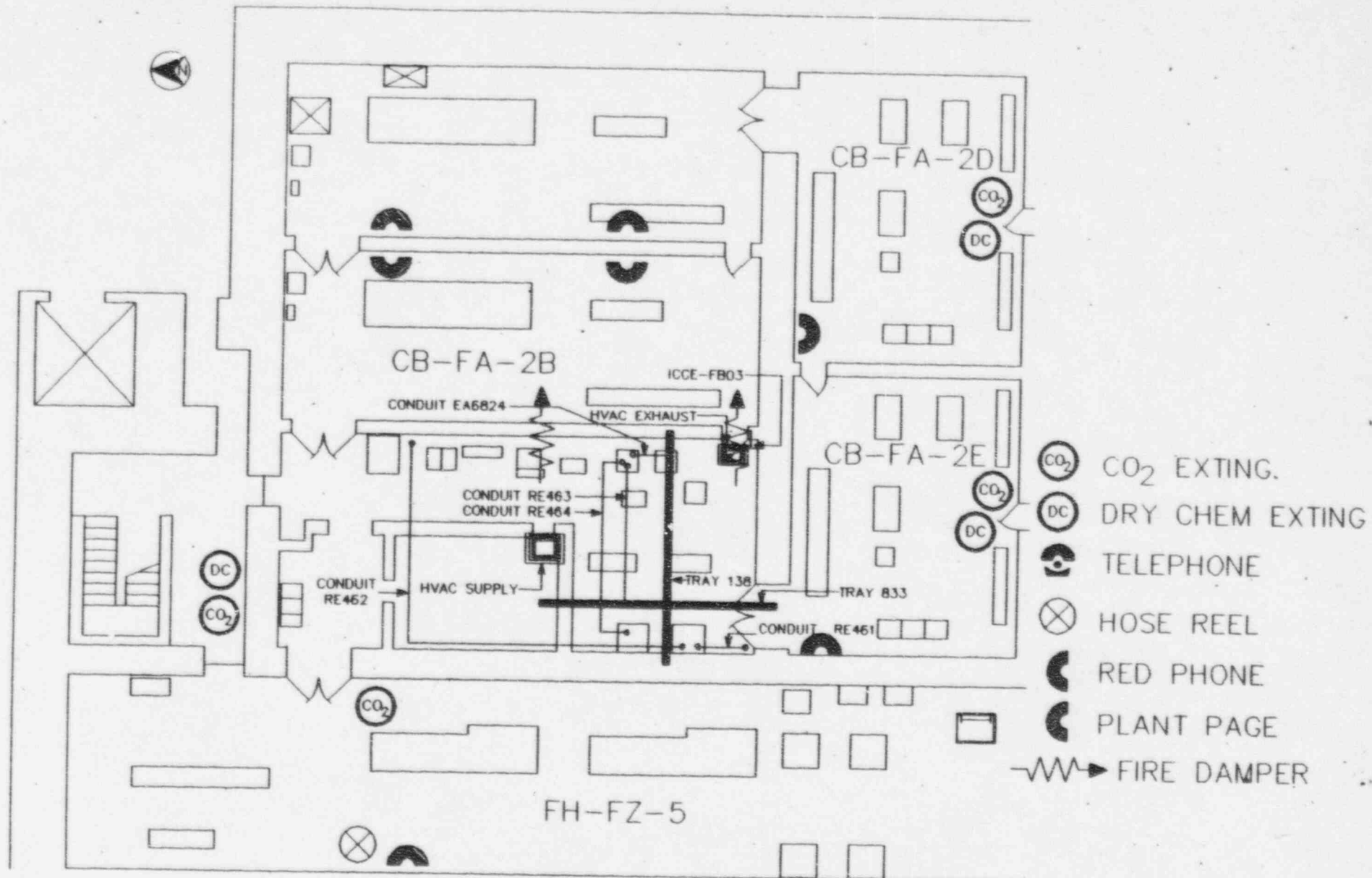
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CONTROL BUILDING ELEV. 322'

CB-FA-2B  
ICCE-FB10 / EA339

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CONTROL BUILDING ELEV. 322'

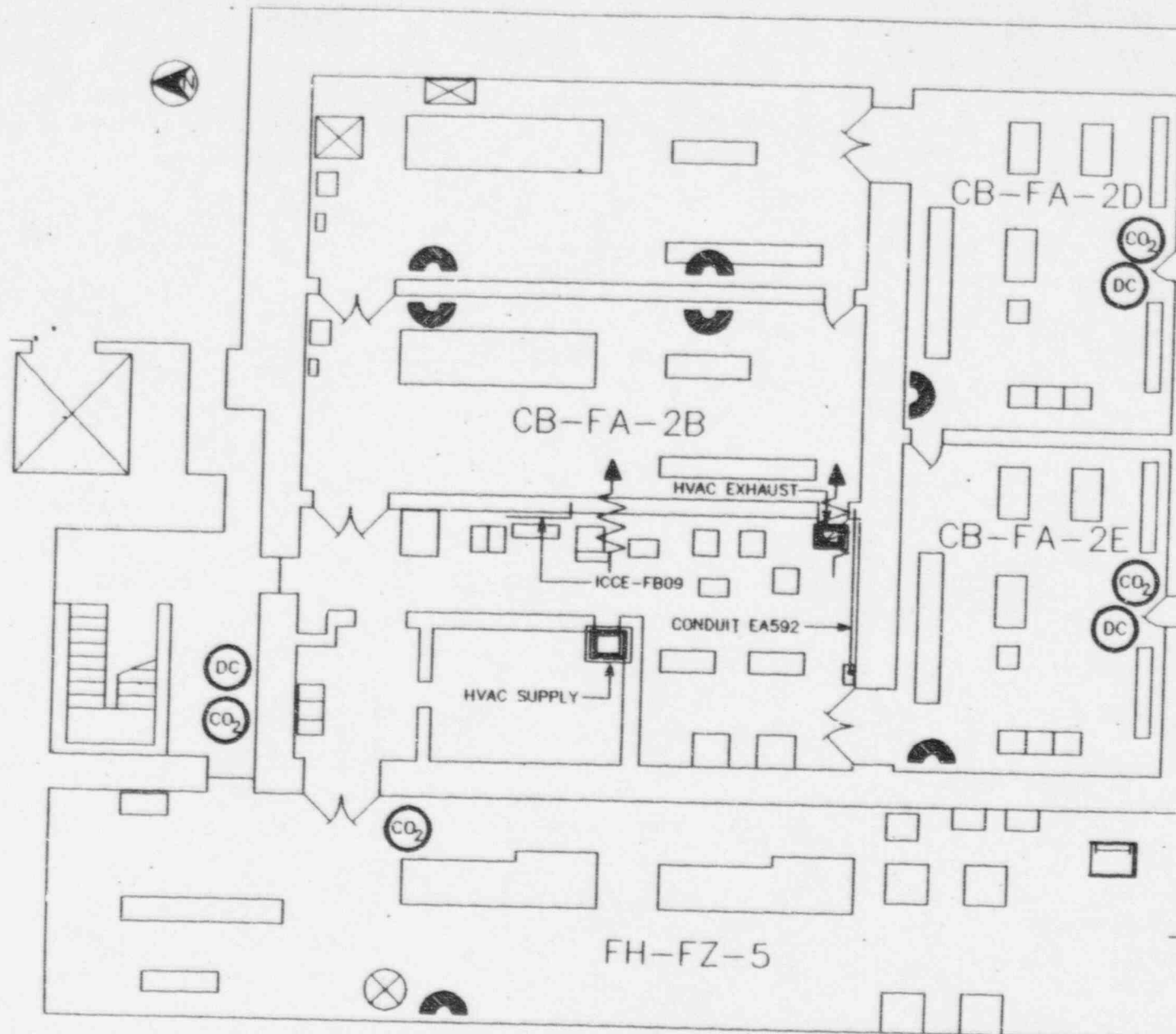
CB-FA-2C








ICCE-FB03 / RE465, RE514, RE473, RE510



CB-FA-2C

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCE-FB03	CONDUIT RE465 CIRCUIT RE465 ↓ RE 473 RE 510 ↓ RE 514	STEAM GENERATOR PRESSURE AND LEVEL	CONDUIT EAG824 CIRCUIT EAG851A ↓ EA6854A TRAY 138 CIRCUIT EA6851A ↓ EA6854A CONDUIT RE463 CIRCUIT RE467 ↓ RE475 RE479 RE499 RE512 RE513 RE517 TRAY 033 CIRCUIT RE467 ↓ RE475 RE479 RE499 RE512 RE513 RE517 CONDUIT RE464 CIRCUIT RE468 ↓ RE476 RE480 RE500 CONDUIT RE478 CIRCUIT RE478 CONDUIT RE526 CIRCUIT RE526	STEAM GENERATOR PRESSURE AND LEVEL

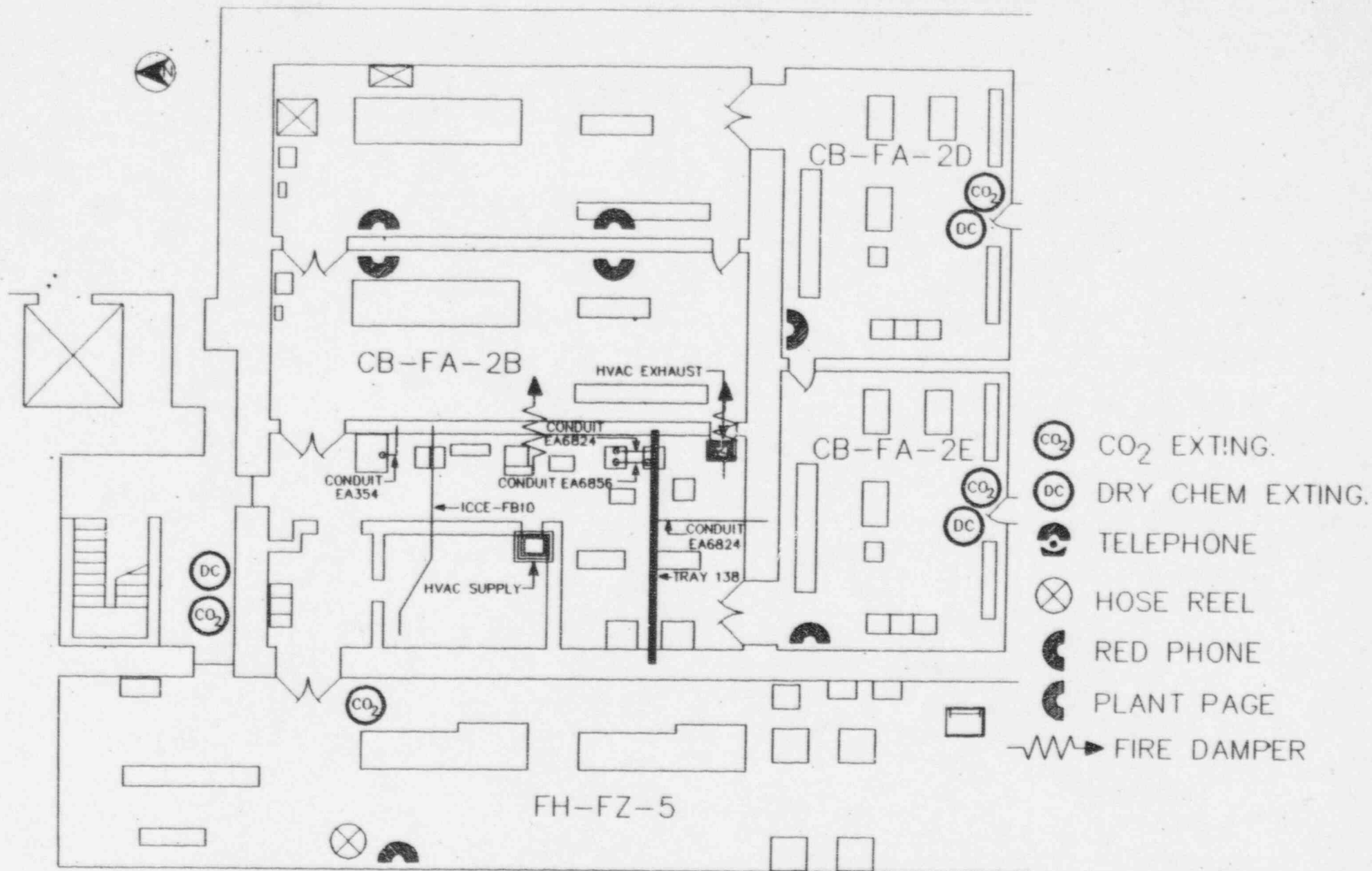


-  CO2 EXTING.
-  DRY CHEM EXTING.
-  TELEPHONE
-  HOSE REEL
-  RED PHONE
-  PLANT PAGE.
-  FIRE DAMPER

CONTROL BUILDING ELEV. 322'  
 CB-FA-2C  
 ICCE-FB09 / EA6912

# CB - FA - 2C

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCE-FB09	CONDUIT EA6912 CIRCUIT EA6912	ELECTRICAL POWER SYSTEM	CONDUIT EA592 CIRCUIT EA592	ELECTRICAL POWER SYSTEM



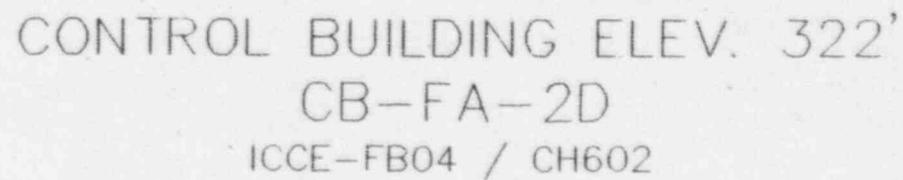
CONTROL BUILDING ELEV. 322'

CB-FA-2C  
ICCE-FB10 / EA339

CB-FA-2C

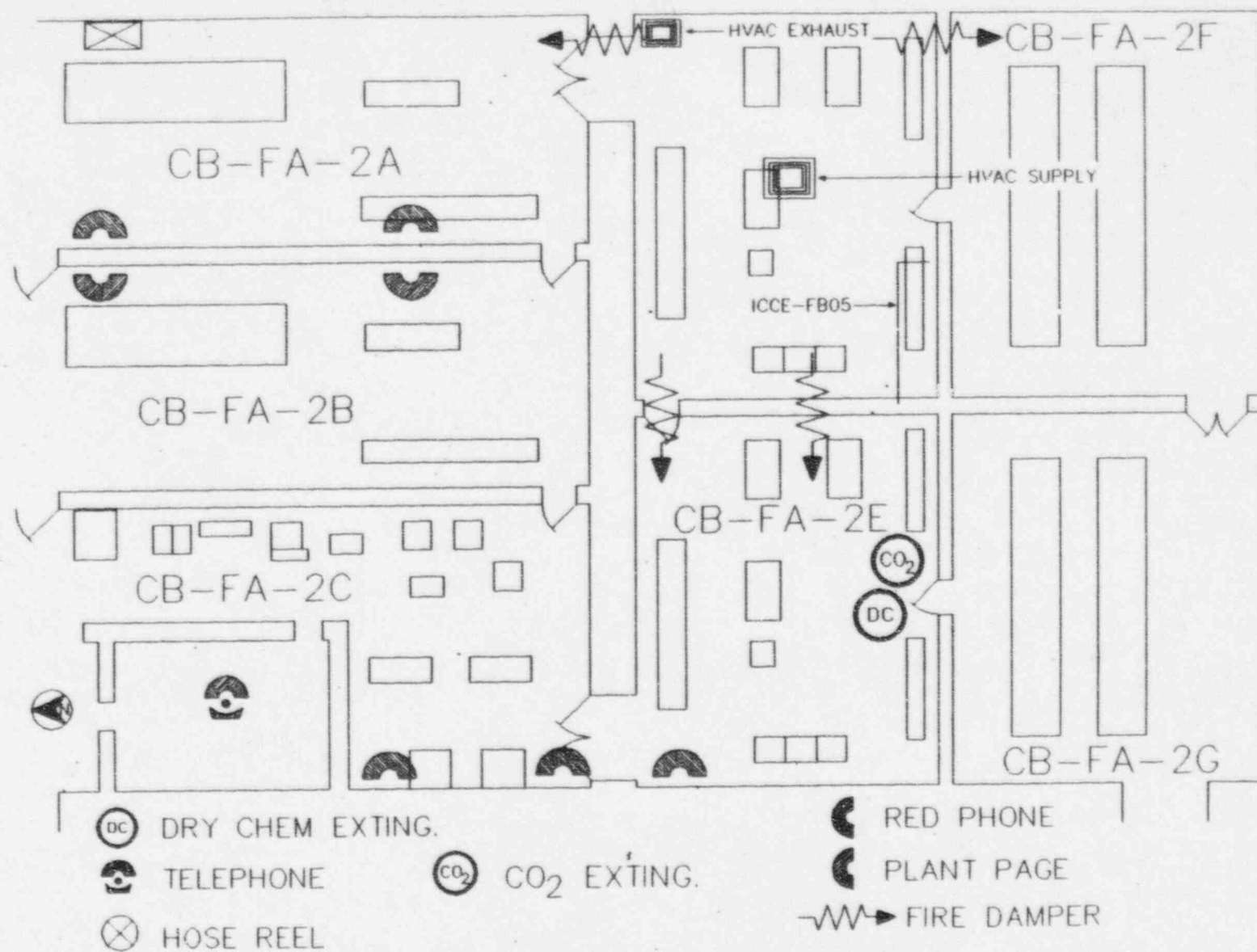
ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCE-FBIO	CONDUIT EA339 CIRCUIT EA339	ELECTRICAL POWER SYSTEM	CONDUIT EA354 CIRCUIT EA354 CONDUIT EA6856 CIRCUIT EA6856 CONDUIT EA6824 CIRCUIT EA6824 TRAY # 138 CIRCUIT EA6824	ELECTRICAL POWER SYSTEM



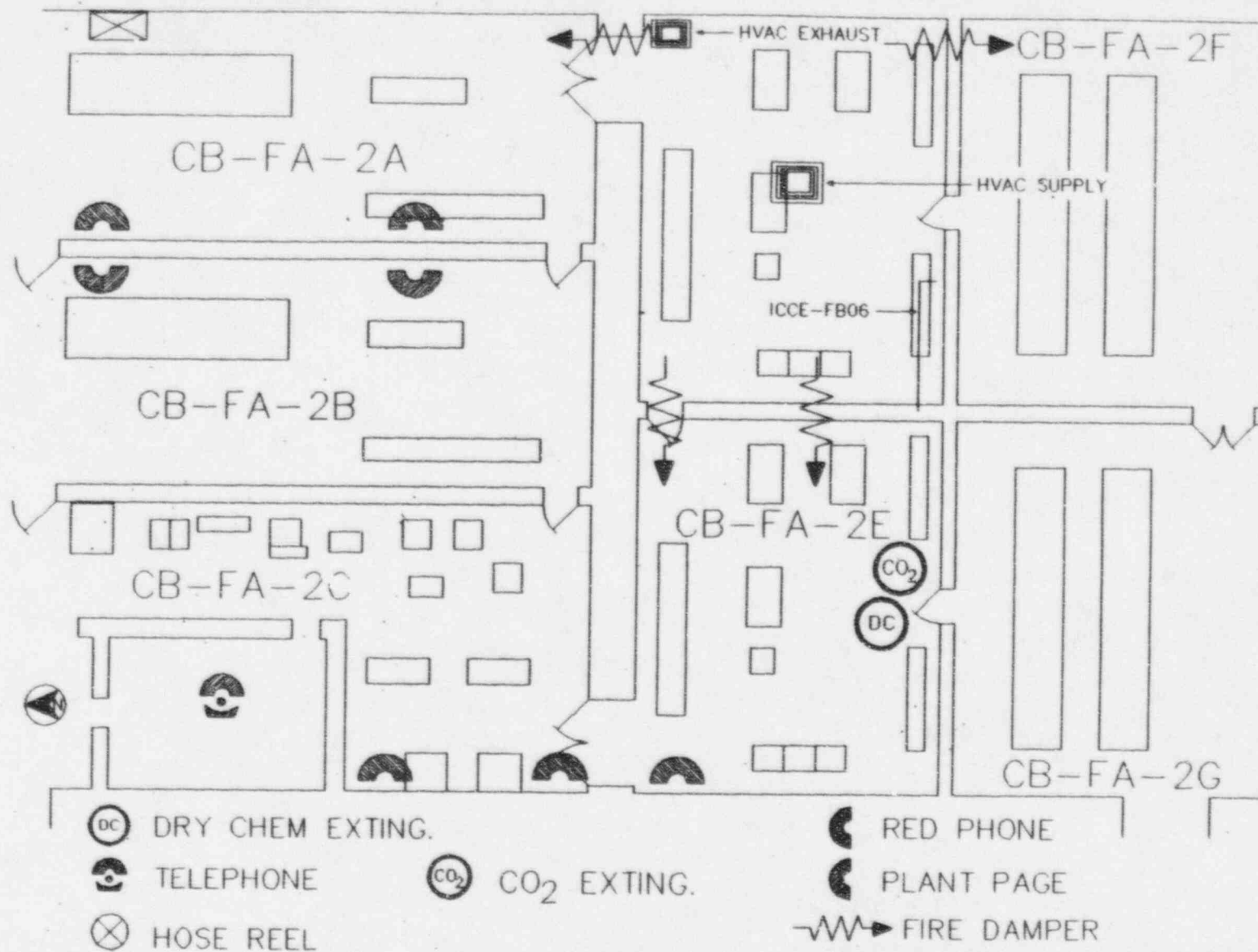


# CB-FA-2D

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCE-FB04	CONDUIT CH602 CIRCUIT CH602	RCP THERMAL BARRIER COOLING	TRAY 144 CIRCUIT CG681 ↓ CG684	RCP THERMAL BARRIER COOLING  SEAL INJECTION

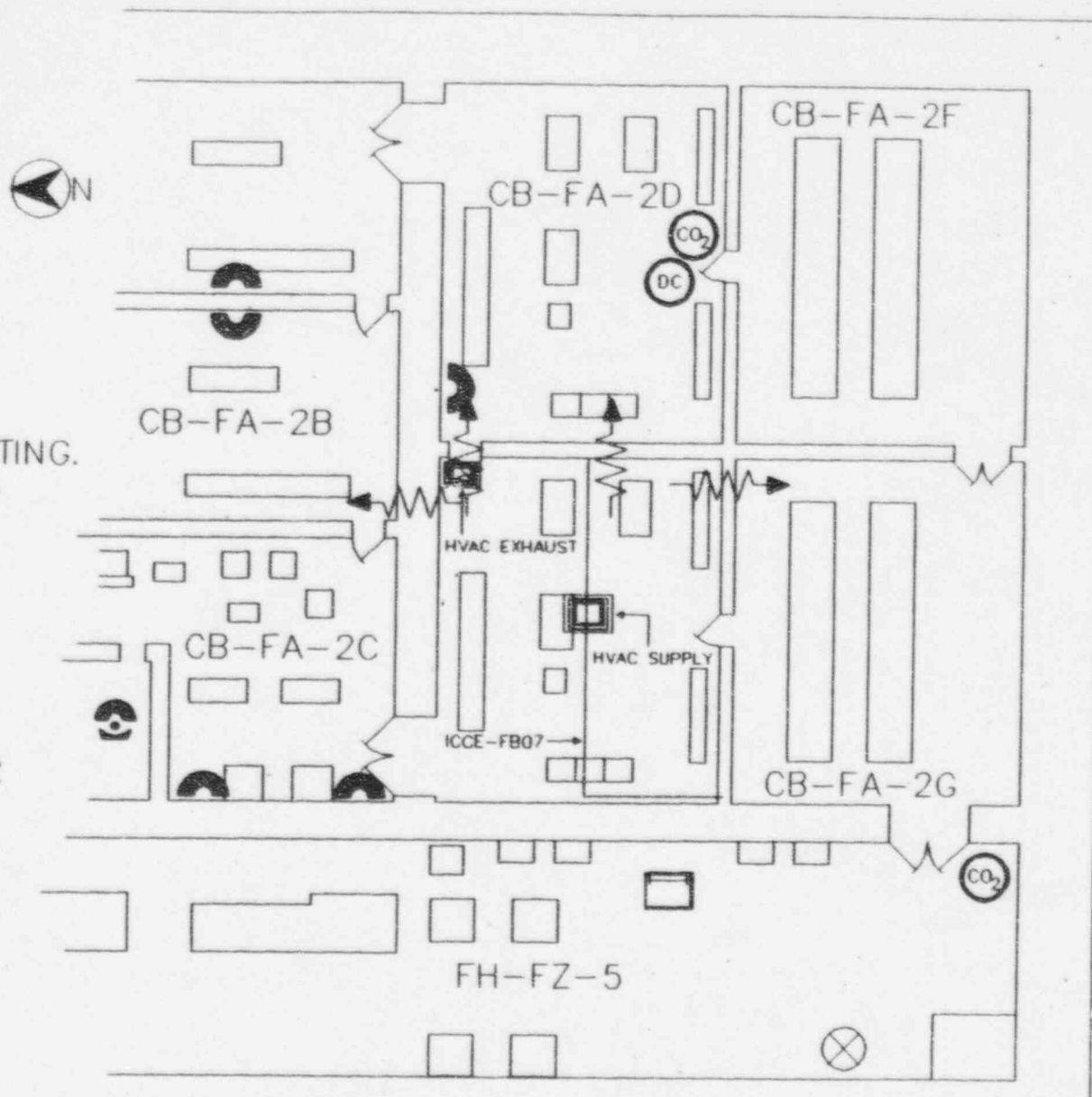


CONTROL BUILDING ELEV. 322'  
 CB-FA-2D  
 ICCE-FB05 / RU288



CONTROL BUILDING ELEV. 322'  
 CB-FA-2D  
 ICCE-FB06 / RU282

- ⊙ CO<sub>2</sub> CO<sub>2</sub> EXTING.
- ⊙ DC DRY CHEM EXTING.
- ☎ TELEPHONE
- ⊗ HOSE REEL
- ☎ RED PHONE
- ☎ PLANT PAGE
- ~> FIRE DAMPER



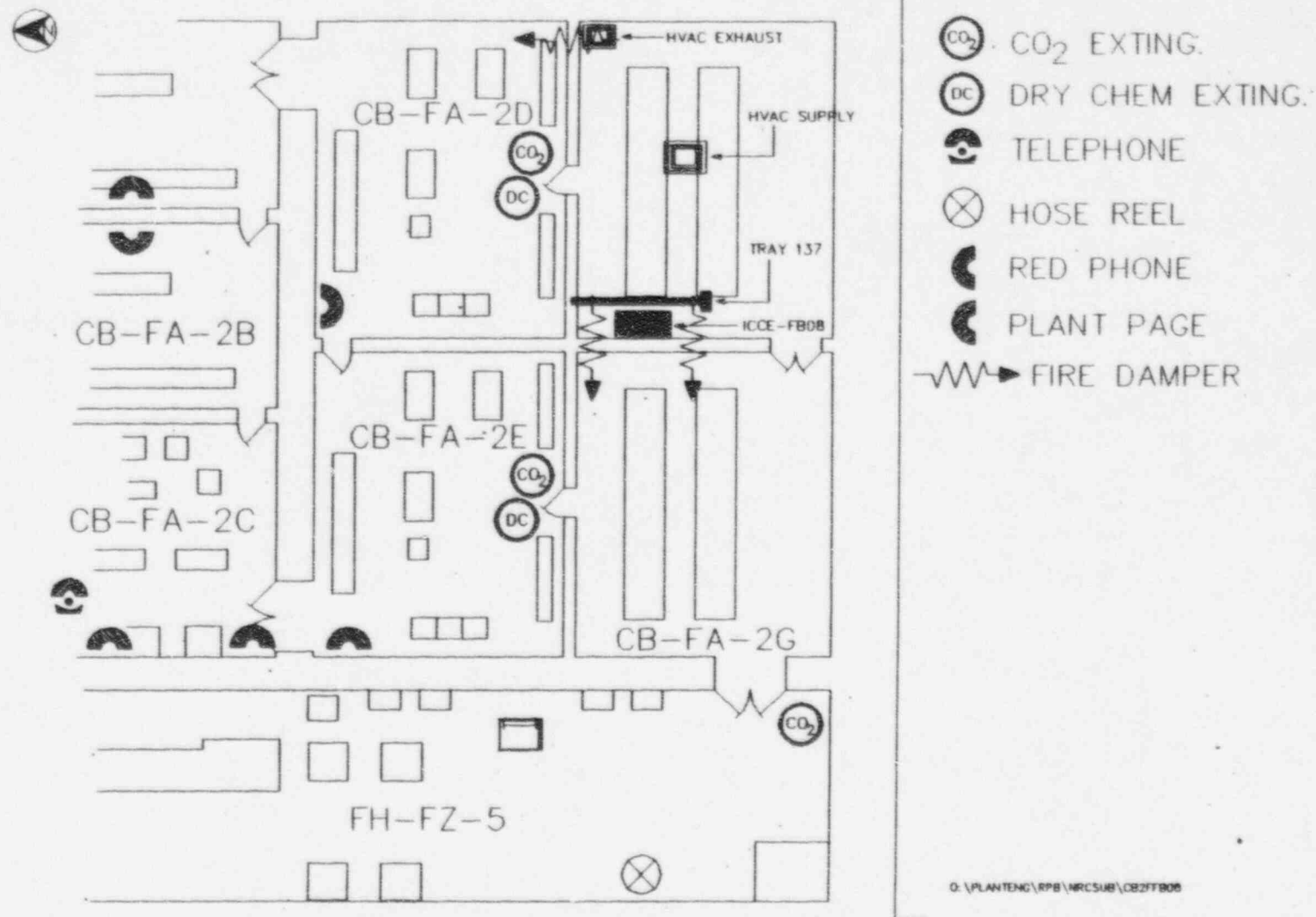
CONTROL BUILDING ELEV. 322'

CB-FA-2E

ICCE-FB07 / EA6041A

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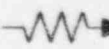


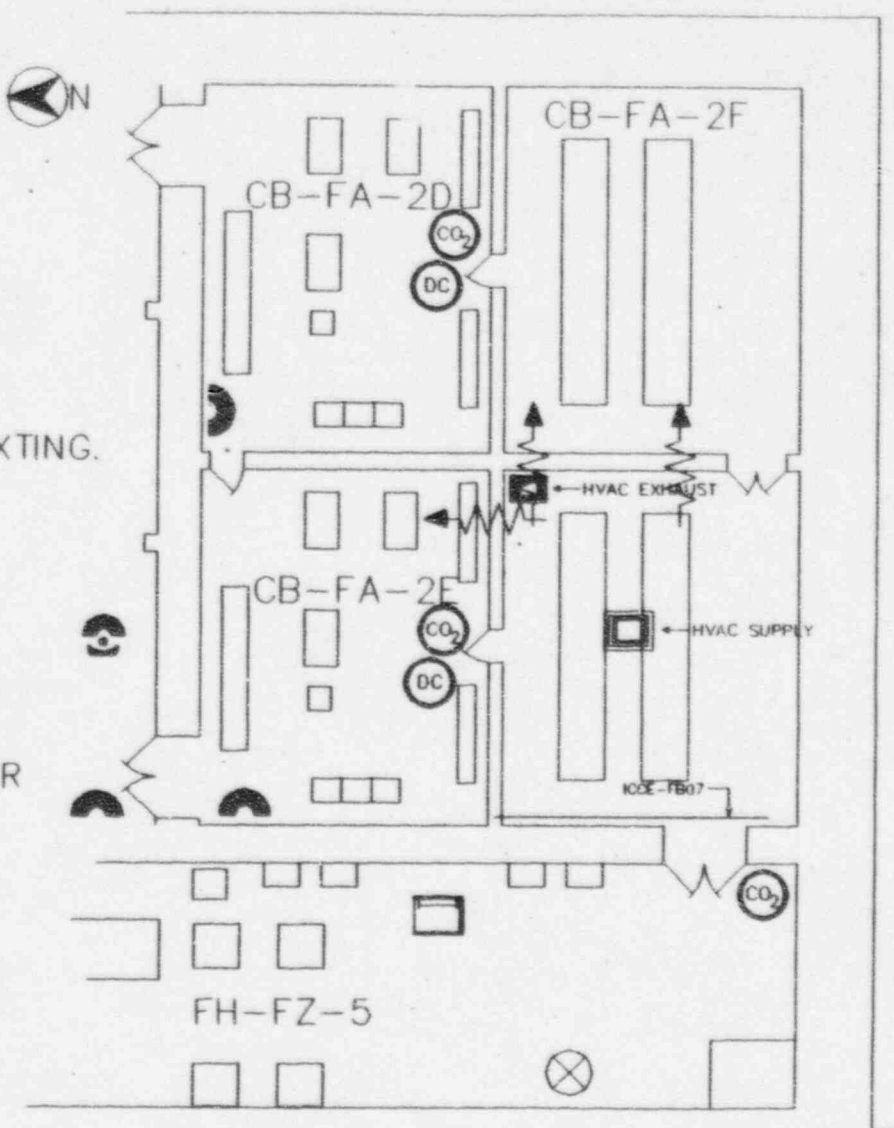


CONTROL BUILDING ELEV. 322'  
 CB-FA-2F  
 ICCE-FB08 / CH201A, CH201B

# CB-FA-2F

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCE-FB08	SPLICE BOX S-16 CIRCUIT CH201A ↓ CH201B CONDUIT CH201A CIRCUIT CH201A CONDUIT CH201B CIRCUIT CH201B TRAY 1017 CIRCUIT CH201A TRAY 137 CIRCUIT CH201A ↓ CH201B	MAKEUP AND SUPPORT FUNCTIONS	TRAY 137 CIRCUIT CR215	MAKEUP AND SUPPORT FUNCTIONS

-  CO<sub>2</sub> EXTING.
-  DRY CHEM EXTING.
-  TELEPHONE
-  HOSE REEL
-  RED PHONE
-  PLANT PAGE
-  FIRE DAMPER

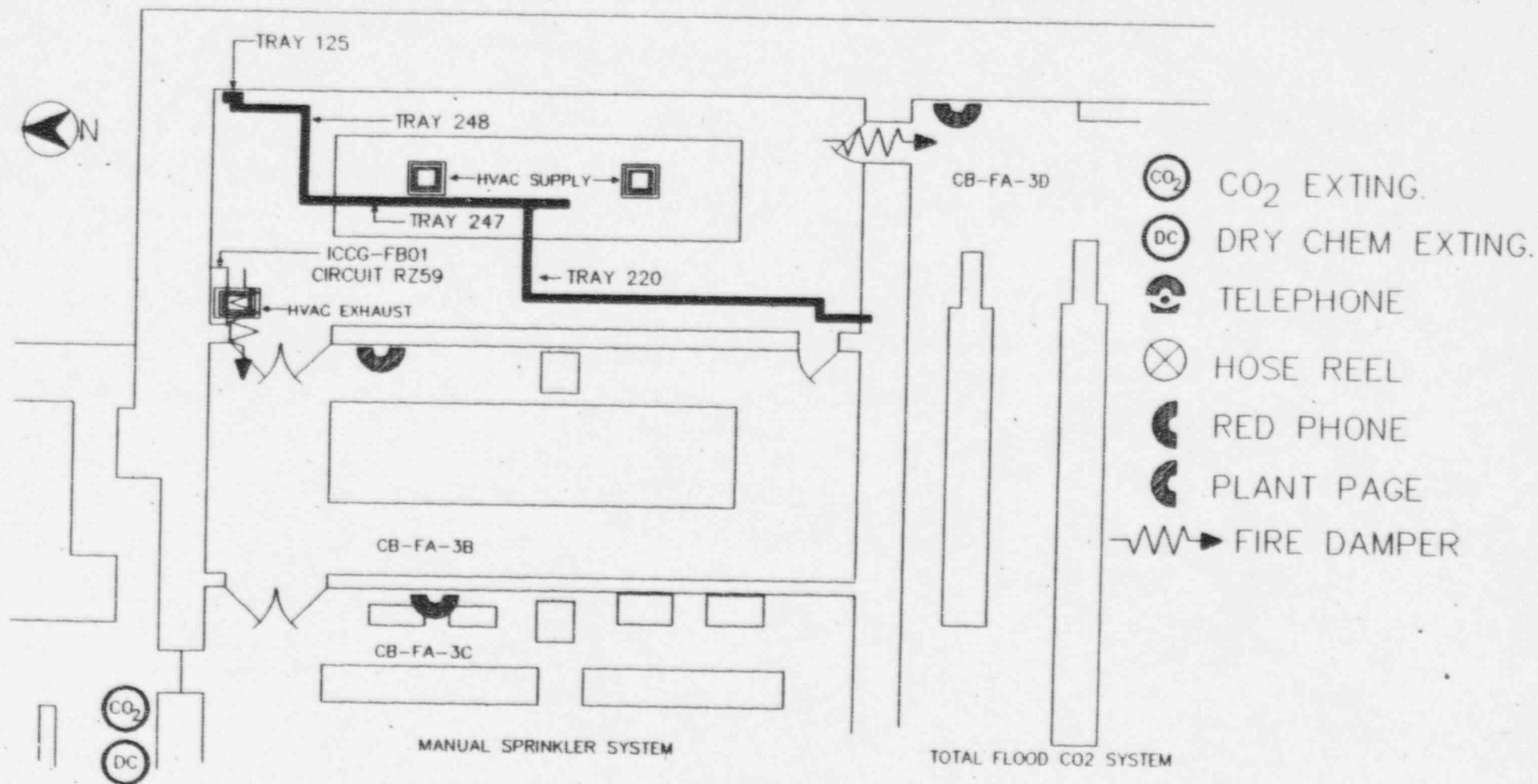


CONTROL BUILDING ELEV. 322'

CB-FA-2G

ICCE-FB07 / EA6041A

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CONTROL BUILDING ELEV. 338'

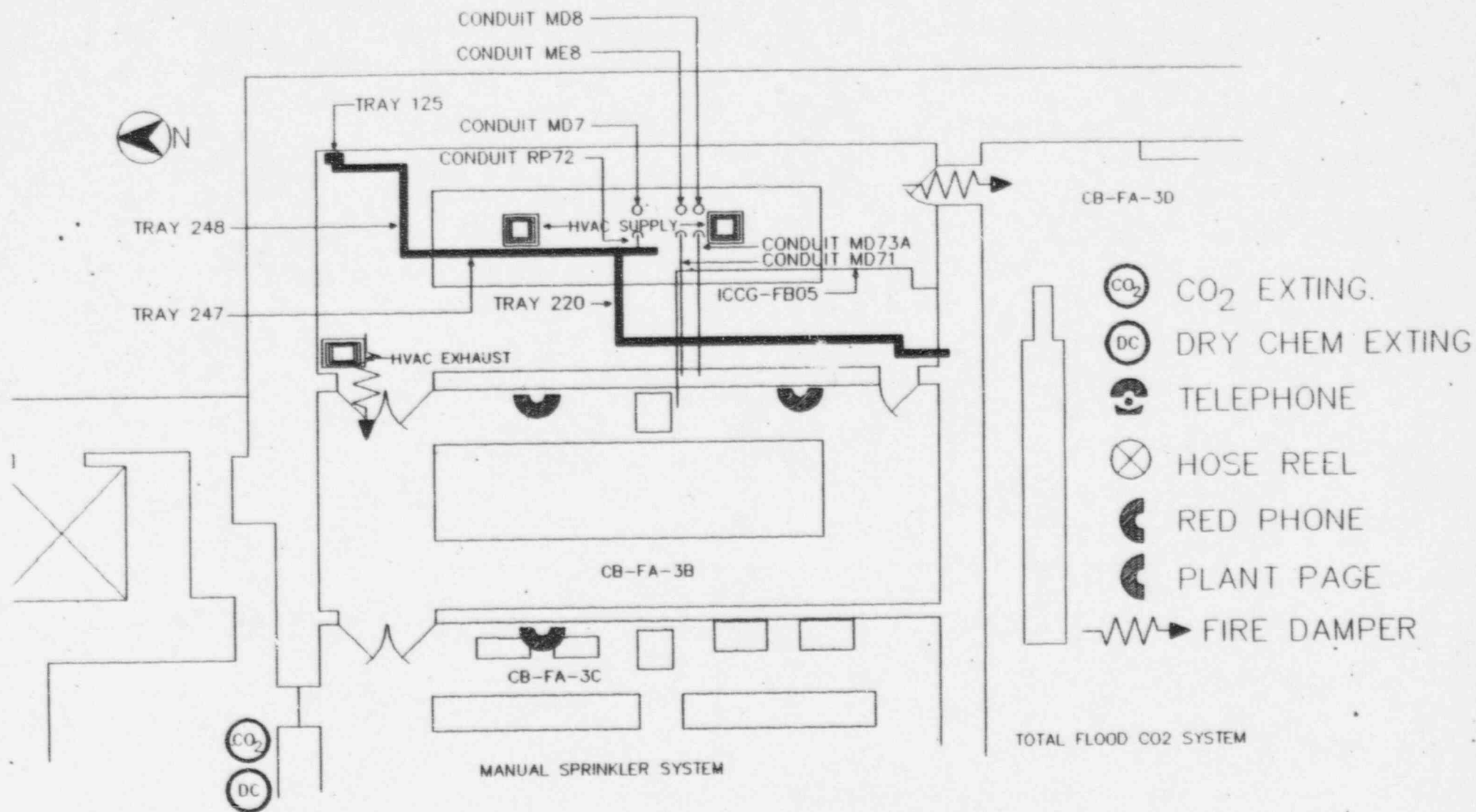
CB-FA-3A

ICCG-FB01 / RZ59

# CB-FA-3A

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCG-FB01	CONDUIT R259 CIRCUIT R259	ELECTRICAL POWER SYSTEM	TRAY 125 CIRCUIT G171 TRAY 247 CIRCUIT G171 TRAY 220 CIRCUIT G171 TRAY 248 CIRCUIT G171	ELECTRICAL POWER SYSTEM





CONTROL BUILDING ELEV. 338'

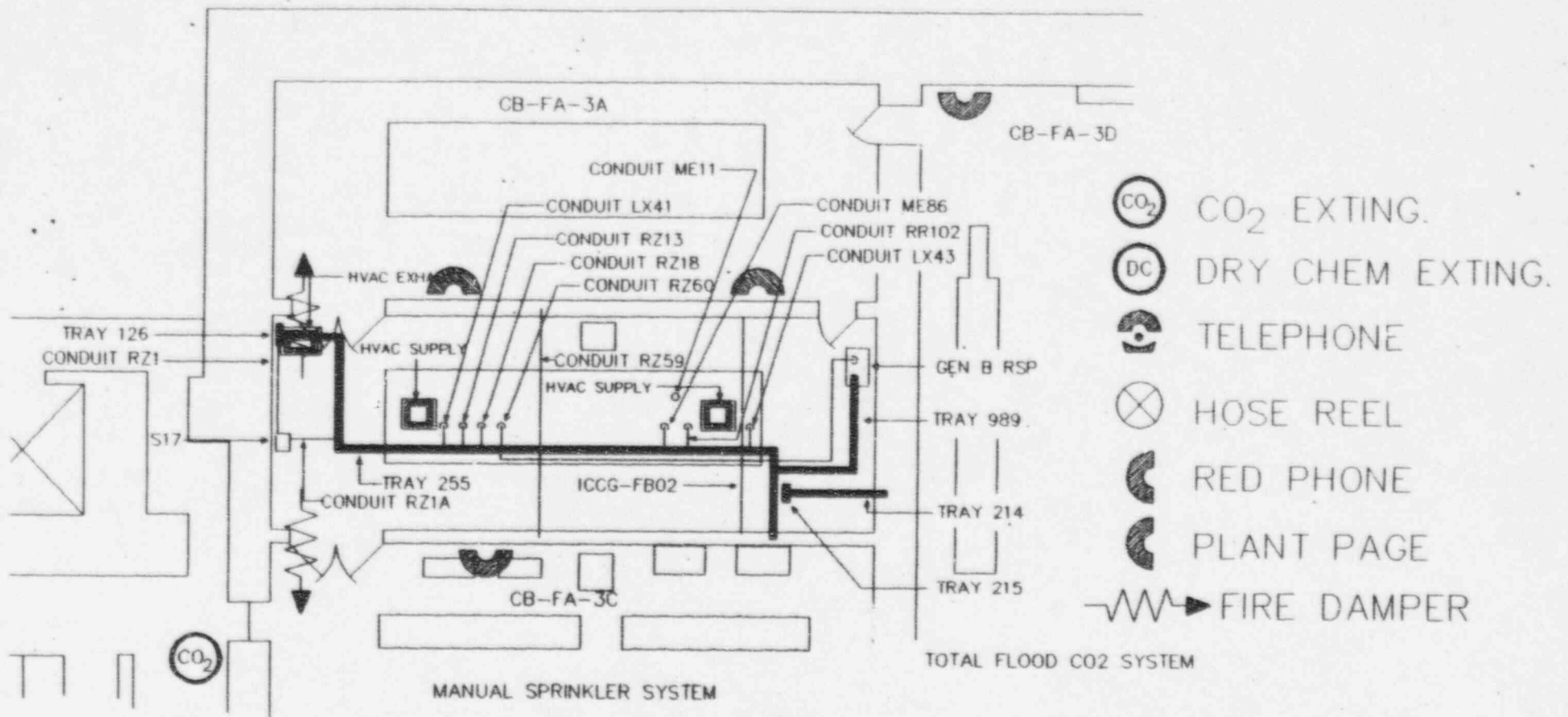
CB-FA-3A

ICCG-FB05 / RV28

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## CB-FA-3A

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCG-FB05	CONDUIT RV28 CIRCUIT RV28	RCP THERMAL BARRIER COOLING	TRAY 125 CIRCUIT MD68 TRAY 248 CIRCUIT MD68 TRAY 247 CIRCUIT MD65A ↓ MD66 MD68 TRAY 220 CIRCUIT MD65A ↓ MD66 CONDUIT MD8 CIRCUIT MD8 CONDUIT ME8 CIRCUIT ME8 CONDUIT MD7 CIRCUIT MD7 CONDUIT RP72 CIRCUIT MD65A ↓ MD66 MD68 CONDUIT MD73A CIRCUIT MD73A CONDUIT MD71 CIRCUIT MD71 CONDUIT RV28 CIRCUIT RV343	SEAL INJECTION



CONTROL BUILDING ELEV. 338'

CB-FA-3B

ICCG-FB02 / RY5, RY6, LX52

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ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
1CCG-FB02	CONDUIT RP71 CIRCUIT LX52 ↓ RYS RY6	ELECTRICAL POWER SYSTEM	TRAY 126 CIRCUIT ↓ LT12B RZ1 RZ2 RZ3 RZ8 RZ13 RZ14 RZ15 RZ16 RZ17 RZ21 RZ22 RZ23 RZ33 RZ34 RZ35 RZ53 RZ55 TRAY 255 CIRCUIT ↓ LT12B LX61 LX62 LX63A ME86 RZ1A RZ1B RZ2A RZ2B RZ4 RZ5 RZ6 RZ3A RZ3B CONT. ON PAGE 2	ELECTRICAL POWER SYSTEM

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
1 CCG-FB02	CONDUIT RP71 CIRCUIT LX52 ↓ RY5 RY6	ELECTRICAL POWER SYSTEM	TRAY 255 CONT. CIRCUIT RZ8A ↓ RZ8C RZ8B RZ13 RZ14 RZ15 RZ16 RZ17 RZ18 RZ19 RZ21A RZ21B RZ22A RZ22B RZ23A RZ23B RZ33A RZ34A RZ34B RZ35A RZ35B RZ36 RZ53B RZ55 RZ56 ↓ TRAY 214 CIRCUIT RZ1B ↓ RZ2B RZ3B RZ5 RZ6 RZ8C RZ21B ↓ CONT ON PAGE 3	ELECTRICAL POWER SYSTEM



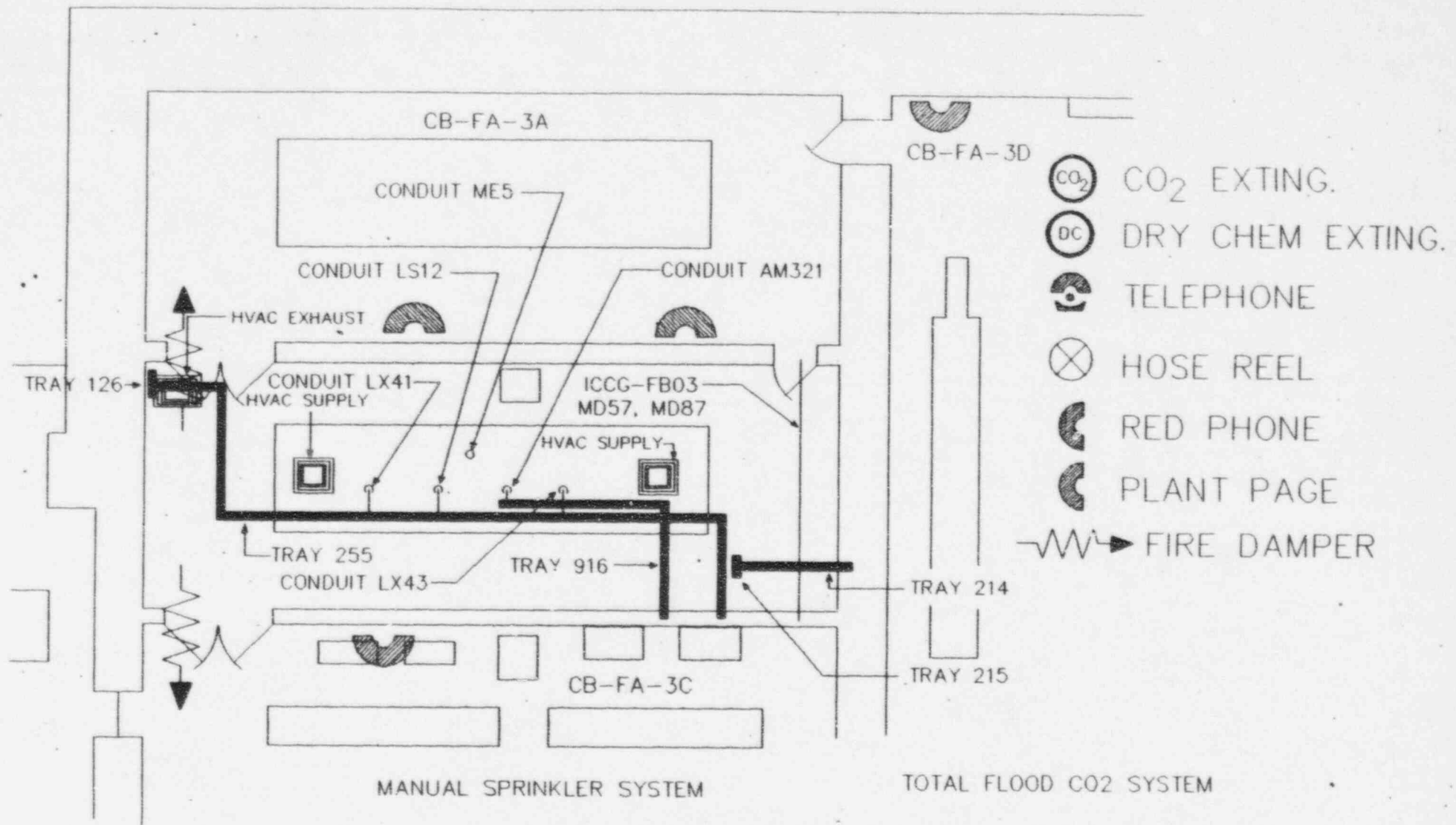
ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
1CCG-FB02	CONDUIT RP71 CIRCUIT LX52 ↓ RY5 RY6	ELECTRICAL POWER SYSTEM	TRAY 214 CONT. CIRCUIT RZ 22B ↓ RZ 34B RZ 35B ME 86 TRAY 215 CIRCUIT ME 86 ↓ RZ 1B RZ 2B RZ 3B RZ 5 RZ 6 RZ 8C RZ 21B RZ 22B RZ 34B RZ 35B TRAY 989 CIRCUIT RZ 1A ↓ RZ 1B RZ 2A RZ 2B RZ 3A RZ 3B RZ 4 RZ 8A RZ 8B RZ 8C RZ 18 RZ 19 RZ 21A RZ 21B RZ 22A RZ 22B CONT ON PAGE 4	ELECTRICAL POWER SYSTEM

## CB-FA-3B

PAGE 4

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCG-FB02	CONDUIT RP71 CIRCUIT LX52 ↓ RY5 RY6	ELECTRICAL POWER SYSTEM	TRAY 989 CONT. CIRCUIT RZ23A RZ23B RZ33A RZ34A RZ34B RZ35A RZ35B RZ36 RZ53B RZ56 ↓ CONDUIT RZ1 CIRCUIT RZ1 RZ2 RZ3 RZ8 RZ21 RZ22 RZ23 RZ33 RZ34 RZ35 RZ53 ↓ CONDUIT RZ1A CIRCUIT RZ1A RZ2A RZ3A RZ8A RZ21A RZ22A RZ23A RZ33A RZ34A RZ35A ↓ CONT ON PAGE 5	ELECTRICAL POWER SYSTEM

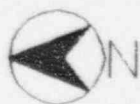
ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCG-FB02	CONDUIT RP71 CIRCUIT LX52 ↓ RY5 RY6	ELECTRICAL POWER SYSTEM	CONDUIT RZ1A CONT. CIRCUIT RZ53B CONDUIT LX41 CIRCUIT LX61 ↓ LX62 LX63A CONDUIT RZ13 CIRCUIT RZ13 ↓ RZ14 RZ15 RZ36 RZ55 RZ56 CONDUIT RZ18 CIRCUIT RZ8B ↓ RZ18 RZ19 CONDUIT RZ60 CIRCUIT RZ60 CONDUIT RZ59 CIRCUIT RZ59 CONDUIT ME11 CIRCUIT ME11 CONDUIT ME86 CIRCUIT ME86 CONDUIT RR10Z CIRCUIT LT12B CONDUIT LX43 CIRCUIT LX63A	ELECTRICAL POWER SYSTEM



CONTROL BUILDING ELEV. 338'

CB-FA-3B

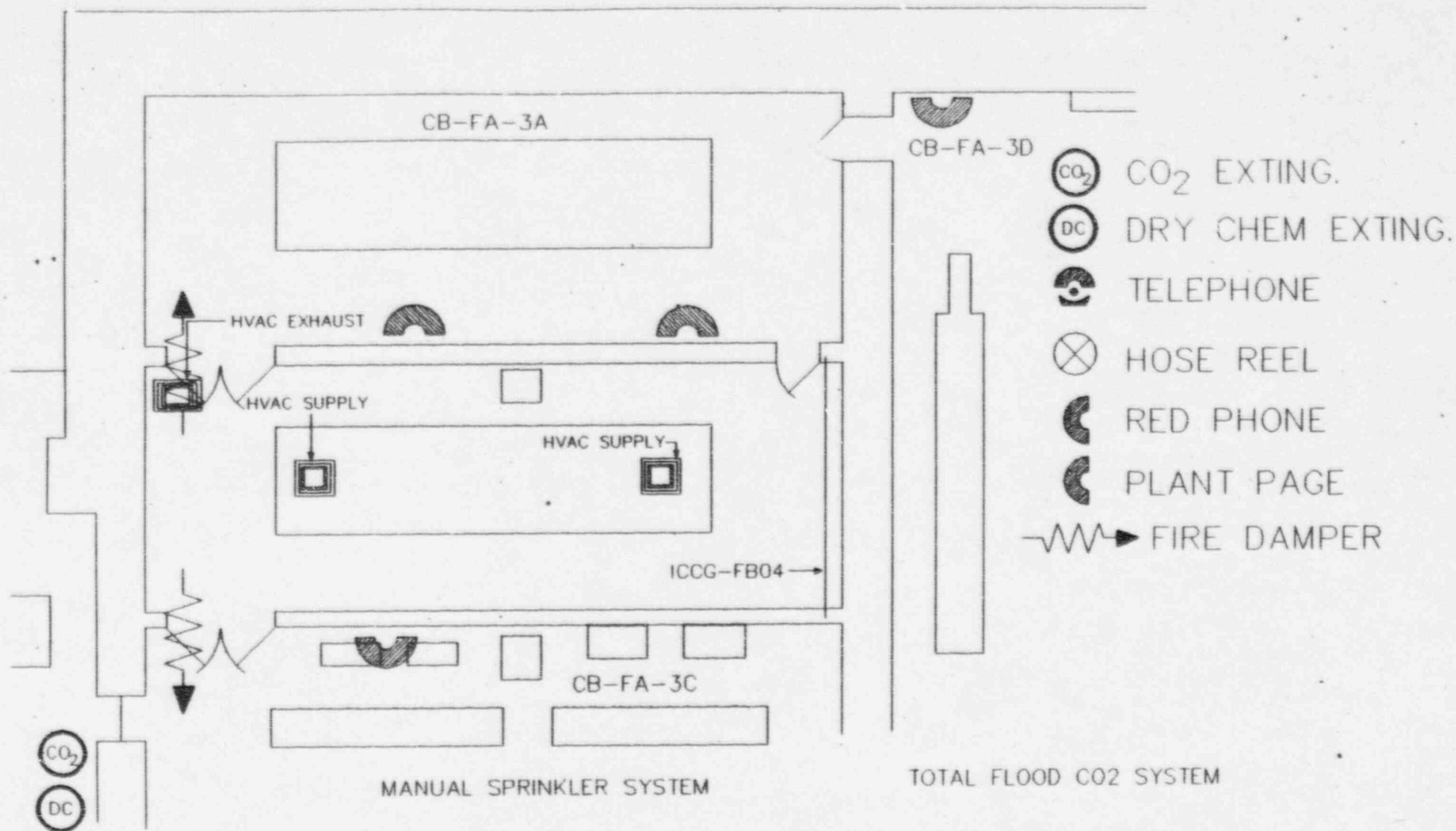
ICCG-FB03 / MD57, MD87



# CB-FA-3B

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCG-FB03	CONDUIT MD57 CIRCUIT MD57	ELECTRICAL POWER SYSTEM	TRAY 126 CIRCUIT LS12 LX41 LX42 LX43 ↓ TRAY 255 CIRCUIT LS12 LX41 LX42 LX43 ME56 ↓ TRAY 214 CIRCUIT ME56 TRAY 215 CIRCUIT ME56 TRAY 216 CIRCUIT ME57 CONDUIT LS12 CIRCUIT LS12 ↓ ME56 CONDUIT LX41 CIRCUIT LX41 CONDUIT LX43 CIRCUIT LX43 CONDUIT ME5 CIRCUIT ME5 CONDUIT AM321 CIRCUIT ME57	ELECTRICAL POWER SYSTEM



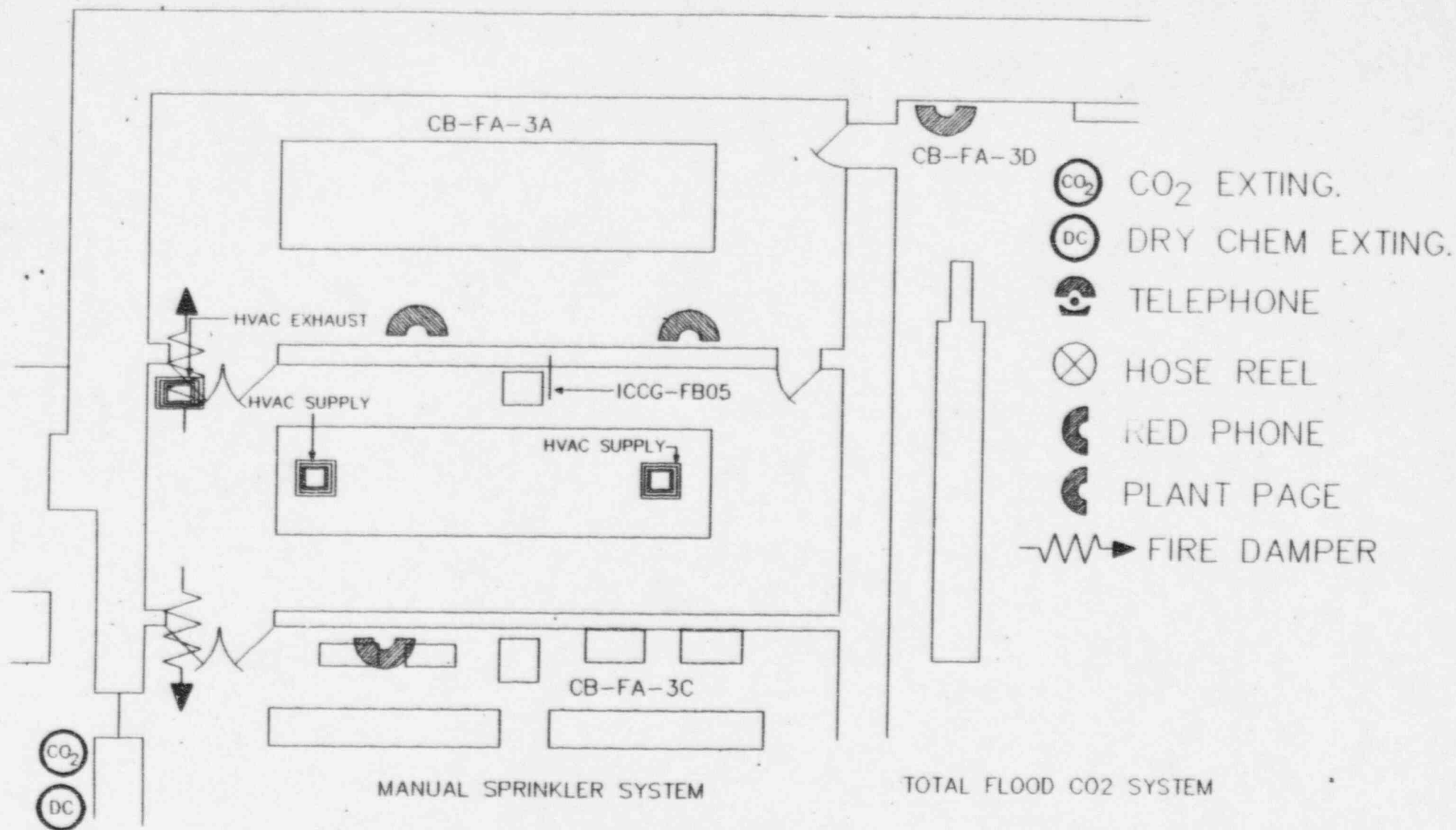


CONTROL BUILDING ELEV. 338'

CB-FA-3B

ICCG-FB04 / RG201

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CONTROL BUILDING ELEV. 338'

CB-FA-3B

ICCG-FB05 / RV28



CO<sub>2</sub> EXTING.



DC DRY CHEM EXTING.



TELEPHONE



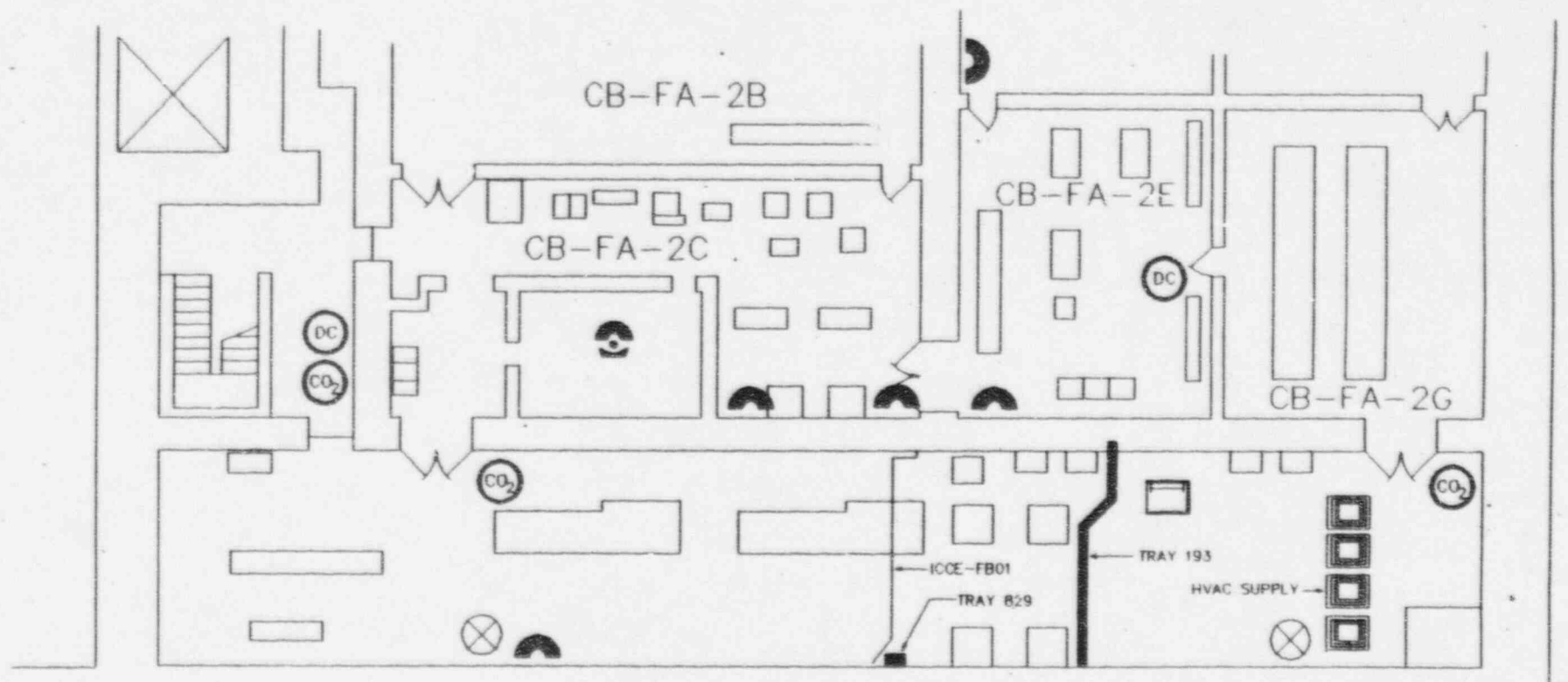
HOSE REEL



RED PHONE



PLANT PAGE



CONTROL BUILDING ELEV. 322'  
FH-FZ-5

ICCE-FB01 / CR232C, CR362, CR365B

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# FH-FZ-5

ENVELOPE	PROTECTED CIRCUIT	PROTECTED FUNCTION	REDUNDANT CIRCUIT	REDUNDANT FUNCTION
ICCE-FB01	CONDUIT CR232C CIRCUIT CR232C ↓ CR362 CR365B	MAKEUP FUNCTIONS  RCP THERMAL BARRIER COOLING	TRAY 829 CIRCUIT RE345 TRAY 193 CIRCUIT CN616	MAKEUP FUNCTIONS  SEAL INJECTION