THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

P.O. BOX 5000 - CLEVELAND, OHIO 44101 - TELEPHONE (216) 622-9800 - ILLUMINATING BLDG. — 55 PUBLIC SQUARE

Serving The Best Location in the Nation

MURRAY R. EDELMAN
VICE PRESIDENT
NUCLEAR

August 1, 1985
PY-CEI/NRR-0304 L

Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Perry Nuclear Power Plant
Docket Nos. 50-440; 50-441
Fire Protection CMEB BTP 9.5-1
Section C.5.1(3), Penetrations

Dear Mr. Youngblood:

As identified in our June 26, 1985 letter (PY-CEI/NRR-0278L), CEI established a testing program with a certified laboratory to evaluate our criteria for sealing inside conduit submitted to you in our letter (PY-CEI/NRR-0234L), dated May 3, 1985. Results of that test program have been evaluated and are presented in detail in the attachment to this letter.

In pursuing this issue with other utilities CEI has encountered a wide range of interpretations of what the NRC's requirements were for BTP CMEB 9.5-1, Section C.5.a(3) for sealing inside conduit. Our test results demonstrate that the problem addressed by BTP CMEB 9.5-1 is products of combustion (smoke) generated within the conduit and is not the tramsmission of hot gases, flame, or radiant energy resulting in the following determination:

1. Unsealed interiors of conduit penetrations 4" or less in diameter do not represent impairments to rated fire barriers by transmitting flames, radiant energy or hot gases.

2. Unsealed interiors of conduit penetrations 3" or larger in diameter (and extending less than 10' from this wall) may transmit smoke created as products of combustion from the cable coverings located inside the conduit.

Based upon the above, CEI proposes a modification to our original sealing criteria to address the transmission of smoke through conduits located in Appendix R rated walls that could impare safe-shutdown electrical components. Our list of Appendix R fire protection walls would be re-reviewed to the revised criteria and sealed as discussed in the attached criteria/analysis.

A002
1/1

When considering our test results, implementation of our revised criteria would provide protection of safe shutdown equipment from the potential damage due to smoke, hot gases and flame. Therefore, our sealing program performance would be in compliance with the BTP goals of having at least one train of equipment required to achieve safe shutdown free of fire damage.

A copy of this letter has been submitted for Region III information. Should you have any questions, please call us.

Very truly yours,

Murray R. Edelman
Vice President
Nuclear Group

MRE: njc

cc: Jay Silberg, Esq.
John Stefano (2)
J. Grobe
J. Ulie, Region III

REVISED CRITERIA BASED ON TEST INFORMATION

Using the test data and previously submitted criteria and justification, a revised set of criteria for sealing inside of conduits has been established as follows:

- As previously stated, all conduits greater than 4 in. in diameter will be sealed at the barrier with a seal of the same rating as the barrier.

- Barriers will be evaluated to determine the need for sealing. The occupancy, safe shutdown equipment and existing fire protection features on each side of the barrier will be evaluated to determine the need for sealing to prevent smoke passage. The following conditions on each side will be used to determine the need for prevention of smoke passage:

  a) If there is automatic suppression provided on both sides of the barrier, a fire of sufficient heat to cause combustion of cables inside the conduits or generation of excessive smoke outside the conduits would not be expected to develop. Therefore, sealing inside conduits would not be required.

  b) If all safe shutdown equipment in the areas on both sides of the barrier is of the same division or not required for safe shutdown, there is no need to seal. The area on a side of a barrier will be considered to have one division of safe shutdown in cases where the conduit of the redundant division is protected by a one hour rated wrap throughout the area.

  c) For barriers where a potential for exposure of redundant safe shutdown trains exists, the following analysis will be made and sealing provided inside the conduit which could affect equipment of the redundant division by passage of smoke.

     1) All conduits 3 inches to 4 inches in diameter will be sealed at the barrier or first opening on both sides of the barrier. This will prevent passage of smoke from either side into the adjacent area.

     2) Conduits less than 3 inches in diameter will be sealed on any side of the barrier where the following conditions exist:

        i) The conduit terminates in a panel or enclosure containing equipment within a 10 feet lineal run from the point it enters the area.

           If the conduit length is more than 10 feet in the area, the products of combustion would condense out inside the conduit and would not be expected to reach equipment.

        ii) The panel or equipment in which the conduit terminates is required for safe shutdown or contains safe shutdown equipment. The affects of smoke and gases would be limited to the immediate enclosed area of conduit termination. Therefore, only those conduits connected to panels

with safe shutdown equipment would have a potential for damage and affect safe shutdown.

If the both above conditions exist on a side of the barrier, the conduit will be sealed on that side of the barrier to prevent the passage of smoke generated in the conduit on the other side (fire side) of the barrier. Each side of a barrier will be evaluated to the above two conditions to determine which conduits less than 3 inches in diameter must be sealed.

An analysis, based on the above criteria, will be done for all barriers described in the FPER as providing separation of redundant trains of safe shutdown equipment. The analysis of area and barriers of potential exposure to safe shutdown equipment and determination of conduits less than 3 inches not requiring sealing will be evaluated by the fire protection engineer.

EXHIBIT 2

Information on Fire Test of Conduit
Penetrations With Unsealed Interiors

EXECUTIVE SUMMARY

During the NRC audit of March 18-22, 1985, concerns were raised on the lack of sealing inside conduits 4 inches or less diameter in accordance with the guidelines of Branch Technical Position CMEB 9.5.1, Section C.5.a(3). In response to the criteria developed by CEI to address the concerns, the NRC has requested additional information and analysis as described in their letter dated June 10, 1985. CEI has proceeded with alternatives given in that letter which were:

- Provide test data for other sealing configurations that demonstrate that their fire rating is equivalent to the barrier in which they are installed.

- Identify and justify the unsealed conduit penetrations considering all relevant factors.

It was requested that CEI assess the adequacy of existing fire protection and establish sealing criteria predicated on fire test results and fire hazards analyses. The analysis should address the quantity and nature of combustible materials, and the fire hazards on both sides of the barrier including: exterior walls; locations of wall openings in relation to the ceiling; location, vulnerability and importance of shutdown systems on both sides of the barrier; and the compensating fire protection.

Testing was performed on conduits penetrating a rated barrier assembly but not sealed inside to determine the following:

1) If unsealed conduits penetrating a fire barrier allow the passage of flame, radiant energy, smoke or hot gases through the barrier such that the 3 hour rating criteria as stated in ASTM E-119 is not maintained.

2) If the above factors, although not sufficient to propagate fire through the barrier could potentially cause damage to equipment on the non-fire side of the barrier.

3) What configuration of conduits would limit the passage of the above factors to an extent that damage would not result to equipment on the non-fire side.

The test configuration was built from materials used in the construction of the plant. Conduit, fixtures boxes and cables were those found throughout the plant. The configuration included 4 inch, 3 inch, 2 inch and 3/4 inch conduits extending approximately 10 feet vertically on the unexposed side and terminating in a junction box. Also a 1 inch and 2 inch conduit were extended about 1 foot on the unexposed side before before terminating in a junction box. All fixtures had neoprene vapor seals as installed in the plant. The vertical testing arrangement would represent a worst case, i.e., cables penetrating a floor/ceiling barrier and results would be conservative when applied to a horizontal penetration configuration through a wall. Each configuration was open on both ends to represent normal air paths.

The testing was performed by Construction Technology Laboratory in accordance with the ASTM 119 time/temperature curve. The temperature on the unexposed side was measured to determine the passage of heat to the unexposed side. Smoke was measured by visual observation and examination of the extent of products of combustion found in the assembly after testing. Details of the test and test data are described in the attached report.

The test data and observations were evaluated to determine the affect on 3 hour barrier rating and passage of smoke and hot gases to the unexposed side. The following conclusions were made:

Three Hour Fire Rating

The temperature data indicates that for all configurations of 4 inches diameter or less, the temperature on the unexposed side of the barrier, including inside the conduits, was less than 300°F. This is within the acceptable limits of ASTM-E-119 of 250°F above ambient (75°F) temperature. Therefore, the 3 hour rating of the barrier is maintained and passage of hot gases, smoke, flame or radiant energy would not propagate the fire past the barrier through any unsealed conduit interiors.

To prevent the passage of smoke, noncombustible sealing material capable of remaining intact up to 300°F would be required on the non-fire side. This would prevent smoke from entering the unexposed area. A 3 hour rating on this material is not required.

Smoke and Hot Gas Concerns

The source of smoke could be both the combustibles within the room and the cables inside the conduit itself. However, the major area of concern is the smoke generated by heating the cables inside the conduit on the exposed side. During the latter part of the test, smoke noted coming from furnace ports was not noticed at the conduit openings.

- The observations made during the test indicated that larger sized conduits, 3 inches diameter and over, allowed quantities of smoke to pass through the barrier and escape the conduits such that an exposure to sensitive equipment on the non-fire side of the barrier could be postulated. The passage of the smoke and hot gases also elevated the temperature inside the conduits to a point at which some equipment might be affected.

A seal inside conduits 3" diameter and larger would have to be placed at the first opening past the barrier (i.e., condulet pull box junction box) to effectively stop smoke. This seal would be required on any side of the barrier where an exposure to safe shutdown equipment exists to contain smoke generated inside the conduit.

The smoke, if released on the non-fire side, could be expected to affect exposed equipment. The vapor seals in conduits would be able to prevent this smoke from entering other conduits on the unexposed side and traveling to other areas. Therefore, only open equipment in the area being analyzed is of concern and conduits passing through the area and equipment in sealed panels would not be susceptible to damage.

- Conduits smaller than 3 inches were able to contain smoke and the products of combustion and elevated temperatures were not a problem a short distance (~12"-18") from the barrier. The products of combustion condensed out in the conduit and fixtures up to about 10 feet on the unexposed side. These products of combustion contain substances which could be detrimental to equipment operation.

ABSTRACT

A 3 hour fire test was performed on conduits penetrating a 3 hour rated wall assembly. This test demonstrated the passage of radiant heat, flame, hot gases and smoke through the unsealed conduit interior to the unexposed side of the barrier. The significant results are a follows:

1) The transmission of heat due to radiant energy, flame, hot gases or smoke was not sufficient to elevated temperatures on the unexposed side of the barrier above the limits defined by ASTM/ANI/IEEE for the 3 hour fire rating of the barrier.

2) Conduits 3 inches or larger allowed transmission of smoke through the barrier and into the adjacent areas through openings in conduits attachments.

3) Conduits smaller than 3 inches in diameter allowed passage of smoke through the barrier but were able to contain the smoke inside the conduit. The smoke only extends a limited distance inside the conduit on the unexposed side.

GENERAL

The fire test was performed on Thursday, July 18, 1985, at the Construction Technology Laboratories, 5420 Old Orchard Road, Skokie, Illinois 60077. The test was witnessed by representatives of The Cleveland Electric Illuminating Co., the Construction Technology Laboratories and Brand Industrial Services, Inc. (BISCO).

Procedures described in the "Fire Test Configuration Utilizing Unsealed Conduit Sections" (Attachment 1) define the design and construction of the configuration tested and the methods used for performance of the test. The test provided information to evaluate the following:

- The potential for a fire to spread to the unexposed side of the barrier due to transmission of radiant heat flame, hot gases or smoke through the unsealed openings inside conduits penetrating the barrier.

- The potential for damage to equipment on the unexposed side of the barrier due to transmission of combustion products from the fire side through the unsealed openings inside the conduits.

TEST ASSEMBLY

The test was performed on a 48" x 48" x 12" thick concrete slab. The conduits were Schedule 40 rigid conduit with sizes of 4 inches, 3 inches, 2 inches, 1 inch and 3/4 inch diameter. Cables used were Hypalon jacketed, ethylene propylene insulated cables. Conduit fill was 40% consisting of power, instrumentation and control cables. The penetration around the conduits was sealed with 12 inches of BISCO SF150NH in accordance with appropriate BISCO procedures. Drawing No. 1 (Attachment 2) shows the test configuration. The types and sizes of materials used are typical of those used in Perry Nuclear Power Plant.

The 48" x 48" x 12" thick concrete test slab was constructed by the Portland Cement Association. The test configuration, penetrating items and seal system were installed by BISCO and Construction Technology Laboratories.

A relay was placed in the junction box at the upper 3/4 inch conduit assembly to see if any observable damage was sustained.

FIRE TEST

The test assembly was exposed to a fire in a vertical position. Furnace pressure was maintained as close to neutral as possible (.004 in negative pressure) throughout the test. The fire exposure followed the standard time/temperature relationship. Furnace temperature was measured by three thermocouples, located in the furnace and was monitored throughout the three hour test.

Temperature measurements, pursuant to ASTM Designation E-119-80 and IEEE 634-1974 were taken at various points on the unexposed side throughout the three hour test. The location of the thermocouples recorded temperature readings are indicated on Drawing No. 2 (Attachment 3). The thermocouples were mounted on the slab, the penetration seal inside the conduit runs at approximately 2 feet intervals and inside the junction boxes. Placement of the thermocouples was witnessed by the testing laboratory.

OBSERVATIONS

Temperature readings on all thermocouples were taken at 5 minute intervals (Attachment 6). In addition, temperature readings were taken on the exterior walls of the conduits, at a point 1/2 inches above the penetration, using a hand held thermocouple. These readings are shown on Table 3 (Attachment 4).

Visual observations were made of smoke on the unexposed side. These are tabulated in Attachment 5.

At approximately 1 hour and 32 minutes into the test, a sample of smoke from the 4 inch conduit was tested using a Samplair pump kit manufactured by MSA. The sample tubes were factory calibrated. The following measurements were obtained:

CO Measurement	.05%
Leakable Chlorides	25-30 ppm

The test was also recorded on video tape.

At the end of the test, covers were removed from the lower junction boxes and conduits. The following observations were made:

1) Both lower assemblies were at ambient temperatures. Moisture seals in condulets (neoprene rubber) showed no sign of heat damage.

2) Cables inside boxes and condulets were intact with no evidence of charring or burning.

3) A black oily residue was noted inside the 2 inch junction box and condulet and the 1 inch condulet.

4) The relay was removed. No residue or apparent damage was observed.

The test configuration was taken apart by Construction Technologies Laboratories on Friday, July 19, 1985. A detailed report of their observations has been prepared. The following important facts were noted:

- The oily residue was tested for acidity and found to have a Ph to 2.0 to 4.0.

- The residue deposits did not appear in the upper junction boxes, where conduits extended more than 10 feet from the penetration.

- The cable did not show signs of burning on the unexposed side of the assembly.

- The metal junction box and conduit assembly on the exposed side was not damaged and remained intact through the 3 hour fire exposure.

TEST SUMMARY

Temperatures on the unexposed side of the assembly remained below 300°F at all points throughout the 3 hour test. The cable on the unexposed side did not burn or transmit fire to the unexposed side. Although not hot enough to propagate fire across the barrier, the smoke is transmitted through conduits 3 inches or more in diameter and is not contained inside the the conduit assembly. Conduits of less than 3 inches diameter would contain any smoke but could transmit the products of combustion to equipment on the unexposed side if the run of conduit from the penetration to the equipment is less than 10 feet.

Attachment 1

FIRE TEST CONFIGURATION UTILIZING UNSEALED CONDUIT SECTIONS

1.0 PURPOSE

To determine the potential for the passage of smoke and hot gas along unsealed conduit passing through a fire barrier.

2.0 REFERENCE

ASTM E119 1973, "Standard Method of Fire Tests of Building and Construction Materials."

ASTM E814 1981, "Fire Tests for Through Penetration Fire Stops," Appendix XI.

Cable Manufacturer Technical Data Sheets.

IEEE 383.

3.0 GENERAL

3.1 The test shall be performed at the Portland Cement Association Research and Development Construction Technology Laboratory, Old Orchard Road, Skokie, Illinois.

3.2 The testing shall be witnessed by representative of the following organizations:

3.2.1 Portland Cement Association

3.2.2 Brand Industrial Services Inc.

3.2.3 The Cleveland Electric Illuminating Company (CEI).

3.3 Data gathered from this test shall be used to supplement the Perry Nuclear Power Plant fire hazards analysis.

3.4 A concrete test assembly approximately 48" x 48" with a 30" x 30" clear opening shall be constructed by Portland Cement Association.

3.5 The conduit configurations shall be assembled by Brand Industrial Services Inc.

3.6 Conduit, cable, fixtures and support steel shall be furnished by CEI and be representative of the materials installed at the Perry Nuclear Power Plant.

3.7 All open areas surrounding the conduit shall be sealed in as detailed on the attached drawing.

4.0 DESIGN AND CONSTRUCTION

4.1 The testing shall be prepared in accordance with this test procedure on an assembly measuring 48" x 48" x 12" with a 30" x 30" clear opening and general layout as shown on the attached drawing.

4.2 The penetrating items shall be typical of those used in the construction of the Perry Nuclear Power Plant and shall consist of:

4.2.1 Junction boxes of galvanized 10 gauge carbon steel and equipped with vapor seals.

4.2.2 Right angle condulets of sizes shown on the attached drawing.

4.2.3 Schedule 40 rigid galvanized conduit.

4.2.4 Hypalon jacketed, ethylene propylene insulated cables.

4.3 The conduit assembly shall extend into the furnace a minimum of 12 inches and on the unexposed side as shown on the attached drawing.

4.4 All conduit sections shall be supported using a combination of single and double unistrut sections.

4.5 All conduit sections shall have approximate 40% fill consisting of instrument, control and power cables.

4.6 The 30" x 30" clear opening shall be sealed with BISCO SF150NH in accordance with the appropriate BISCO procedures.

4.7 All applicable BISCO standard quality assurance procedures will be utilized on this test.

4.8 Actual field conditions will be duplicated by this test.

5.0 TESTING

5.1 The test assembly shall be subjected to a three hour fire exposure in the floor furnace at the Portland Cement Association.

5.2 Test Equipment

5.2.1 Test furnace capable of meeting of exceeding 1925°F as specified in ASTM E-119.

5.2.2 Standard ITE control relays or equal.

5.2.3 Thermocouples - Electrically insulated with heat/moisture resistant coverings and with not heavier than No. 18B and S gauge leads.

5.2.4 Suitable video equipment for recording the test.

5.3 Test Method

5.3.1 Place test assembly in the test furnace in the horizontal position with the longer conduit runs on the unexposed side.

5.3.2 Fire exposure shall follow the standard time/temperature curve as defined in ASTM E-119.

5.3.3 Where applicable, temperature measurements at various points along the unexposed side of the assembly as well as internally in the conduit shall be made throughout the test in accordance with ASTM E-119.

5.3.4 Testing shall be recorded. Black and white background drops shall be used for visual indication of smoke.

5.3.5 Visual observations made during the test shall be recorded.

5.3.6 Typical relays shall be placed in the unexposed junction boxes to determine potential smoke affects on equipment.

6.0 REVIEW OF TEST DATA

6.1 Furnace temperatures and individual surface temperatures shall be reviewed to determine the performance of the assembly.

6.2 Cable temperatures should not exceed 780°F at the junction boxes.

6.3 The relays shall be functionally tested and examined for residual deposits resulting from smoke.

6.4 The unexposed conduit sections shall be disassembled and examined for visual signs of jacket and insulation degradation.

6.5 All junction boxes shall be disassembled and the vapor seal examined for decomposition or degradation.

6.6 The hose stream portion of ASTM E-119 shall not be considered a necessary part of this test.

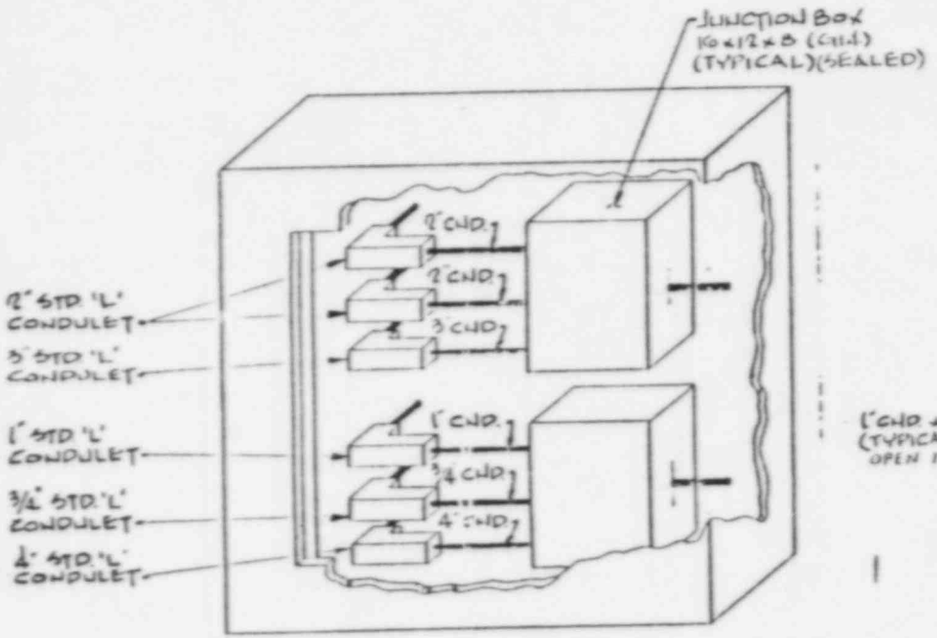
6.7 Failure of any portion of this test included in ASTM E-119 shall not be construed as failure of the entire test.

6.8 Deposits found inside assembly after test shall be tested to determine potential affect on equipment.

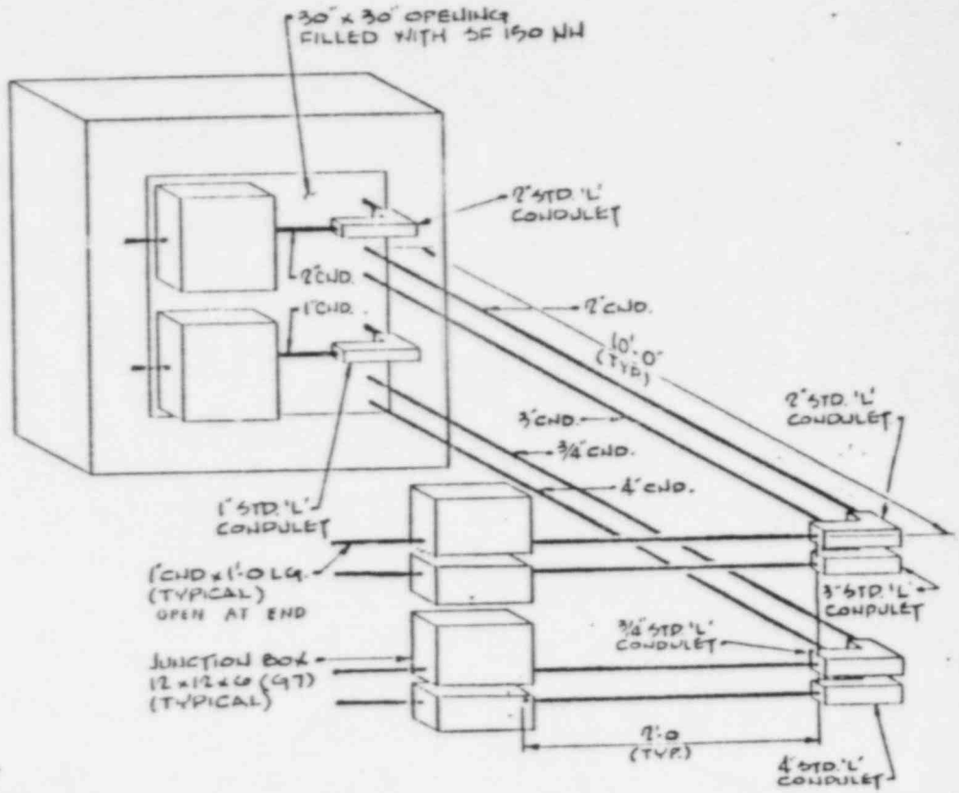
DESIGN CONFIGURATION FOR FIRE TEST

DESIGN CRITERA

1) CONFIGURATION COMPRISED OF CONDULETS, PULL/JUNCTION BOXES AS INSTALLED A PNPD.
2) CABLE FILL 40% COMPRISED OF 1/3 POWER, 1/3 CONTROL AND 1/3 INSTURMENTATION CABLES.



EXPOSED SIDE

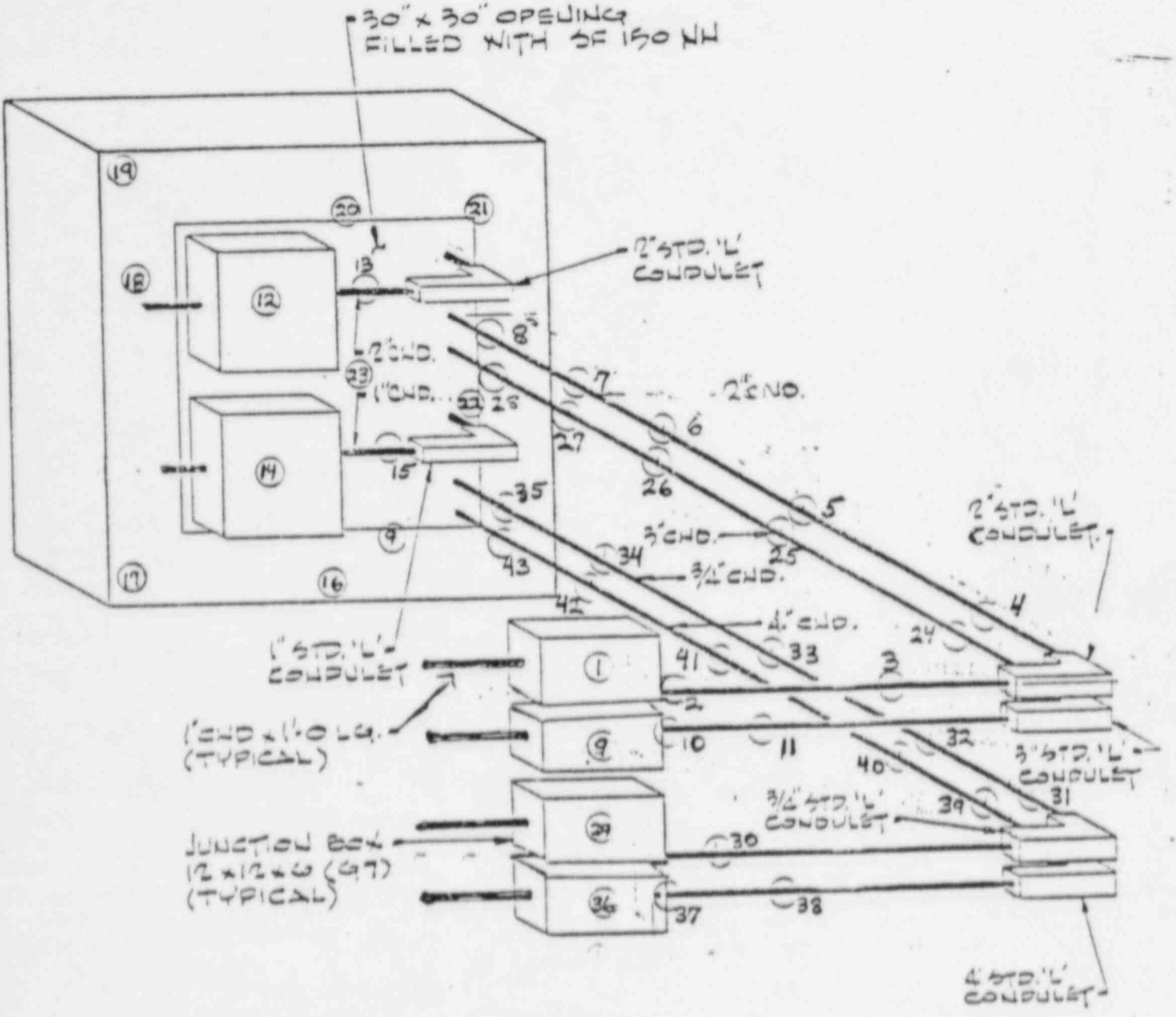


UNEXPOSED SIDE

Attachment 2
Drawing No. 1

Attachment 3

Drawing No. 2



UNEXPOSED SIDE

THERMOCOUPLE PLACEMENT - (E)

NOTES

1. INTERNALLY MOUNT THERMOCOUPLE #'s 10, 11, 13, 15, 22, 23, 2-8, 24-28, 30, 35, 37-43 INSIDE CONDUIT.
2. THERMOCOUPLE SPACING ALONG 10' CONDUIT LENGTHS SHALL BE 2' ON CENTER.
3. THERMOCOUPLE #'s 1, 9, 12, 14, 29, 36 SHALL BE PLACED INSIDE THE JUNCTION BOXES.

TABLE 3

1 Hr. 23 Min. Into Test	SURFACE TEMPERATURE MEASUREMENTS	
	1/2" Above Conduit/Slab Interface	
	2" Lower Assembly	170°F
	2" Upper Assembly	167°F
	3" Upper Assembly	192°F
	1" Lower Assembly	116°F
	3/4" Upper Assembly	112°F
	4" Upper Assembly	187°F

2 Hrs. 47 Min. Into Test	SURFACE TEMPERATURE MEASUREMENTS	
	1/2" Above Conduit/Slab Interface	
	2" Lower Assembly	165°F
	2" Upper Assembly	182°F
	3" Upper Assembly	246°F
	1" Lower Assembly	150°F
	3/4" Upper Assembly	142.5°F
	4" Upper Assembly	224°F

Attachment 5

TEST OBSERVATIONS

Test Started - 11:37 AM, Thursday, July 18, 1985
Test Ended - 2:37 PM, Thursday, July 18, 1985

Test performed by Russ Hall, Senior Furnace Technician, Construction Technology Laboratories.

Notes - Smoke described as light, moderate and heavy as follows:

Light - Equivalent to the smoke generated by a lit cigarette.

Moderate - About 5-10 times light smoke.

Heavy - Sufficient smoke to obstruct view.

Moderate and heavy smoke were observable on video tape but light smoke did not show.

TIME INTO TEST HRS:MIN		OBSERVATIONS
:00		Test Started
:07	A. -	Light gray smoke medium density. Coming from furnace ports.
:08	-	Light smoke generated from lower 2" conduit.
	-	Heavy smoke coming from upper 4" conduit.
	-	Light smoke being generated from upper 2" conduit junction box, 1" nipple.
0:13	-	Light smoke being generated from 3" conduit.
0:20	-	Smoke generation stopped at upper and lower 2" Ø conduit sections.
	-	Smoke generation significantly reduced on 3" conduit to trace amount.
	-	Trace (light) amount of smoke observed at lower 3/4" conduit point.
	-	Smoke continues out of 4" conduit.
	-	4" Ø conduit touched by R. Salkiewicz approximately 6" on the unexposed side. Conduit warm to touch.
0:35	-	3" conduit sample point generating trace amounts of smoke. 4" Ø conduit sample point and condulet unchanged indicating smoke still being generated in the furnace as observed by intermittent releases through furnace ports.
0:38	-	Trace amounts of smoke out 3" condulet.
0:59	-	Lower conduit sample points ambient temp.
1:00	-	Trace amounts of smoke being generated at 4" condulet and 3" conduit sample point. No smoke being generated at remaining conduit sample points.
1:23	-	Light gray smoke tract amount out of furnace access hatch.

TIME INTO TEST HRS:MIN	OBSERVATIONS
2:00	- Trace amounts at smoke generated through 3" ∅ conduit. - Trace amounts of smoke continue to be generated from 4" ∅ condulet. - Trace amounts of smoke continue from combustion chamber access hatch. - All other sampling points remain unchanged, i.e., no smoke.
2:20	- All traces of smoke ceased from all conduits and furnace.
3:00	- No change except smoke from 4" ∅ condulet ceased at 2 hr. 20 min. into test.

END OF TEST

Attachment 6

THERMOCOUPLE READINGS

DW94/T/22/kf

INDEX= 2

FRAME NO.	PRINT NO.	T/C NO.	TEMPERATURE, DEG. F	TEMPERATURE INCR., DEG. F	TIME INCR., MINUTES
9	1	1	79.6	79.6	0
9	2	2	79.3	79.3	0
9	3	3	79.1	79.1	0
9	5	4	79.0	79.0	0
9	6	5	78.8	78.8	0
9	7	6	78.8	78.8	0
9	8	7	78.7	78.7	0
9	9	8	78.6	78.6	0
9	10	9	79.5	79.5	0
9	11	10	79.3	79.3	0
9	12	11	79.0	79.0	0
:1	1	12	79.3	79.3	0
:1	2	13	79.1	79.1	0
:1	3	14	79.3	79.3	0
:1	4	15	79.2	79.2	0
:1	5	16	79.0	79.0	0
:1	6	17	79.0	79.0	0
:1	7	18	79.1	79.1	0
:1	8	19	79.0	79.0	0
:1	9	20	79.1	79.1	0
:1	10	21	78.7	78.7	0
:1	11	22	79.0	79.0	0
:1	12	23	79.2	79.2	0
:3	1	24	79.0	79.0	0
:3	2	25	78.9	78.9	0
:3	3	26	78.7	78.7	0
:3	4	27	78.7	78.7	0
:3	5	28	78.8	78.8	0
:3	6	29	79.7	79.7	0
:3	7	30	79.3	79.3	0
:3	8	31	79.2	79.2	0
:3	9	32	79.2	79.2	0
:3	10	33	79.2	79.2	0
:3	11	34	79.1	79.1	0
:3	12	35	79.0	79.0	0
:4	1	36	79.3	79.3	0
:4	2	37	79.0	79.0	0
:4	3	38	79.1	79.1	0
:4	4	39	78.9	78.9	0
:4	5	40	78.4	78.4	0
:4	6	41	78.8	78.8	0
:4	7	42	78.8	78.8	0
:4	10	43	78.7	78.7	0

TEST TIME: 0:00:00
FURNACE ATMOSPHERE TEMPERATURE: 81.4 DEG. F
ASTM TEMPERATURE: 68 DEG. F
DIFFERENCE: 13.4 DEG. F

FURNACE ATMOSPHERE T/C's - DEG. F:

T/C # 0 = 82
T/C # 1 = 81
T/C # 2 = 82

INDEX= 5

FRAME NO.	PRINT NO.	T/C NO.	TEMPERATURE, DEG. F	TEMPERATURE INCR., DEG. F	TIME INCR., MINUTES
9	1	1	80.1	2.1	5
9	2	2	78.3	.9	5
9	3	3	77.9	.8	5
9	5	4	78.1	1.1	5
9	6	5	78.1	1.2	5
9	7	6	78.0	.9	5
9	8	7	78.7	1.5	5
9	9	8	153.8	74.2	5
9	10	9	78.0	.3	5
9	11	10	77.5	.1	5
9	12	11	77.1	.1	5
1	1	12	78.5	.5	5
1	2	13	78.0	.6	5
1	3	14	78.4	-.2	5
1	4	15	78.5	.5	5
1	5	16	77.1	.1	5
1	6	17	76.9	-.0	5
1	7	18	77.1	-.0	5
1	8	19	77.0	.1	5
1	9	20	77.0	-.1	5
1	10	21	76.9	.2	5
1	11	22	77.1	.1	5
1	12	23	77.1	.0	5
3	1	24	77.1	.0	5
3	2	25	77.0	.2	5
3	3	26	79.9	3.2	5
3	4	27	77.2	.5	5
3	5	28	98.0	20.5	5
3	6	29	78.6	-.4	5
3	7	30	78.1	-.0	5
3	8	31	78.2	.2	5
3	9	32	78.2	.1	5
3	10	33	78.6	.3	5
3	11	34	78.8	.3	5
3	12	35	93.3	-6.5	5
4	1	36	77.5	.1	5
4	2	37	77.8	.7	5
4	3	38	77.6	.4	5
4	4	39	77.5	.6	5
4	5	40	77.3	.9	5
4	6	41	91.3	9.2	5
4	7	42	119.8	33.3	5
4	10	43	171.8	65.2	5

TEST TIME: 0:15:00
FURNACE ATMOSPHERE TEMPERATURE: 1387.0 DEG. F
ASTM TEMPERATURE: 1399 DEG. F
DIFFERENCE: -12 DEG. F

FURNACE ATMOSPHERE T/C's - DEG. F:

T/C # 0 = 1370
T/C # 1 = 1371
T/C # 2 = 1420

INDEX= 8

FRAME NO.	PRINT NO.	T/C NO.	TEMPERATURE, DEG. F	TEMPERATURE INCR., DEG. F	TIME INCR., MINUTES
9	1	1	82.2	.3	5
9	2	2	79.4	.3	5
9	3	3	78.5	.2	5
9	5	4	79.0	.3	5
9	6	5	79.2	.3	5
9	7	6	79.8	.5	5
9	8	7	84.8	1.4	5
9	9	8	216.9	13.7	5
9	10	9	78.5	.2	5
9	11	10	77.9	.2	5
9	12	11	77.5	.2	5
:1	1	12	80.1	.3	5
:1	2	13	80.1	.8	5
:1	3	14	78.8	.1	5
:1	4	15	79.6	.4	5
:1	5	16	77.2	.0	5
:1	6	17	77.1	.0	5
:1	7	18	77.3	.1	5
:1	8	19	77.2	.1	5
:1	9	20	77.3	.1	5
:1	10	21	79.6	1.4	5
:1	11	22	77.5	.2	5
:1	12	23	77.5	.1	5
:3	1	24	77.7	.3	5
:3	2	25	77.9	.3	5
:3	3	26	92.1	1.3	5
:3	4	27	80.5	.3	5
:3	5	28	149.0	14.7	5
:3	6	29	78.8	.1	5
:3	7	30	78.6	.2	5
:3	8	31	78.6	.1	5
:3	9	32	79.0	.3	5
:3	10	33	79.5	.3	5
:3	11	34	80.5	.6	5
:3	12	35	96.0	.3	5
:4	1	36	79.2	.4	5
:4	2	37	78.9	.4	5
:4	3	38	79.6	.7	5
:4	4	39	85.0	4.9	5
:4	5	40	90.7	6.8	5
:4	6	41	121.5	7.0	5
:4	7	42	168.3	15.8	5
:4	10	43	187.6	30.7	5

TEST TIME: 0:30:00
FURNACE ATMOSPHERE TEMPERATURE: 1545.4 DEG. F
ASTM TEMPERATURE: 1550 DEG. F
DIFFERENCE: -4.6 DEG. F

FURNACE ATMOSPHERE T/C's - DEG. F:

T/C # 0 = 1535
T/C # 1 = 1538
T/C # 2 = 1564

INDEX= 11

FRAME NO.	PRINT NO.	T/C NO.	TEMPERATURE, DEG. F	TEMPERATURE INCR., DEG. F	TIME INCR., MINUTES
9	1	1	81.8	-.1	5
9	2	2	80.0	.2	5
9	3	3	78.9	.2	5
9	5	4	79.3	-.0	5
9	6	5	79.6	.2	5
9	7	6	80.3	.1	5
9	8	7	88.2	1.1	5
9	9	8	220.6	1.8	5
9	10	9	78.9	.1	5
9	11	10	78.1	.1	5
9	12	11	77.8	.1	5
1	1	12	80.4	.1	5
1	2	13	82.0	.7	5
1	3	14	79.2	.0	5
1	4	15	80.3	.2	5
1	5	16	77.4	.0	5
1	6	17	77.2	-.0	5
1	7	18	77.5	.0	5
1	8	19	77.3	.1	5
1	9	20	77.4	-.0	5
1	10	21	84.6	1.7	5
1	11	22	77.8	.1	5
1	12	23	77.7	.1	5
3	1	24	78.4	.3	5
3	2	25	78.8	.2	5
3	3	26	97.3	1.8	5
3	4	27	82.2	.5	5
3	5	28	169.9	6.4	5
3	6	29	79.3	.1	5
3	7	30	79.2	.1	5
3	8	31	79.3	.2	5
3	9	32	80.4	.4	5
3	10	33	81.0	.5	5
3	11	34	82.2	.5	5
3	12	35	102.5	2.7	5
4	1	36	79.8	-.1	5
4	2	37	79.1	-.1	5
4	3	38	80.5	.1	5
4	4	39	85.0	-.2	5
4	5	40	88.5	-.5	5
4	6	41	117.0	2.5	5
4	7	42	167.6	2.0	5
4	10	43	209.7	-1.8	5

TEST TIME: 0:45:00
FURNACE ATMOSPHERE TEMPERATURE: 1619.4 DEG. F
ASTM TEMPERATURE: 1638 DEG. F
DIFFERENCE: -18.6 DEG. F

FURNACE ATMOSPHERE T/C's - DEG. F:

T/C # 0 = 1612
T/C # 1 = 1612
T/C # 2 = 1635

INDEX= 14

FRAME NO.	PRINT NO.	T/C NO.	TEMPERATURE, DEG. F	TEMPERATURE INCR., DEG. F	TIME INCR., MINUTES
9	1	1	81.3	-.1	5
9	2	2	80.4	.2	5
9	3	3	79.2	.1	5
9	5	4	79.7	.3	5
9	6	5	80.0	.2	5
9	7	6	81.1	.3	5
9	8	7	91.0	1.0	5
9	9	8	218.2	1.1	5
9	10	9	79.3	.2	5
9	11	10	78.6	.1	5
9	12	11	78.3	.2	5
:1	1	12	80.8	.2	5
:1	2	13	85.0	1.1	5
:1	3	14	79.9	.2	5
:1	4	15	80.9	.1	5
:1	5	16	77.5	.1	5
:1	6	17	77.3	.0	5
:1	7	18	77.6	.0	5
:1	8	19	77.4	.0	5
:1	9	20	77.7	.0	5
:1	10	21	88.5	1.2	5
:1	11	22	78.5	.3	5
:1	12	23	77.9	.1	5
:3	1	24	79.1	.2	5
:3	2	25	79.8	.3	5
:3	3	26	103.9	2.2	5
:3	4	27	83.8	.5	5
:3	5	28	194.0	5.9	5
:3	6	29	79.9	.2	5
:3	7	30	80.3	.5	5
:3	8	31	80.7	.6	5
:3	9	32	82.3	.7	5
:3	10	33	82.8	.5	5
:3	11	34	83.9	.5	5
:3	12	35	112.2	3.2	5
:4	1	36	80.1	.1	5
:4	2	37	79.7	.2	5
:4	3	38	81.1	.0	5
:4	4	39	85.5	.6	5
:4	5	40	88.1	-.2	5
:4	6	41	116.8	1.2	5
:4	7	42	173.3	2.3	5
:4	10	43	219.9	-9.3	5

TEST TIME: 1:00:00
FURNACE ATMOSPHERE TEMPERATURE: 1695.7 DEG. F
ASTM TEMPERATURE: 1700 DEG. F
DIFFERENCE: -4.3 DEG. F

FURNACE ATMOSPHERE T/C's - DEG. F:

T/C # 0 = 1687
T/C # 1 = 1687
T/C # 2 = 1714

INDEX= 20

FRAME NO.	PRINT NO.	T/C NO.	TEMPERATURE, DEG. F	TEMPERATURE INCR., DEG. F	TIME INCR., MINUTES
9	1	1	81.3	.1	5
9	2	2	81.0	.1	5
9	3	3	80.2	.3	5
9	5	4	80.5	.3	5
9	6	5	81.3	.3	5
9	7	6	82.9	.5	5
9	8	7	94.8	.6	5
9	9	8	232.1	3.6	5
9	10	9	80.1	.3	5
9	11	10	79.7	.3	5
9	12	11	79.3	.3	5
1	1	12	83.1	.5	5
1	2	13	92.1	1.1	5
1	3	14	81.2	.4	5
1	4	15	82.6	.4	5
1	5	16	78.2	.2	5
1	6	17	77.8	.1	5
1	7	18	78.5	.3	5
1	8	19	78.1	.2	5
1	9	20	78.4	.2	5
1	10	21	94.1	.5	5
1	11	22	80.6	.4	5
1	12	23	78.2	.1	5
3	1	24	80.2	.2	5
3	2	25	81.2	.3	5
3	3	26	120.2	2.6	5
3	4	27	87.1	1.0	5
3	5	28	212.9	5.1	5
3	6	29	80.9	.2	5
3	7	30	82.0	.4	5
3	8	31	82.4	.4	5
3	9	32	84.0	.2	5
3	10	33	85.0	.4	5
3	11	34	86.5	.4	5
3	12	35	127.6	2.6	5
4	1	36	80.5	.1	5
4	2	37	80.5	.2	5
4	3	38	81.6	.2	5
4	4	39	85.0	-.0	5
4	5	40	87.3	-.1	5
4	6	41	132.1	14.7	5
4	7	42	186.5	3.1	5
4	10	43	269.8	1.9	5

TEST TIME: 1:30:00
FURNACE ATMOSPHERE TEMPERATURE: 1784.6 DEG. F
ASTM TEMPERATURE: 1792 DEG. F
DIFFERENCE: -7.4 DEG. F

FURNACE ATMOSPHERE T/C's - DEG. F:

T/C # 0 = 1778
T/C # 1 = 1777
T/C # 2 = 1799

INDEX= 25

FRAME NO.	PRINT NO.	T/C NO.	TEMPERATURE, DEG. F	TEMPERATURE INCR., DEG. F	TIME INCR., MINUTES
9	1	1	81.7	.2	5
9	2	2	81.4	.1	5
9	3	3	80.9	.1	5
9	5	4	81.0	.1	5
9	6	5	81.8	.1	5
9	7	6	83.8	.2	5
9	8	7	97.2	.5	5
9	9	8	252.9	5.6	5
9	10	9	80.8	.3	5
9	11	10	80.4	.2	5
9	12	11	80.1	.2	5
1	1	12	85.5	.5	5
1	2	13	95.9	.7	5
1	3	14	82.5	.2	5
1	4	15	84.7	.4	5
1	5	16	79.6	.3	5
1	6	17	78.7	.2	5
1	7	18	80.0	.4	5
1	8	19	79.3	.2	5
1	9	20	79.8	.4	5
1	10	21	98.3	.7	5
1	11	22	83.6	.8	5
1	12	23	78.6	.1	5
3	1	24	80.9	.3	5
3	2	25	82.3	.3	5
3	3	26	125.4	.6	5
3	4	27	91.5	1.4	5
3	5	28	238.0	5.1	5
3	6	29	82.1	.2	5
3	7	30	82.4	.1	5
3	8	31	82.7	.1	5
3	9	32	84.4	.3	5
3	10	33	85.9	.3	5
3	11	34	88.9	.5	5
3	12	35	139.6	2.6	5
4	1	36	81.0	.3	5
4	2	37	81.1	.1	5
4	3	38	82.1	.2	5
4	4	39	85.3	.0	5
4	5	40	87.3	.1	5
4	6	41	130.1	7.9	5
4	7	42	192.8	1.2	5
4	10	43	277.9	17.1	5

TEST TIME: 1:55:00
FURNACE ATMOSPHERE TEMPERATURE: 1836.3 DEG. F
ASTM TEMPERATURE: 1843 DEG. F
DIFFERENCE: -6.7 DEG. F

FURNACE ATMOSPHERE T/C's - DEG. F:

T/C # 0 = 1829
T/C # 1 = 1829
T/C # 2 = 1851

INDEX= 31

FRAME NO.	PRINT NO.	T/C NO.	TEMPERATURE, DEG. F	TEMPERATURE INCR., DEG. F	TIME INCR., MINUTES
9	1	1	82.4	.1	5
9	2	2	82.0	.1	5
9	3	3	81.6	.2	5
9	5	4	81.8	.1	5
9	6	5	82.9	.2	5
9	7	6	85.4	.3	5
9	8	7	100.7	.4	5
9	9	8	265.6	4.3	5
9	10	9	81.7	.1	5
9	11	10	81.4	.2	5
9	12	11	81.0	.1	5
1	1	12	87.8	.2	5
1	2	13	95.7	-1.0	5
1	3	14	84.3	.2	5
1	4	15	86.6	.1	5
1	5	16	82.2	.5	5
1	6	17	80.6	.3	5
1	7	18	82.9	.5	5
1	8	19	81.7	.5	5
1	9	20	82.3	.4	5
1	10	21	103.5	1.5	5
1	11	22	88.2	1.0	5
1	12	23	79.4	.1	5
3	1	24	81.9	.1	5
3	2	25	83.8	.1	5
3	3	26	125.1	-2.9	5
3	4	27	94.2	.1	5
3	5	28	258.7	3.5	5
3	6	29	83.1	.1	5
3	7	30	83.7	.1	5
3	8	31	83.9	.1	5
3	9	32	85.9	.3	5
3	10	33	87.6	.3	5
3	11	34	91.3	.3	5
3	12	35	151.7	1.8	5
4	1	36	81.7	-.0	5
4	2	37	82.0	.1	5
4	3	38	83.0	.1	5
4	4	39	86.7	.5	5
4	5	40	88.5	.1	5
4	6	41	127.2	7.6	5
4	7	42	189.0	-4.9	5
4	10	43	257.9	-2.0	5

TEST TIME: 2:25:00
FURNACE ATMOSPHERE TEMPERATURE: 1889.8 DEG. F
ASTM TEMPERATURE: 1881.5 DEG. F
DIFFERENCE: 8.3 DEG. F

FURNACE ATMOSPHERE T/C's - DEG. F:

T/C # 0 = 1888
T/C # 1 = 1885
T/C # 2 = 1896

INDEX= 38

FRAME NO.	PRINT NO.	T/C NO.	TEMPERATURE, DEG. F	TEMPERATURE INCR., DEG. F	TIME INCR., MINUTES
9	1	1	83.5	.1	5
9	2	2	82.9	.0	5
9	3	3	82.5	.0	5
9	5	4	82.8	.1	5
9	6	5	84.1	.0	5
9	7	6	86.9	.0	5
9	8	7	100.2	-.5	5
9	9	8	273.9	3.5	5
9	10	9	82.8	.0	5
9	11	10	82.5	.0	5
9	12	11	82.4	.0	5
1	1	12	89.3	.1	5
1	2	13	95.5	-.1	5
1	3	14	86.1	.1	5
1	4	15	88.5	.2	5
1	5	16	86.7	.6	5
1	6	17	83.8	.4	5
1	7	18	88.1	.8	5
1	8	19	85.5	.5	5
1	9	20	86.7	.6	5
1	10	21	109.4	.7	5
1	11	22	94.5	1.1	5
1	12	23	80.6	.2	5
3	1	24	83.4	.1	5
3	2	25	85.2	.2	5
3	3	26	120.1	-.8	5
3	4	27	93.2	-.1	5
3	5	28	284.6	2.6	5
3	6	29	84.3	.1	5
3	7	30	85.0	.1	5
3	8	31	85.5	.0	5
3	9	32	87.4	-.0	5
3	10	33	89.1	.0	5
3	11	34	93.0	.5	5
3	12	35	166.3	1.7	5
4	1	36	82.6	.1	5
4	2	37	82.9	.1	5
4	3	38	83.6	-.0	5
4	4	39	86.4	.1	5
4	5	40	89.5	.0	5
4	6	41	119.5	-1.5	5
4	7	42	175.4	.1	5
4	10	43	276.5	4.9	5

TEST TIME: 3:00:00
FURNACE ATMOSPHERE TEMPERATURE: 1904.2 DEG. F
ASTM TEMPERATURE: 1925 DEG. F
DIFFERENCE: -20.8 DEG. F

FURNACE ATMOSPHERE T/C's - DEG. F:

T/C # 0 = 1899
T/C # 1 = 1899
T/C # 2 = 1914