FIRE TEST PROCEDURE FOR CABLE
AND PIPE PENETRATIONS

CALVERT CLIFFS NUCLEAR POWER PLANT
UNITS 1 & 2

BALTIMORE GAS AND ELECTRIC COMPANY

Prepared By Iremnath Bhatia Date Jan 11, 80

Reviewed By _____ Date _____

Reviewed By R. L. Hunter Date Jan 14, 1980

Approved By _____ Date _____

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CONTENTS

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CALVERT CLIFFS NUCLEAR POWER PLANT

Sponsor: Baltimore Gas and Electric Company

Laboratory:

A. Purpose:

The purpose of this test is to evaluate the existing cable and pipe penetration fire stop design and construction in order to qualify them by test at an independent test laboratory per ASTM E-119-1976 Standard Time-Temperature Curve for the required three hour separation. In addition, other materials will be tested and evaluated simultaneously which may be utilized, if required.

B. Scope:

1. Test shall be conducted on a custom concrete slab having both a 1'-0" and a 2'-0" thick segment with an assortment of blockouts as shown in Figure 1. It shall be fire endurance tested for a minimum of three hours in accordance with ASTM E-119-1976 Standard Time-Temperature Curve and hose stream test shall be performed per IEEE Std. 634-1978, Section 5.3.12, except for the use of a nozzle from the Sponsor's inventory.
2. A single test, having various fire stop penetration configurations as shown on Figure 2 through 6, shall be conducted within thirty (30) days of issuance of a written Purchase Order to proceed.
3. Each arrangement, i.e., each of six trays, three raceway blockouts and two cast-in-place elements, shall be installed, supported, tested and reported independently from every other arrangement, thus constituting eleven concurrent fire endurance and hose stream tests.

4. The fire stop assembly shall be tested in the horizontal configuration (floor configuration) to qualify for both floor and wall fire stop design.

C. Description of Test Materials:

1. The test slab shall be designed to fit the test furnace furnished with required blockouts as shown in Figure 1, formed, reinforced, and cured by the Laboratory. The Laboratory shall supply the Sponsor with the necessary drawings of the final slab design at the time of, or prior to, written acceptance of the contract.
2. The test slab, masonry grout, twelve (12) inch pipe sleeves, all test instrumentation, unistrut material, miscellaneous hardware and tools shall be supplied by the Laboratory. Also, additional material as listed in Appendix B shall be provided by the Laboratory.
3. All cable, pipe, trays, conduit and wireways as well as all filler material other than grout shall be supplied by the Sponsor in order that the test reproduces the installed field conditions.
4. The installation of pipe, electrical cable and raceway (i.e., cable trays, conduit and wireway), grouting and filling with fire resistive materials shall be by the Laboratory. The Sponsor shall furnish no test site labor, but shall provide a representative to witness the installation.
5. Cable trays, conduit and pipe shall be approximately six (6) ft. long and installed with approximately one (1) foot extension below the slab (into the furnace) leaving three (3) or four (4) feet extending above the slab top surface, depending upon location on the slab. Wireways shall be approximately 3'-2" long and installed approximately one (1) foot extension below the slab (into the furnace) leaving two (2) inches extending above the slab top surface.

6. Conduits and wireways shall be filled to 40% based on cross sectional area utilizing 90% by number silicone and 10% by number non-silicone cables.

7. Cable trays and covers shall be galvanized steel and installed as shown on Figures 1 and 2.

8. Wireways shall be 4" x 4" galvanized steel; conduit shall be Schedule 40 rigid galvanized steel in 1, 2 and 4 inch diameters. All shall be installed in three separate 15" x 8" blockouts, supported and back-filled in 3 different configurations as shown in Figures 3, 4, and 5.

9. Sleeve and pipe penetrations shall consist of two 12" diameter by 15" long standard weight steel pipe sleeves cast in place, and two 8" diameter by 6' long, Schedule 40, steel pipes capped on the bottom as shown on Figure 6.

10. Cable supplied in trays, wireways and conduit shall be low voltage power, control and instrumentation with silicone rubber insulation, glass braid and an overall asbestos braid jacket, as provided by the Sponsor. Sponsor shall also furnish non-silicone rubber (XLP or EPR) insulated cable for use as outlined in C.11.

11. Cable tray fill shall be as follows, based on <u>physical capacity</u>, i.e., level cross section as opposed to a percentage of mass vs. void area as is common in the electrical trade:

Tray	Fill	Cable Type*
1	10%	All non-silicone
2	100%	90% silicone, 10% non-silicone
3 to 6 incl.	50%	90% silicone, 10% non-silicone

*Percentage by number of cables.

The recommended cable tray, wireway and conduit fills are shown in Appendix C.

D. Description of Test

1. The fire stop configuration shall be fire endurance tested to the ASTM E-119-1976 Standard Time-Temperature Curve for a minimum of three hours.

2. Immediately following the fire endurance test, the assembly shall be hose stream tested to IEEE Std. 634-1978, Section 5.3.12, consisting of a straight stream setting from a 1½ inch nozzle from the Sponsor's stock at a pressure of 75 psi, at a distance of 10 ft., with a minimum flow of 75 gal./min. The hose-stream shall be directed at the exposed side of the slab for a period of time determined by the net exposed slab surface area, on the basis of 2½ min. per 100 sq. ft.

3. Thermocouples shall be available and instrumented for use in monitoring temperatures of various elements during the fire endurance test. Minimum requirements of IEEE Std. 634-1978, Section 5.3.7 through 11., should be used.

4. Extra Kaowool shall be kept on hand during the fire test for use in plugging openings as a result of possible failure ranging from flaring around one or several cables in a tray to the loss of a complete 15" x 8" blockout, in order that flaming from such a loss will be restricted from deteriorating adjacent elements or voiding the entire three hour test by loss of furnace heat.

E. Acceptance Criteria

1. Each of the individual cable and pipe penetration fire stops shall be considered acceptable for use in rated fire barrier provided:

   a. Each fire stop withstands the fire endurance test as described without passage of flame or gases hot enough to ignite the cable

or other fire stop materials on the unexposed side for a period equal to the required fire rating.

b. Each fire stop withstands the hose stream test as described without causing an opening through the fire stop.

2. The successful completion of the above tests by such penetration assembly in the horizontal configuration shall qualify each such assembly for field installation consistent with the rating achieved in both horizontal and vertical penetrations except penetrations detailed in Figures 3, 4, and 5.

3. Results of one or several tray, conduit, or wireway penetrations shall not prejudice the results of any other individual penetration designs.

F. Documentation

1. Following the procedures as outlined in this Specification and also the standards as listed in B.1, all data shall be provided to document satisfactory compliance.

2. Engineering data and references to the other publications which were used to make the test and select the equipment shall be included in the documentation.

3. The results, pass or fail for each penetration, shall be documented and supplemented with photographs and a statement of the conclusions drawn by Laboratory. A final certified test report shall be transmitted to the Sponsor within 21 days of the completion of the test.

4. Installation methods shall be described including any Quality Assurance data applicable to the specific materials and installation methods used.

C. General

Personnel from Baltimore Gas and Electric Co., Bechtel Corp. (consultant) and NRC shall be allowed to witness the tests. The Sponsor shall be notified 5 working days in advance of the performance of the test.

APPENDIX A

Installation Details

Figure 1

A general arrangement plan view (Fig. 1) of the stepped, two thickness test slab is shown which shall be sized by the Laboratory in the optimum configuration to reflect:

1. The size and shape of the test furnace to be used.
2. The necessity to test the four blockouts and two cast-in-place arrangements shown, with reasonable spacing to prevent a failure of one element from adversely affecting any other elements.

In general, detailed Figure 2 (Trays #1, #2, and #3), and 3 are depictions of existing field conditions in the Sponsor's plant. The other arrangements are variations which are presumed to have superior fire and hose stream resistive characteristics should any of the primary arrangements prove to have inadequate endurance to the tests.

Figure 2

All ladder trays are to be grouted into a single 3'-0" by 6'-0" blockout, using concrete, and reinforcing rod if necessary, similar to that used in casting the test slab. Grouting shall take place after cable and solid tray covers are installed. Each tray shall penetrate one (1) foot below and (4) feet above the slab and shall be individually supported on the cold side (top) by use of galvanized steel Unistrut, or equal, in accordance with good industry practice. Solid tray covers shall be two (2) feet long and penetrate six (6) inches above and below the slab.

Each tray shall have Kaowool hand packed around individual cables to a depth as shown in Fig. 2 at both top and bottom surfaces of the blockout. Both exposed surfaces of the Kaowool packing shall be covered with a succession of

three (3) applications of approximately ¼" wet Flamemastic 71A Spray to form a final, cured coating of 3/8" depth. See individual tray details for precise location of the Kaowool packing and Flamemastic coat. Trays #1, #2 and #3 shall have Kaowool packed within the blockout, leaving 6 inches of unsealed cable in the center, with the Flamemastic at the blockout surfaces. These represent the existing field conditions, with a variety of cable fills.

Tray #4 shall be a duplicate of Tray #1 except that the 6 inch space between Kaowool packs shall be filled with Silicone RTV Foam (20 lbs./cu. ft. density). Individual cables shall be moved from side to side, as the foam is poured in place, to assure maximum fill without air gaps.

Tray #5 shall be a duplicate of Tray #1 except that all outside surfaces of the fire stops, tray and cover shall be coated with an Intumescent Paint (Vimasco P.O.F. 62-10) in accordance with the manufacturer's instructions.

Tray #6 shall be a duplicate of Tray #1 except that the six (6) inch space at each end, extending beyond the surface of the slab and fire stop, shall be filled with Silicone RTV Foam (20 lbs./cu. ft. density). Individual cables shall be moved from side to side, as the foam is poured in place, to assure maximum fill without air gaps. One inch Kaowool blanket dams will be installed to detain the foam in place prior to curing. The dams shall remain after curing.

Figures 3, 4 and 5

The three (3) 15" x 8" blockouts duplicate a common size in the Calvert Cliffs Control Room floor. Each one contains one each: 4" square wireway, 4" conduit, 2" conduit and 1" conduit; all containing conductors typical of those actually installed at the jobsite. Each wireway shall extend one foot into the furnace below the slab, and two inches on the unexposed side above the slab. Each raceway shall be clamped to a Unistrut laid flat on the top of slab, bridging

the blockout. The exposed (bottom) of the blockout shall be enclosed with a 12" x 19" - ½" thick Marinite (36A or XL) board with cutouts to fit the four (4) raceways in each case and centrally mounted to provide a two (2) inch border on all four sides. The Marinite shall be covered with three applications of approximately ¼" wet Flamemastic 71A sprayed to form a 3/8" dry cured coating.

Figure 3 arrangement shall have the void above the Marinite board filled with vermiculite up to the top of slab, the wireway and conduits shall be packed with 3" of Kaowool, and the top of fill and raceways shall be covered with Flamemastic 71A similar to the bottom coat on the Marinite board.

Figure 4 arrangement shall have the void filled with 18 inches of vermiculite followed by 6" of Silicone RTV Foam up to the top level of the slab. The wireway and conduits shall be filled with a 1" Kaowool dam and 6" of Silicone RTV Foam (20 lbs./cu. ft. density) to the top of the slab.

Figure 5 arrangement shall be a duplicate of Figure 3 in all respects but with the addition of a three (3) inch high sheet metal dam on top of the slab, enclosing a 10" by 17" space which shall be filled with Silicone RTV Foam (20 lbs./cu. ft. density).

Figure 6 - The two 12 inch pipe sleeves shall be cast in the slab. Both 8 inch pipes shall be individually supported on the unexposed (top) side by use of galvanized steel Unistrut, or equal, in accordance with good industry practice. The annular spaces between pipes and sleeves shall be closed with Kaowool or Silicone RTV Foam (20 lbs./cu. ft. density) supplied for that purpose by the Sponsor, as detailed in Figure 6.

Note: All cables in the cable trays, wireways and conduits shall be supported on both sides of the slab.

APPENDIX B

Materials List

The following material will be supplied by the Sponsor:

6 ladder type cable trays 24" x 3" x 6'-0" with 2'-0" long solid tray covers

3 pieces 4" x 4" x 3'-2" steel wireway

3 pieces 4" dia. x 3'-2" rigid steel conduit

3 pieces 2" dia. x 3'-2" rigid steel conduit

3 pieces 1" dia. x 3'-2" rigid steel conduit

2 pieces 8" dia. x 6'-0" Schedule 40 steel pipe and pipe caps

1 spray nozzle

Cable - see Appendix C

The materials, as listed below, shall be supplied by the Laboratory. If the Laboratory has any difficulties in obtaining this material, it should be stated and the Sponsor will furnish this.

Intumescent Paint (Vimasco P.O.F. 62-10) 1 Gallon.

Flamemaster, Flamemastic 71A 5 Gallons.

John Mansville - Marinite Board (36A or XL) ½" thick x 4'-0" x 4'-0".

Babcock and Wilcox Kaowool, Basic Fiber, Bulk A, 35 lbs.

Dow Corning's 3-6548 Silicone RTV Foam, sufficient to fill 2.0 cubic feet when cured.

Vermiculite, sufficient to fill 2.0 cubic feet.

APPENDIX C

A. The following cable types and quantities will be supplied by Sponsor.

TYPE	FUNCTION	BG&E CABLE CODE	QUANTITY (FEET)
2/C #14 AWG SILICONE	CONTROL	B12/B62	672
5/C #14 AWG SILICONE	CONTROL	B14/B64	708
7/C #12 AWG SILICONE	CONTROL	B19	822
3/C #10 AWG SILICONE	POWER	B01/B51	912
2/C #14 AWG SILICONE	INSTRUMENT	C01/C51	894
2/C #14 AWG XLP	CONTROL	B25/B75	312
5/C #14 AWG XLP	CONTROL	B27/B77	204
3/C #8 AWG XLP	POWER	B28/B78	120

B. Recommended Fills

The eight cable types are to be cut into 6 foot lengths and installed into the various raceways with the following distribution and quantity:

TRAY #1 (10% Fill)

B28/B78	20 CABLES

TRAY #2 (100% Fill)

B12/B62	27 CABLES
B14/B64	27 CABLES
B19	37 CABLES
B01/B51	37 CABLES
C01/C51	37 CABLES
B25/B75	10 CABLES
B27/B77	10 CABLES
TOTAL	185

1841 317

TRAY #3, 4, 5, & 6 (50% Fill)

B12/B62	16 CABLES
B14/B64	16 CABLES
B19	22 CABLES
B01/B51	22 CABLES
C01/C51	22 CABLES
B25/B75	6 CABLES
B27/B77	6 CABLES
TOTAL	110

4" X 4" WIREWAY (3 Each) (40% Fill)

B14/B64	4 CABLES
B19	4 CABLES
B01/B51	4 CABLES
C01/C51	4 CABLES
B25/B75	2 CABLES
TOTAL	18

4" CONDUIT (3 Each) (40% Fill)

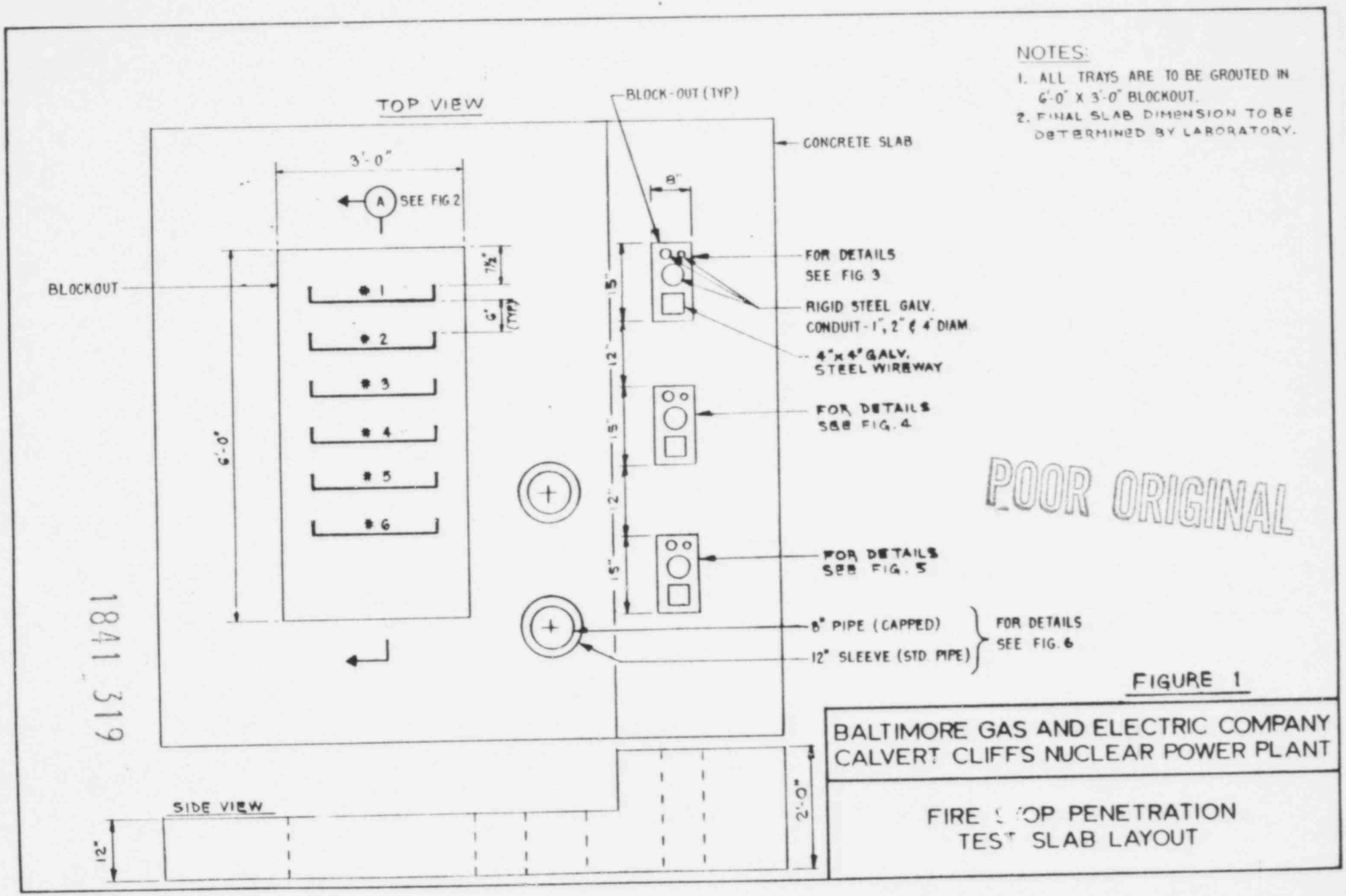
B12/B62	4 CABLES
B14/B64	4 CABLES
B01/B51	4 CABLES
C01/C51	4 CABLES
B25/B75	2 CABLES
TOTAL	18

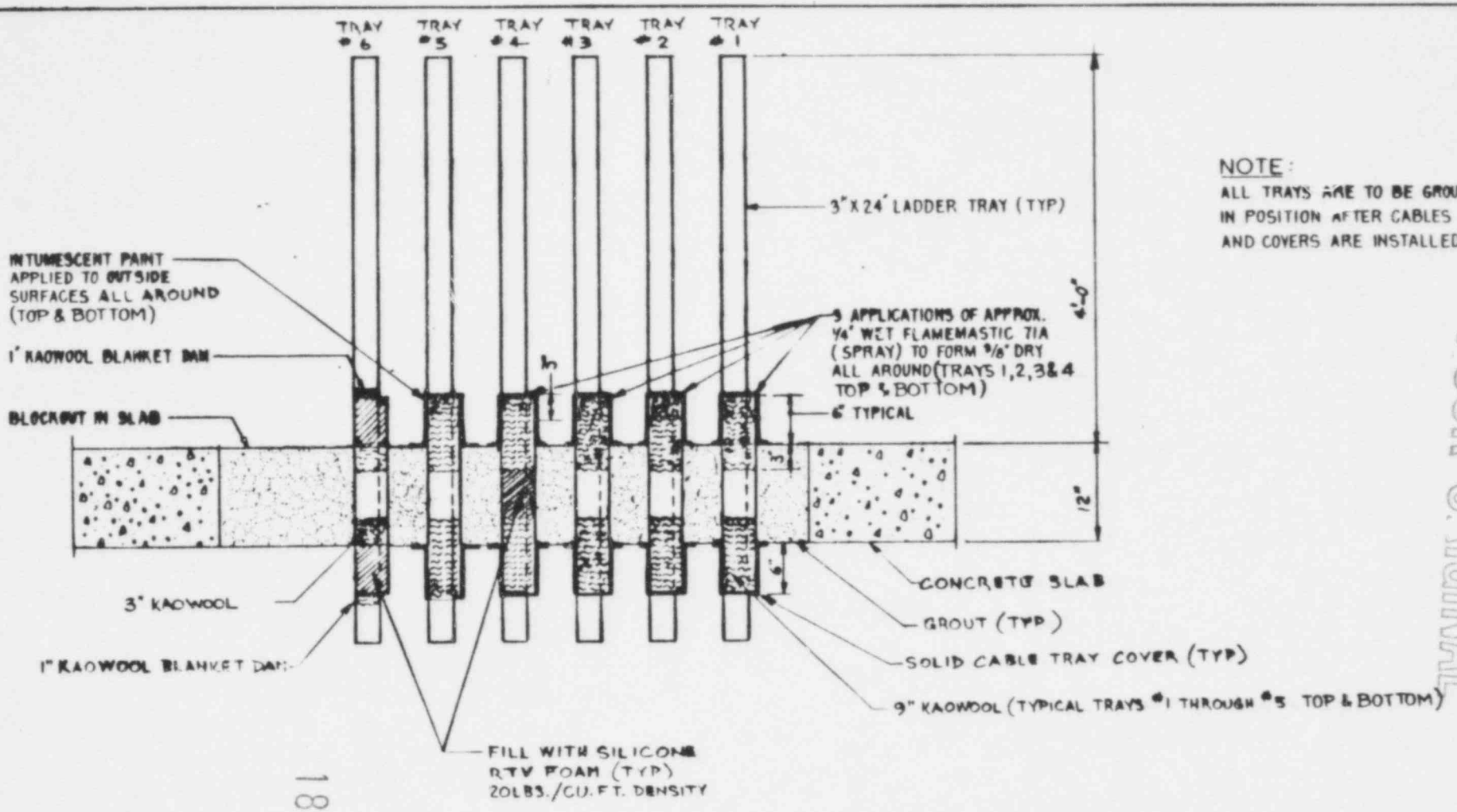
2" CONDUIT (3 EACH) (40% Fill)

B12/B62	2 CABLES
B14/B64	1 CABLE
B01/B51	1 CABLE
B25/B75	1 CABLE
TOTAL	5

1" CONDUIT (3 Each) (40% Fill)

B12/B62	1 CABLE
B25/B75	1 CABLE
TOTAL	2


NOTES:
1. ALL TRAYS ARE TO BE GROUTED IN 6'-0" X 3'-0" BLOCKOUT.
2. FINAL SLAB DIMENSION TO BE DETERMINED BY LABORATORY.
TOP VIEW
BLOCK-OUT (TYP)
CONCRETE SLAB
3'-0"
A SEE FIG. 2
8"
BLOCKOUT
7½"
6" (TYP)
#1
#2
#3
#4
#5
#6
6'-0"
15"
12"
15"
12"
15"
FOR DETAILS SEE FIG. 3
RIGID STEEL GALV. CONDUIT - 1", 2" & 4" DIAM.
4"x4" GALV. STEEL WIREWAY
FOR DETAILS SEE FIG. 4
FOR DETAILS SEE FIG. 5
8" PIPE (CAPPED)
12" SLEEVE (STD PIPE)
FOR DETAILS SEE FIG. 6
SIDE VIEW
12"
2'-0"
POOR ORIGINAL
1841 319
FIGURE 1
BALTIMORE GAS AND ELECTRIC COMPANY
CALVERT CLIFFS NUCLEAR POWER PLANT
FIRE STOP PENETRATION
TEST SLAB LAYOUT



NOTE:
ALL TRAYS ARE TO BE GROUTED IN POSITION AFTER CABLES AND COVERS ARE INSTALLED.

A FIGURE 2

BALTIMORE GAS AND ELECTRIC COMPANY
CALVERT CLIFFS NUCLEAR POWER PLANT

FIRE STOP PENETRATION
TRAY BLOCKOUT DETAILS

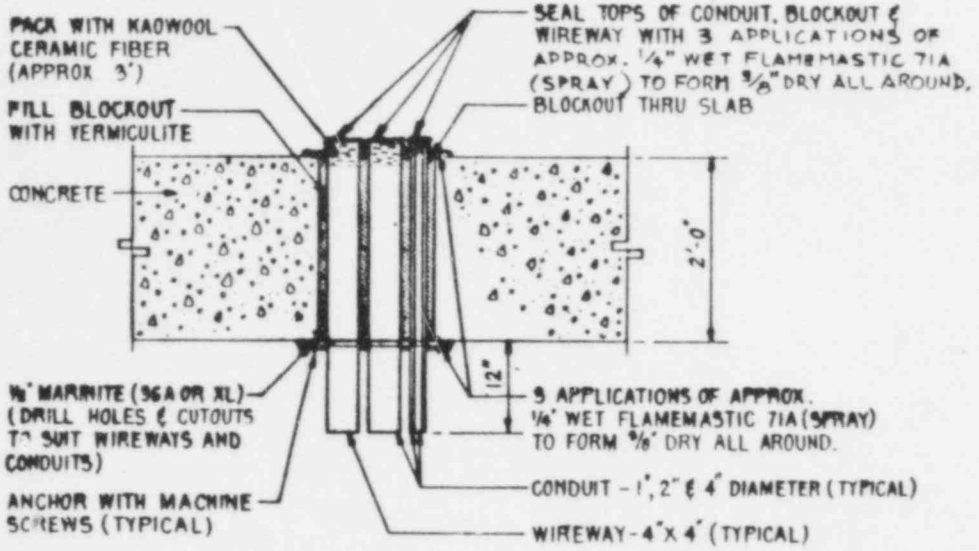


FIGURE 3
INSTALLED CONDITION

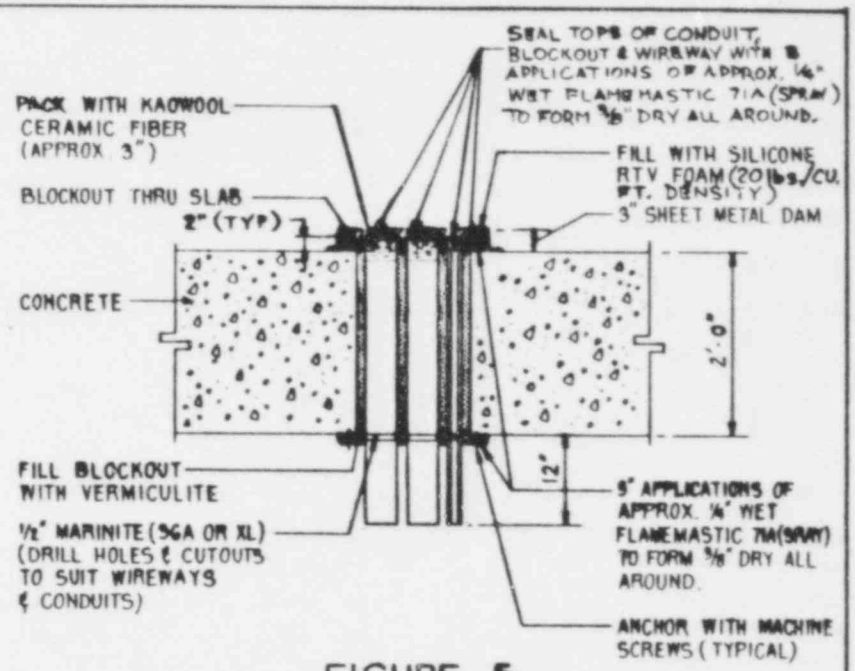


FIGURE 5

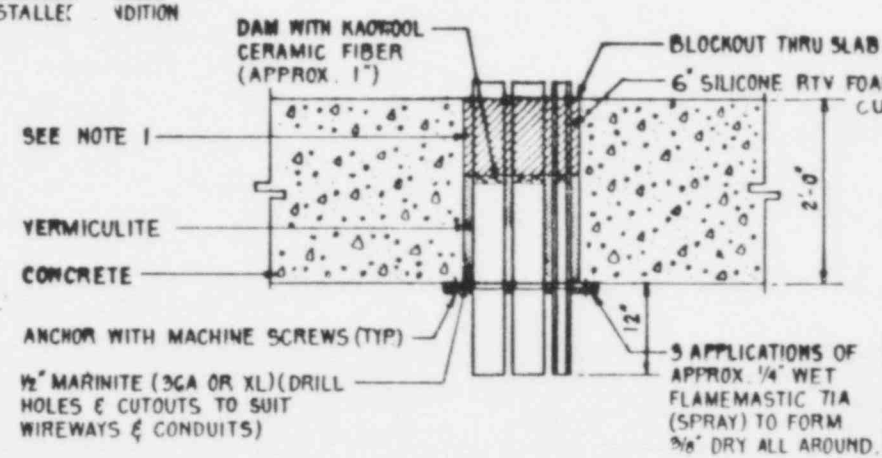


FIGURE 4

NOTES:

1. FILL BLOCKOUT WITH VERMICULITE TO DEPTH OF 18 INCHES & FILL THE 6" REMAINING WITH SILICONE RTV FOAM.

BALTIMORE GAS AND ELECTRIC COMPANY
CALVERT CLIFFS NUCLEAR POWER PLANT

FIRE STOP PENETRATION
CONTROL ROOM FLOOR BLOCKOUT
PENETRATION DETAILS

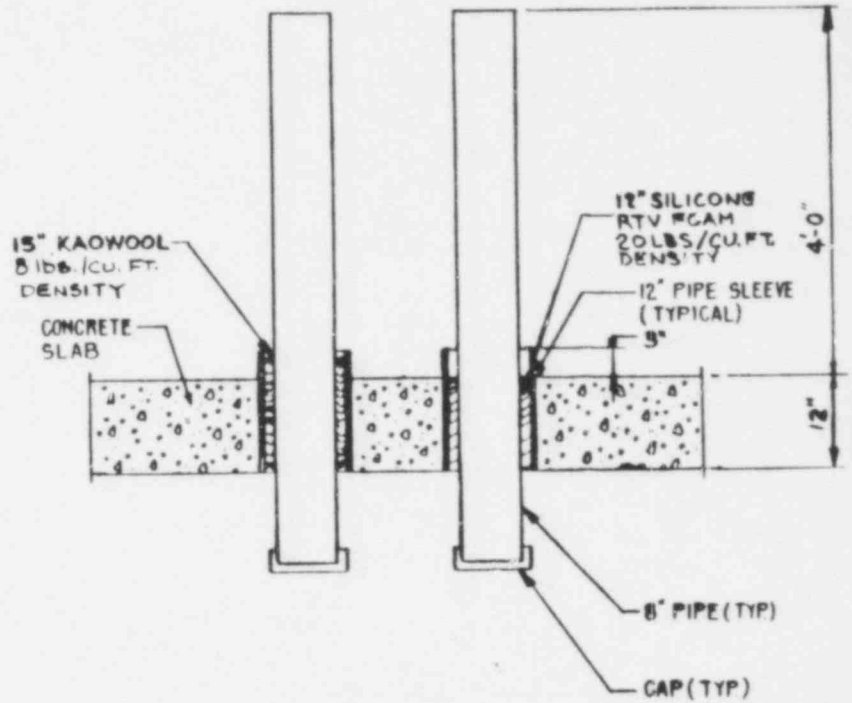


FIGURE 6

BALTIMORE GAS AND ELECTRIC COMPANY
CALVERT CLIFFS NUCLEAR POWER PLANT

FIRE STOP PENETRATION
PIPE
PENETRATION DETAILS