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EXPERIMENTAL PENETRATION SEAL FIRE RESISTANCE TEST

3-HOUR QUALIFICATION TEST

Project No. 14980-106206

3 HOUR FIRE RESISTANCE EVALUATION OF 14 DIFFERENT FIRE BARRIER PENETRATION SEAL DESIGNS

May 17, 2000

Prepared For:

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OMEGA POINT LABORATORIES

ABSTRACT

This document describes the evaluation of 14 distinctly different fire penetration seal systems when exposed to an ASTM E119 fire exposure for a period of 180 minutes (3 h), followed by a 30° fog nozzle hose stream test. The evaluations were performed in accordance with the IEEE 634 Standard Cable Penetration Fire Stop Qualification Test. These evaluations also take into consideration fire barrier penetration seal acceptance criteria specific to Duke Power Company nuclear generating stations.

General conclusions of the overall performance of each seal system, as well as a breakdown of the performance of each penetrating item can be found in the Conclusions section of this document.

The details, procedures and observations reported herein are correct and true within the limits of sound engineering practice. All specimens and test sample assemblies were produced, installed and tested under the surveillance of either the manufacturer's or the testing laboratory's in-house Quality Assurance Program. This report describes the analysis of a distinct assembly and includes descriptions of the test procedure followed, the assembly tested, and all results obtained. All test data are on file and remain available for review by authorized persons.

Clecia S. Patton for
Constance A. Humphrey
Manager, QA Dept.

5-19-00
Date

Deggary N. Priest
President

5/19/00
Date

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INTRODUCTION[1]

"The use of fire rated walls and floors in industrial and commercial properties has been widely accepted for many years. Fire barriers, of a known fire resistance, are used to segregate important, high valued and/or hazardous operations from adjoining areas into acceptable . . . risks. The importance of separation to preserve safe shutdown capability in nuclear power plants places even greater emphasis on fire boundaries."

The variance in the design and construction of fire stop systems is infinite. It is absolutely impossible to expose each design to a fire evaluation. For that reason, designs which are engineered to be applicable to a range of systems are tested and engineering evaluations done to show a high degree of confidence in those designs which are very similar. Often however, these evaluations become second and third degree and it becomes more and more difficult to evaluate systems as their design drifts further away from the original tested design. Consequently, additional fire tests are then called for to re-establish a baseline.

This fire test evaluation was performed to obtain test data related to various unique aspects associated with silicone foam penetration seals (e.g., material cure time, cell structure, etc.). It was the intent of this test program to obtain data related to specific conditions for which either no known data or very limited test data exists. Configurations contained in these evaluations were not intended to replicate any specific installed condition, but rather these configurations serve as controlled designs for the purpose of collecting performance data for comparison.

This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

OBJECTIVE

Newly installed or repaired silicone foam penetration seals typically are allowed to cure for at least 24-hours before being declared complete. The 24-hour cure time period is based on information provided by the silicone foam material manufacturer (Dow Corning®). According to manufacturer's product information, when Part A and Part B components of the silicone foam material are mixed a cure reaction takes place. During this reaction the silicone foam material cures or "snaps" to an expanded state. This reaction also results in the evolution of hydrogen gas. While gas generation is essentially completed during the first few minutes after the Part A and Part B components are mixed, hydrogen gas will continue to be released from the

[1] ANI/MAERP RA Guidelines For Fire Stop and Wrap Systems at Nuclear Facilities, Rev. 0, November, 1987.

foam for at least 24-hours. The rate of release is dependent upon penetration size, seal design and ambient temperature, and the amount of hydrogen gas generated is based upon the amount of material used. Ultimately, because of the closed cell nature of the cured silicone foam, the hydrogen gas is released over a period of time by diffusion.

Because the silicone foam material cures or "snaps" to its final physical foam in a matter of minutes the physical seal is in place essentially minutes after material installation. However, because of the hydrogen gas evolution and diffusion process discussed above, the silicone foam material is allowed to further cure for at least 24-hours prior to being declared complete. More often than not repairs and/or modifications are made to existing penetration seals using limited quantities of new silicone foam material. Therefore, based on the manufacturer's product information many of these repair activities may result in the creation of a negligible amount of hydrogen gas. If this is the case, then many silicone foam seals could be declared complete almost immediately upon completion of the material installation process.

The primary objective of this test was to subject several silicone foam seals, each allowed to cure for a varying amount of time, to a standard fire endurance and hose-stream test to obtain performance data. Successful results of this test program will provide data that may be used to support shorter cure time requirements for silicone foam seals based on the amount of seal material installed.

Additional objectives of this test were to confirm previous Duke Power testing (conducted in March of 1999) with respect to silicone foam cell structure and to obtain test data related to penetration seals installed in sleeves that extend beyond the plane of the barrier.

TEST PROCEDURE

Several standard test methods have been promulgated which describe methods used to evaluate fire stop systems. They all describe very similar fire exposure, but vary in their interpretation of the results. This evaluation was performed under the basic requirements of the IEEE 634 (1978 Edition), Standard Cable Penetration Fire Stop Qualification Test, with reference to ASTM E119-76, Fire Tests of Building Construction and Materials, as needed. In addition to these requirements, this evaluation invokes specific acceptance criteria (i.e., temperature limitations) applicable to Duke Power Company nuclear generating stations.

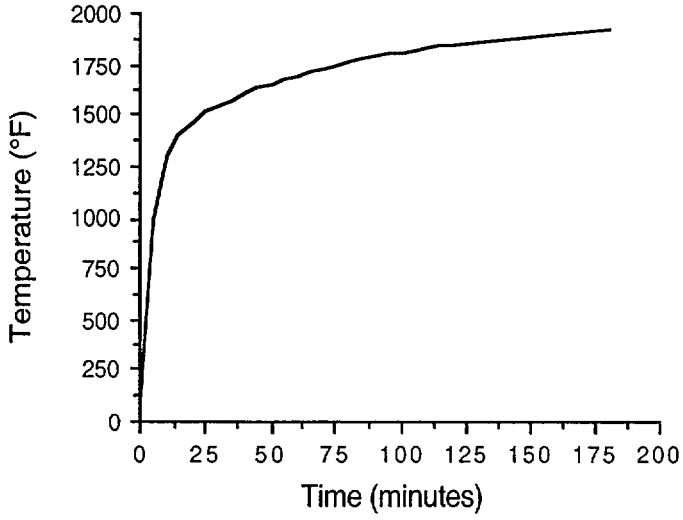
Fire Test Furnace

The 7' x 12' x 40" deep horizontal test furnace is designed to allow the specimen to be uniformly exposed to the specified time-temperature conditions. It is fitted with 26 symmetrically-located diffuse-flame natural gas pipe burners located at floor level. The test furnace is capable of a maximum heat output of 5 million Btu/hour, and is designed to allow an even heat flux distribution across the under surface of a horizontal test specimen. Windows are located on two sides of the furnace to allow observation of the specimen during fire exposure. The furnace is constructed so that

the front (40" x 12') wall section can be removed to allow the evaluations of wall/ceiling interfaces and other specific applications. For this evaluation, the front wall section remained in place.

The temperature within the furnace is determined to be the mathematical average of thermocouples located symmetrically within the furnace and positioned twelve inches away from the exposed face of the test specimen. The materials used in the construction of these thermocouples are those suggested in the test standard. During the performance of a fire exposure test, the furnace temperatures are monitored at least every 15 seconds and displayed for the furnace operator to allow control along the specified time-temperature curve. All data is saved to a magnetic disk every minute.

The fire exposure is controlled to conform to the ASTM E119 standard time-temperature curve shown in Figure 1, as defined by the table below:



Temperature (°F)	Time (min)
1000	5
1300	10
1462	20
1550	30
1700	60
1792	90
1850	120
1888	150
1925	180

Figure 1

The fire test is controlled according to the standard time/temperature curve, as indicated by the average temperature obtained from the readings of the furnace interior thermocouples symmetrically located across the specimen, 12 inches away. The thermocouples are enclosed in protection tubes of such material and dimensions that the time constant of the thermocouple assembly lies between 5.0 and 7.2 minutes, as required by the ASTM E119 test standard. The furnace temperature during a test is controlled such that the area under the time-temperature curve is within 5% of the corresponding area under the standard time-temperature curve for the three hour test period.

Furnace Pressure

The furnace pressure was controlled to be +0.01 inches of water column with respect to the surrounding laboratory atmosphere, measured 0.78" below the concrete test slab, following a five minute stabilization period.

Thermocouples

Temperatures on the unexposed side of the test specimen are measured with Type K, 24 gauge, Chromel-Alumel electrically-welded thermocouples formed from Chromel and Alumel wires of "special limits of error (±1.1°C)," and covered with braided fiberglass insulation. The thermocouples are covered with 2" x 2" x 0.4" felted mineral fiber pads, held in position with glass fiber adhesive tape, stainless steel wire, and/or weighted down depending upon the application.

Data Acquisition Systems

The outputs of the specimen's thermocouples and furnace probes are monitored by two data acquisition systems. The first data acquisition system is a 40 channel cart consisting of two 20 channel John Fluke Mfg. Co., Model Fluke Hydra Data Acquisition Units, and a Umax (Apple compatible) computer. The second system consists of a 300 channel Yokogawa, Inc., Model Darwin Data Acquisition Unit, and a Umax (Apple compatible) computer. Both computers are programmed in LabVIEW 5.0 to send the command to the data acquisition systems to sample the data input lines and to convert the raw data into a usable format for display on screen and storage as an ASCII tab-delimited text file.

Hose Stream Test

Following the fire exposure test the test specimen was removed from the test furnace and exposed to the impact, erosion, and cooling effects of a hose stream directed at the exposed surface of the test specimen as outlined in the standard. For this test evaluation, the hose stream exposure was performed on the test specimen in accordance with the requirements of IEEE 634.

The stream was delivered, for a minimum period of 2 1/2 minutes per 100 sq. ft. of test slab, through a 1 1/2" hose discharging through a nozzle producing a 30° included angle of spray, from a distance of 10 feet.

Acceptance Criteria

IEEE 634 contains some discussion of the failure criteria which was deemed appropriate to reproduce here.

Rating of a Fire Resistive Barrier, with No Penetrations

This rating is expressed in hours and represents the ability of that barrier to withstand, without failure, exposure to a standard fire for that length of time. A fire rating for a

barrier may be arrived at by testing it according to the procedure outlined in ANSI A2.1-1972, Methods of Fire Tests of Building Construction and Materials (ASTM E119).

A barrier achieves its rating if, during the specified time, it contains the fire and its surface unexposed to the fire does not heat up sufficiently to ignite cotton waste or the temperature does not exceed 250°F above ambient. In addition, following the fire, the barrier is required to withstand a specified standard fire hose test on the hot face.

Fundamental Difference Between a Fire Test on a Barrier Alone and a Penetration-Barrier Combination

The fire resistive barrier described above has a relatively low thermal conductivity so that it can maintain a 1300 – 1600°F temperature difference between the face exposed to the fire and the opposite face. A cable penetration has a metallic electrical conductor which has a very high thermal conductance. It may have many large copper conductors and steel trays or conduits or metal parts of the penetration, all of which pass through the barrier. On the cool side of the barrier, these metal parts are necessarily at a higher temperature than the wall adjacent to the penetration. The stop material filling the interstices between cables or between cables and the barrier should give comparable thermal conductance to the barrier itself, in addition to resisting the fire.

Thus, the higher temperature rise of the metallic parts of the penetration presents a new and different problem and may make it impossible to use the same pass-fail criteria as for the barriers. An obvious failure occurs when sufficient heat is transmitted so that the insulation of the cable on the cold side bursts into flame.

Maximum Allowable Cable Penetration Fire Stop Face Temperature

If one examines the temperatures across the unexposed face of the cable penetration fire stop near the end of a 3 h test, the temperatures will vary widely depending on the distance from a cable or a raceway. The temperature of the unexposed face of the cable penetration fire stop material at a point away from the cable or the raceway will also depend on the thermal conductivity of the cable penetration fire stop material. The maximum temperature on that face is the important one...

6. Evaluation of Test Results

Cable penetration fire stops which allow cables or fire stop materials on the unexposed side to ignite, or allow thermocouples on the unexposed side to exceed the temperature limits specified, or any visible flame on the unexposed side, within the specified fire rating time, or the hose stream to cause through-openings, fail the test.

6.1 Acceptance. The test can be considered acceptable and the cable penetration fire stop suitable for use in accordance with the fire rating, provided the following is met:

6.1.1 The cable penetration fire stop shall have withstood the fire endurance test as specified without passage of flame or gases hot enough to ignite the cable or other fire stop material on the unexposed side for a period equal to the required fire rating.

6.1.2 Transmission of heat through the cable penetration fire stop shall not raise the temperature on its unexposed surface above the self-ignition temperature as determined in ANSI K65.111-1971 of the outer cable covering, the cable penetration fire stop material, or material in contact with the cable penetration fire stop. . . ***For power generating stations, the maximum temperature is 700°F.***

6.1.3 The fire stop shall have withstood the hose stream test without the hose stream causing an opening through the test specimen.

As stated in the Test Plan (Appendix B of this report), the results of this test are to be evaluated using the specific acceptance criteria committed to by each of the Duke Power nuclear generating stations. This criteria is as follows:

- For ONS and MNS electrical penetration seal designs, the IEEE-634 acceptance criteria stated above (i.e., 6.1.1, 6.1.2 and 6.1.3) is applicable. The IEEE-634 acceptance limit of 700°F (6.1.2 above) applies to both penetrant temperatures and unexposed side surface temperatures.

- For CNS electrical penetration seal designs, the IEEE-634 acceptance criteria stated above (i.e., 6.1.1, 6.1.2 and 6.1.3) is applicable, with the following exception. The IEEE-634 acceptance limit of 700°F (6.1.2 above) applies to unexposed side penetrant temperatures only. The unexposed side surface temperature for CNS electrical penetration seals is limited to a temperature rise of 325°F (i.e., 325°F + ambient).

- For ONS, MNS and CNS mechanical penetration seal designs, the IEEE-634 acceptance criteria stated above (i.e., 6.1.1, 6.1.2 and 6.1.3) is applicable, with the following exception. The IEEE-634 acceptance limit of 700°F (6.1.2 above) is reduced to 680°F. This temperature was selected because it represents the lowest temperature of any material normally found in close proximity to piping penetrations (i.e., Armstrong Armalok pipe insulation). This limit applies to both penetrating item temperatures and unexposed side surface temperatures for mechanical penetrations.

TEST ASSEMBLY

Test Slab

This project was accomplished through the construction and testing of fourteen different fire penetration seal assemblies, contained in an 8" thick normal weight concrete slab. The slab consisted of 3,000 psi, normal weight siliceous aggregate concrete with #5 rebars spaced nominally 12" o.c. Rebars were positioned $1^1/2$" up from the exposed surface of the slab, and were securely welded to 8" structural channel which made up the perimeter of the slab (see Appendix A). The concrete was

poured, allowed to set for six days, and then exposed to elevated temperatures (350°F) until its internal air moisture content was less than 75% relative humidity.

Penetration Seal Systems

The slab contained fourteen penetration seal systems. These systems are briefly described below and more completely described in the OPL Project No. 14980-106206 TEST PLAN, Rev. 0, dated February 24, 2000 (see Appendix B) and shown on the "as-built" construction drawings (see Appendix A).

PENETRATION NO.	DESCRIPTION
1, 2, 4 & 5	These penetration systems were each 12" diameter by 8" long steel sleeves containing a single 2" diameter schedule 40 pipe concentrically positioned within the sleeve. Each penetration seal consisted of an 8" depth of silicone foam with 1" thick ceramic fiber damming material on both sides of the penetration. The silicone foam cure time for each of these penetrations was as follows: ~ 2-hour cure time (Penetration 1) ~ 4-hour cure time (Penetration 4) ~ 6-hour cure time (Penetration 2) > 24-hour cure time (Penetration 5) The penetration with the > 24-hour cure time seal had a simulated repair in the area of the pipe penetration. The repair area seal had an ~ 4-hour cure time.
3 & 6	These penetration systems were both 12" diameter by 8" long steel sleeves containing Duke Power plant specific cables. Both penetration seals consisted of a 6" depth of silicone foam with 1" thick ceramic fiber damming material on both sides of the penetration. The silicone foam cure time for each of these penetrations was as follows: ~ 4-hour cure time (Penetration 3) > 24-hour cure time (Penetration 6)

Table continued from previous page:

PENETRATION NO.	DESCRIPTION
7 & 8	These penetration systems were both 12" x 24" blockouts containing a single 6" x 12" ladder-back cable tray and Duke Power plant specific cabling. Both penetration seals consisted of an 8" depth of silicone foam with 1" thick ceramic fiber damming material on both sides of the penetration. The silicone foam cure time for baseline seal for both of these penetrations was > 24-hours. Each penetration had a simulated repair in the area of the cabling. The repair area seals had the following cure times: ~ 2-hour cure time (Penetration 7) ~ 30-minute cure time (Penetration 8) Additionally, an area approximately 3" x 24" (behind the cable tray in Pen. 7) was sealed with silicone foam formulated to intentionally have non-optimal cell structure (i.e., large and elongated cells).
9 & 12	These penetration systems were each 12" diameter by 12" long steel sleeves containing a single 2" diameter schedule 40 pipe concentrically positioned within the sleeve. The sleeves were cast in place such that they extended 2" beyond the plane of the barrier on both sides. Each penetration seal consisted of a 12" depth of silicone foam without permanent damming. The silicone foam cure time for each of these penetrations was as follows: ~ 2-hour cure time (Penetration 12) > 24-hour cure time (Penetration 9) The penetration with the > 24-hour cure time seal had a simulated repair in the area of the pipe penetration. The repair area seal had an ~ 30-minute cure time.

Table continued from previous page:

PENETRATION NO.	DESCRIPTION
10 & 13	These penetration systems were each 12" diameter by 12" long steel sleeves containing a single 2" diameter schedule 40 pipe concentrically positioned within the sleeve. The sleeves were cast in place such that they extended 2" beyond the plane of the barrier on both sides. Each penetration seal consisted of a 10" depth of silicone foam with 1" thick ceramic fiber damming material on both sides of the penetration. The silicone foam cure time for each of these penetrations was as follows: ~ 6-hour cure time (Penetration 13) > 24-hour cure time (Penetration 10) The penetration with the > 24-hour cure time seal had a simulated repair in the area of the pipe penetration. The repair area seal had an ~ 6-hour cure time.
11 & 14	These penetration systems were each 12" diameter by 12" long steel sleeves containing Duke Power plant specific cabling. The sleeves were cast in place such that they extended 2" beyond the plane of the barrier on both sides. Each penetration seal consisted of a 10" depth of silicone foam with 1" thick ceramic fiber damming material on both sides of the penetration. The silicone foam cure time for both of these penetrations was > 24-hours. Additionally, Penetration 14 had a simulated repair in the area of the cable bundle. The repair area seal had an ~ 30-minute cure time.

The installation of all fire seals was performed by Promatec Technologies, Inc. personnel trained and qualified in the installation of those materials, using professional equipment and operating under their own QA Program. Promatec Technologies, Inc. installation instructions were used in conjunction with the DE&S generated installation instructions contained in Appendix E of this test report.

Unexposed Surface Thermocouples

The general philosophy of thermocouple placement was to allow the temperatures of each type of penetrating item to be monitored at the intersection with the seal surface and at 1" above the seal surface. Several thermocouples were also placed at positions on the surface of the seal. Seal surface thermocouples were positioned to monitor temperatures on both the baseline seal material and repair areas of the seal, where applicable. A drawing depicting thermocouple locations is contained in Appendix C of this test report.

TEST RESULTS

Because of the time critical schedule for initiating this test, the test slab was placed on the Laboratory's fire resistance furnace prior to the final installation of all seal repairs. All thermocouple leads for penetrations 1-7 and 10-13 were connected to the data acquisition system and their outputs verified. At approximately 12:40 pm the final seal material was poured for the repair areas of Penetrations 8, 9 and 14. Immediately after the silicone foam material set up, the tops of the final three seals were trimmed. The top-side damming material was installed on Penetrations 8 and 14 as required by design. Thermocouples were positioned on Penetrations 8, 9 and 14 and the leads connected to the data acquisition system were verified. On March 2, 2000, the furnace was ignited.

The ambient temperature at the start of the test was 73°F, with 79% relative humidity. The furnace was fired at 1:07 p.m. and the E119 standard time-temperature curve followed for 180 minutes. The specimen was then removed from the furnace and exposed to a hose stream test as described. The pressure differential between the inside of the furnace (as measured approximately 3/4" below the exposed surface of the test slab) and the laboratory ambient air was maintained at +0.01 inches of water column for the duration of the fire exposure test (after the first five minutes, during which furnace stabilization was achieved).

Persons present to witness the test were as follows:

Cal Banning	-	DE&S
Scott Groesbeck	-	DE&S
Chris Gibson	-	DE&S
Brian Murphy	-	DE&S
Jeff Suter	-	DE&S
Wayne Aregood	-	DESR
Doug Brandes	-	Duke Power
Matt Hogan	-	Duke Power
Harold Lefkowitz	-	Duke Power
James Oldham	-	Duke Power
Denis Shumaker	-	PSE&G
Ken Erdman	-	OPPD
Deggary N. Priest	-	Omega Point Laboratories, Inc.
Connie Humphrey	-	Omega Point Laboratories, Inc.
Cleda Patton	-	Omega Point Laboratories, Inc.
Mike Dey	-	Omega Point Laboratories, Inc.
Troy Bronstad	-	Omega Point Laboratories, Inc.
Laudencio Castanon	-	Omega Point Laboratories, Inc.
Oscar Estrada	-	Omega Point Laboratories, Inc.

Observations made during the test were as follows:

TIME	OBSERVATIONS
0:00	Furnace ignited at 1:07 p.m.
0:30	Damming boards darkening.
2:00	Smoke and melting cable jackets.
4:15	Black smoke within the furnace and white smoke coming from the tops of the cable trays.
7:50	Heavy flaming from cable trays on the exposed surface.
14:00	The damming board on Item 13 is being pushed upwards slightly.
30:00	The damming board on Item 10 is being pushed upwards slightly.
45:00	The damming board on Items 3, 6, 7, 8 10, 11, 13 & 14 have been pushed upwards slightly.
90:00	All previously raised covers have continued to rise further. The seal material under the damming board is visible in Items 3, 6, 11, 13 & 14. Thermocouples falling from Items 13 & 14. They were replaced. Also TC #22 was replaced.
96:00	Smoke coming from around the pipe in Item #13. Blisters on the cold side of Items 9 & 12.
120:00	TC #53 replaced.
124:45	Item 13 flaming on unexposed surface.
125:16	TC #34 replaced as best as was possible.
132:00	TCs on Item 9 have tipped over and some have fallen off. Item 9 is smoking heavily, with severe swelling.
139:05	Item 9 flaming on unexposed surface.
143:45	Item 12 flaming on unexposed surface.
156:30	Item 10 flaming on unexposed surface.
180:00	Furnace extinguished.

Hose Stream Test

The slab was then lifted by steel chain and slowly spun, while the hose stream test was performed. The hose stream was delivered, for a minimum period of 5:00 (min:sec), through a 1^1/2" hose discharging through a nozzle producing a 30° included angle of spray, from a distance of 10 feet.

183:50	Hose stream began.
188:50	Hose stream stopped.

The maximum temperatures obtained for each thermocouple are shown in the table below, with the times those temperatures were achieved.

Pen. / TC#	Time to Failure	Pen. / TC#	Time to Failure	Pen. / TC#	Time to Failure
1 / 1	-	6 / 19	-	10 / 37	157
1 / 2	-	7 / 20	-	10 / 38	156
1 / 3	-	7 / 21	-	10 / 39	157
2 / 4	-	7 / 22	-	10 / 40	157
2 / 5	-	7 / 23	-	11 / 41	-
2 / 6	-	7 / 24	-	11 / 42	-
3 / 7	-	7 / 25	-	11 / 43	-
3 / 8	-	7 / 26	-	12 / 44	149
3 / 9	-	8 / 27	-	12 / 45	132
4 / 10	-	8 / 28	-	12 / 46	135
4 / 11	-	8 / 29	-	13 / 47	137
4 / 12	-	8 / 30	-	13 / 48	124
5 / 13	-	8 / 31	-	13 / 49	133
5 / 14	-	8 / 32	-	14 / 50	-
5 / 15	-	9 / 33	142	14 / 51	-
5 / 16	-	9 / 34	142	14 / 52	-
6 / 17	-	9 / 35	136	14 / 53	-
6 / 18	-	9 / 36	143		

NOTE: For the purposes of this evaluation, "Failure" was defined by any seal surface temperature that exceeded 325°F above initial temperature, any other temperature that exceeded 680°F for mechanical penetrations or 700°F for electrical penetrations. A dash (-) indicates that the limiting temperature was not reached or exceeded within the 180 minute fire exposure period.

POST-TEST OBSERVATIONS DURING DISASSEMBLY OF SEALS

Following the test, the specimens were allowed to cool for several hours (overnight) and then disassembled for observations and photographs.

ITEM NO.	OBSERVATION
1	3 – 4" of intact seal material around the perimeter, 2" of intact material at the pipe. The char on the exposed surface of the seal was held in place by the bottom damming board, which remained firmly attached.
2	3 - 4" of intact seal material around the perimeter, 2" of intact material at the pipe. The char on the exposed surface of the seal was held in place by the bottom damming board, which remained firmly attached.

Table continued from previous page:

ITEM NO.	OBSERVATION
3	Although this penetration passed the hose stream test, the penetration seal ignited approximately 20 minutes after the hose stream test. Lab personnel extinguished the flame with a dry-chem extinguisher. The following morning, none of the seal material remained.
4	3 – 4" of intact seal material around the perimeter, 2-1/2" of intact material at the pipe. The char on the exposed surface of the seal was held in place by the bottom damming board, which remained firmly attached.
5	3 – 4" of intact seal material around the perimeter, 2" of intact material at the pipe. The char on the exposed surface of the seal was held in place by the bottom damming board, which remained firmly attached. The repair seal material was charred the same as the original.
6	Some slight shrinkage of the foam from the sleeve around the perimeter. Approximately 1" deep foam remained.
7	Approximately 4" of seal material remained around the concrete perimeter, with 3" depth remaining at the cables. Some char at the cable/foam interface. No apparent difference between the open cell and the other foam. Repair foam similar to the rest.
8	The seal was slightly raised at the surface of the tray 3 – 4". No difference between repair and original foams. Some char at the cable/foam interface.
9	Seal completely gone.
10	Seal completely gone.
11	One half of the exposed damming board is gone. Approximately 1" of foam remains where the damming board is gone, 3 – 4" remains where the board is still in place.
12	Seal completely gone.
13	Seal completely gone.
14	1 – 2-1/2" of seal material depth remains.

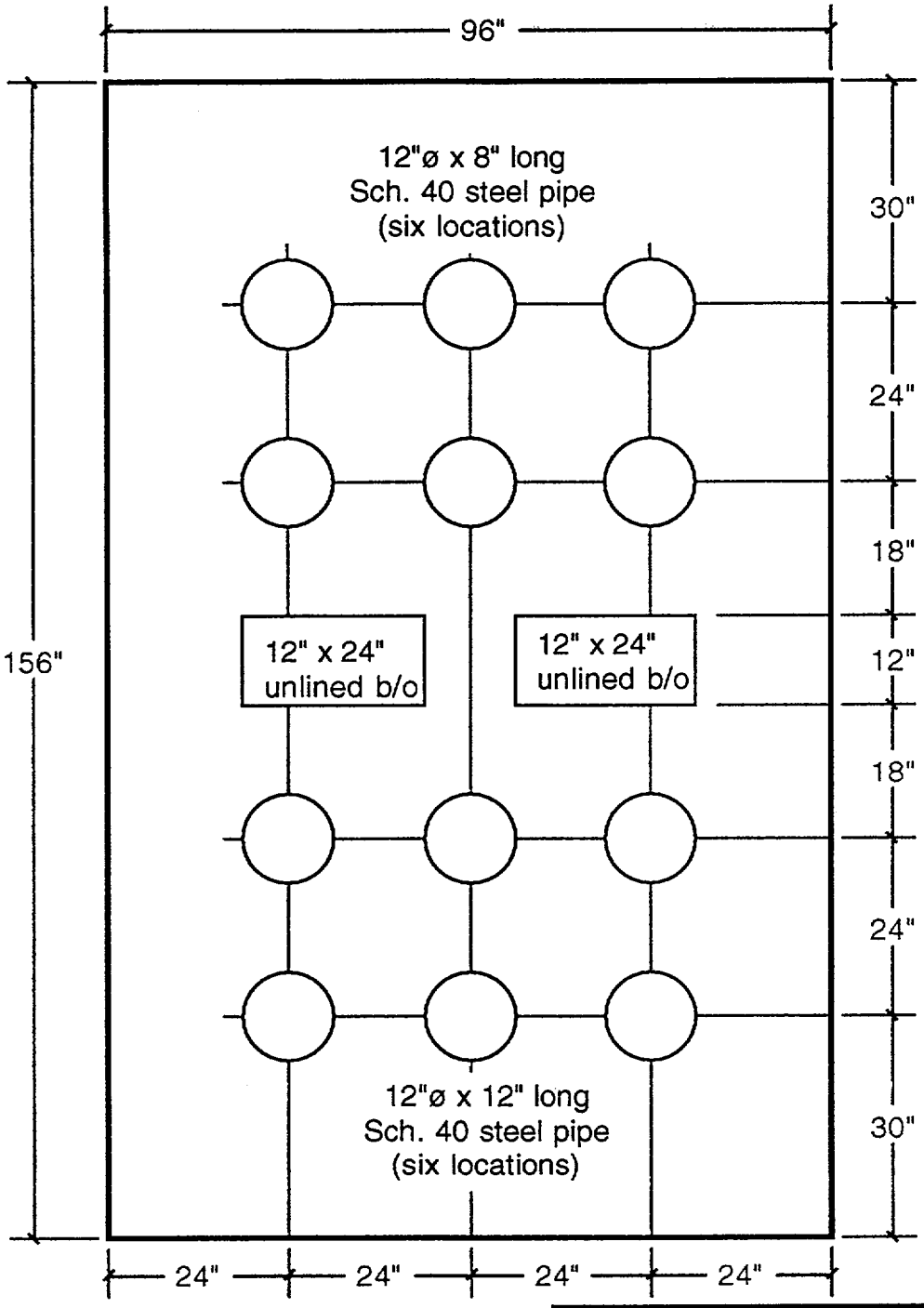
CONCLUSIONS

Based on the first occurrence of either unexposed surface flaming or Duke Power plant specific acceptance criteria for mechanical and electrical penetration seals (as specified on page 7 of this report), fire endurance ratings have been assigned to each penetration seal as follows:

PENETRATION SEAL	FIRE ENDURANCE (minutes)	PENETRATION SEAL	FIRE ENDURANCE (minutes)
1	180	8	180
2	180	9	136
3	180	10	156
4	180	11	180
5	180	12	132
6	180	13	124
7	180	14	180

Appendix A

CONSTRUCTION DRAWINGS



Note:
The 8" thick, normal-weight concrete slab contained twelve 12" Sch.40 pipe sleeves and two 12" x 24" unlined blockouts as indicated.

OMEGA POINT LABORATORIES, INC. Project No. 14980-106206
DUKE ENGINEERING & SERVICES INC.
Fig. 1 Slab Layout
Drwn by: D.N.Priest Date: 1/14/00 OPL Approval: C Humphrey Date: 1/19/00 DESI Approval: S Symbeck Date: 1/26/00

Scale: 1/2"=1'

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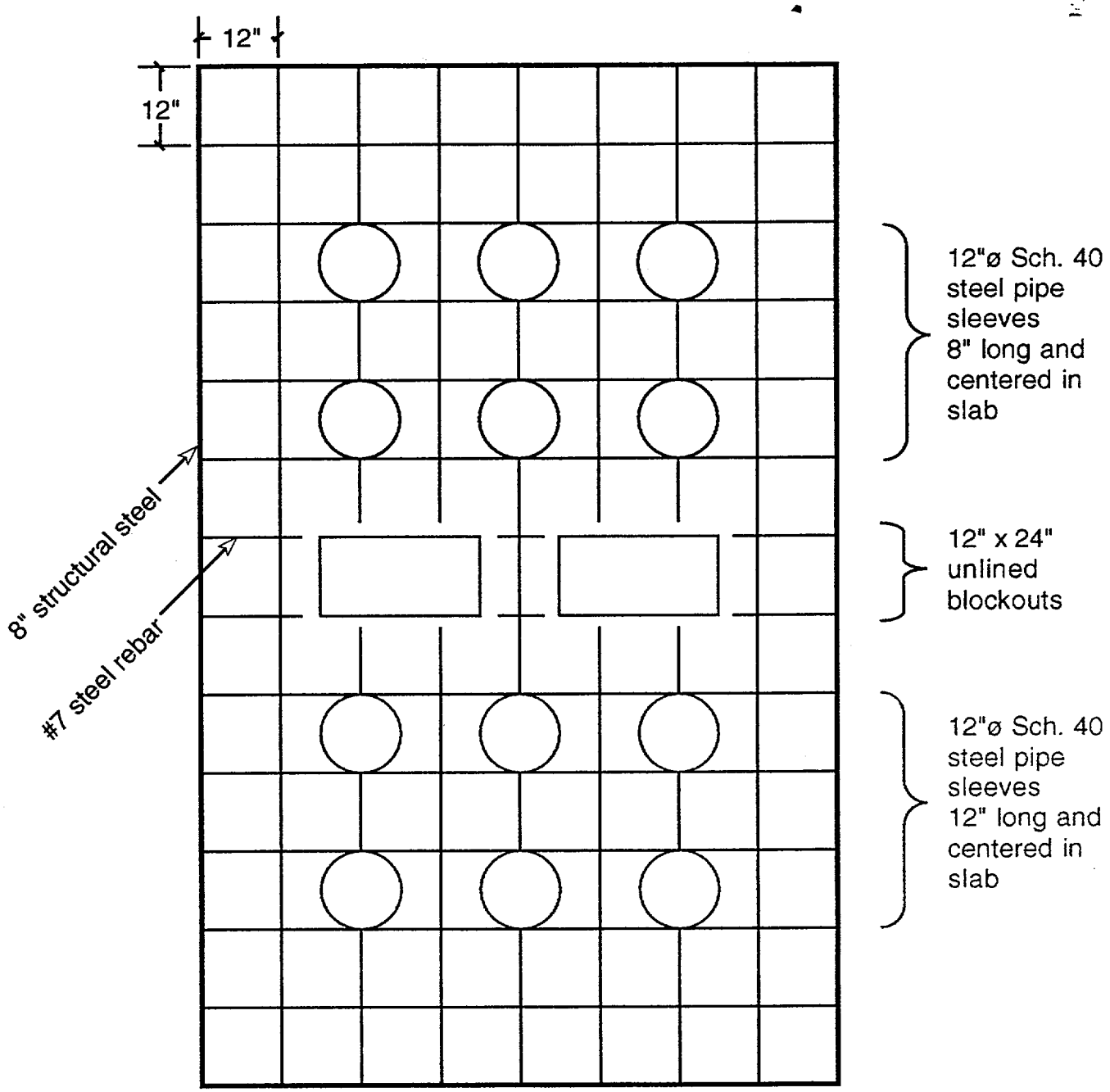


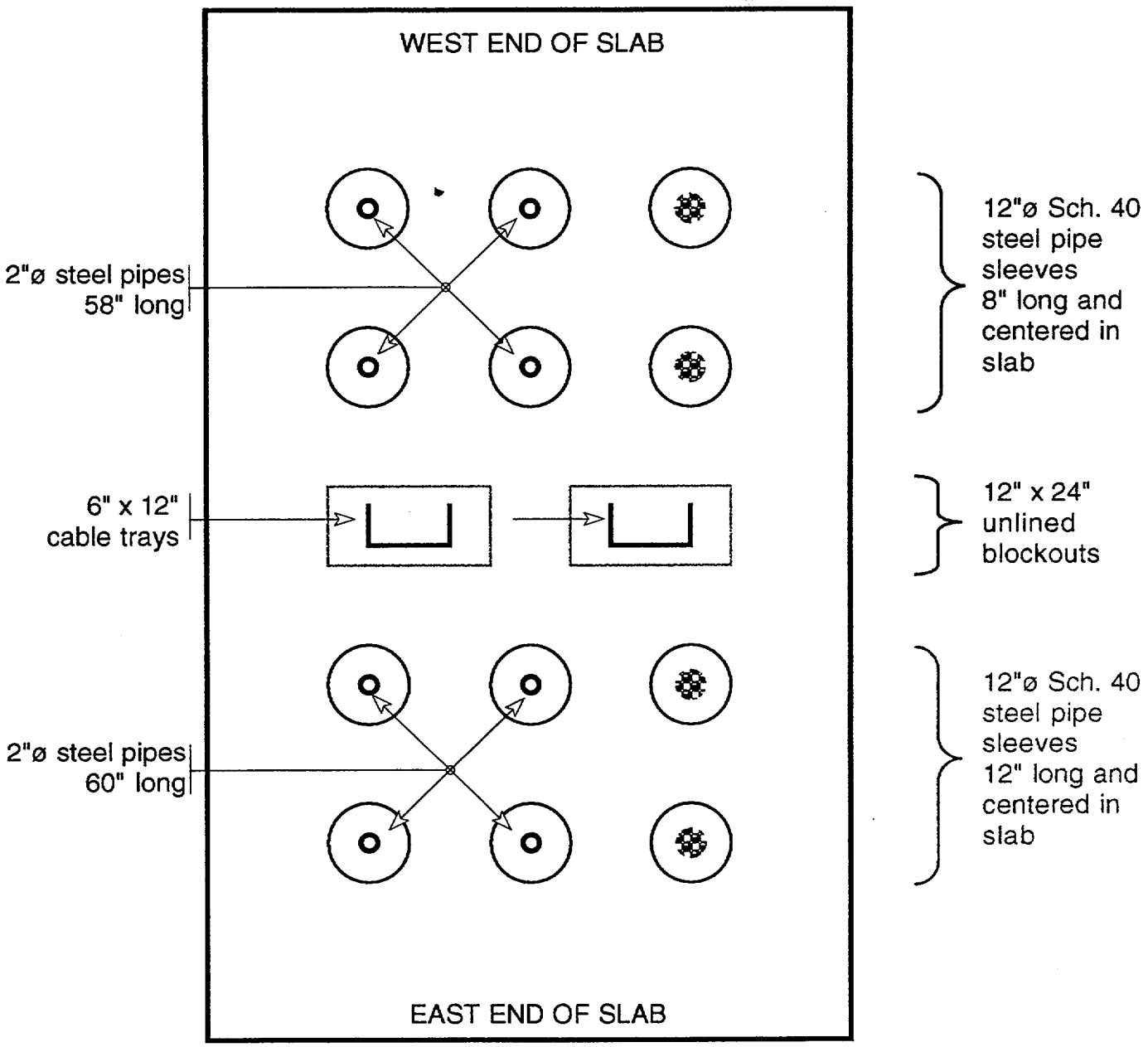
Note:
The 8" thick, normal-weight concrete slab consisted of a perimeter of 8" structural steel channel with #7 steel rebar spaced 12" o.c. with a minimum embedment of 1-1/2". 12" diameter steel sleeves and 12" x 24" unlined blockouts were positioned as indicated.

B.O.M.
8" channel: 510 ft
#7 rebar: 2500 ft
Concrete: 2.25 sq.yd.
Weight of slab: 10,000 lb

OMEGA POINT LABORATORIES, INC. Project No. 14980-106206
DUKE ENGINEERING & SERVICES INC.
Fig. 2 Rebar Layout
Drwn by: D.N.Priest Date: 1/14/00 OPL Approval: C Humphrey Date: 1/19/00 DESI Approval: [illegible] Date: 4/26/00

Scale: 1/2"=1'

OMEGA POINT LABORATORIES



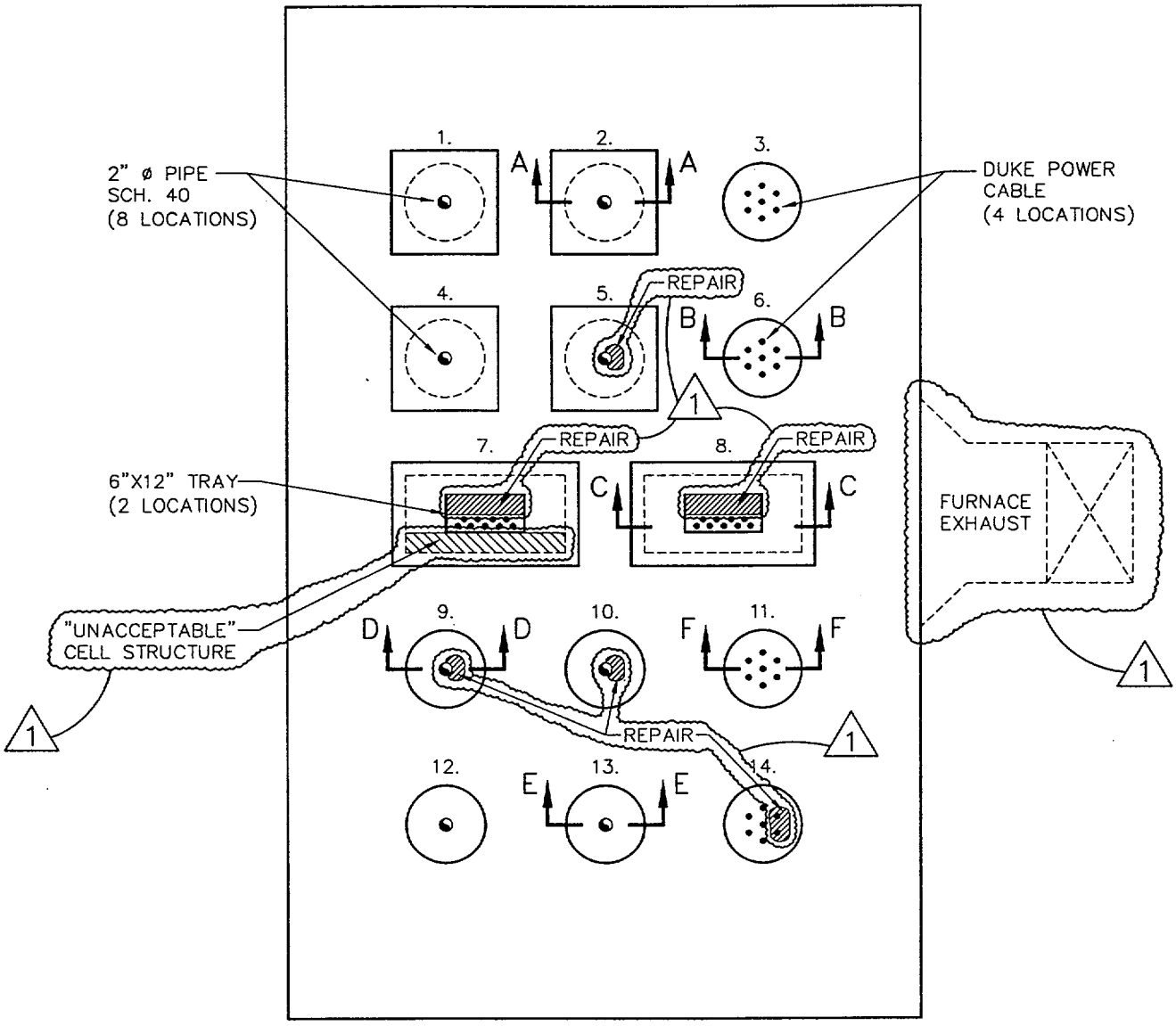
Note:
All 2"ø steel pipes, cable bundles and trays were mounted in the center of the sleeve or blockout, with 12" extending below the bottom of the slab or the sleeve. All were supported at 12" and 30" above the top surface of the slab.

OMEGA POINT LABORATORIES, INC. Project No. 14980-106206
DUKE ENGINEERING & SERVICES INC.
Fig. 3 Penetration Layout
Drwn by: D.N.Priest Date: 2/15/00 OPL Approval C.Humphrey Date: 2/15/00 DESI Approval L.S. Date: 3/2/00

Scale: 1/2"=1'

OMEGA POINT LABORATORIES

REV	DRWN	DSGN	VER	APP	DATE
1	ELT	LSG	RLD	LSG	5/17/00



"AS-BUILT"

NOTES: 1. PIPE PROVIDED BY OPL.
2. TRAYS AND CABLES PROVIDED BY DUKE POWER.
3. CABLE FILL PER PAGE 2.

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REVISION 1
DUKE POWER CURE TIME FIRE TEST
PAGE 1 OF 2
SLAB LAYOUT PLAN VIEW

1	ELT	LSG	RLD	2SG	5/17/00
REV	DRWN	DSGN	VER	APP	DATE

CABLE ID NO.	DE MARK NO.	CABLE TYPE	CABLE OD	CABLE AREA	(# OF CABLES PER TRAY) PEN 7	PEN 8	PEN 3	PEN 6	PEN 11	PEN 14
01051042N	**3XJ12G1**	**CONTROL**	**0.76**	**0.454**	**3**	**3**	**1**	**1**	**1**	**1**
01051029N	**8XJ12G1**	**CONTROL**	**1.02**	**0.817**	**3**	**3**	**1**	**1**	**1**	**1**
01051022N	**12XJ12G1**	**CONTROL**	**1.12**	**0.985**	**3**	**3**	**1**	**1**	**1**	**1**
01051025N	**19XJ12G1**	**CONTROL**	**1.30**	**1.327**	**3**	**3**	**1**	**1**	**1**	**1**
01091065N	**4SPXJ16G.3**	**INST.**	**0.92**	**0.665**	**3**	**3**	**1**	**1**	**1**	**1**
1091086	**1SPXJ16G.3**	**INST.**	**0.64**	**0.322**	**3**	**3**	**1**	**1**	**1**	**1**
01051030N	*8X12G1*	*CONTROL*	*0.90*	*0.636*	*1*	*1*	*2*	*2*	*2*	*2*
01091085N	*12X16G.1*	*CONTROL*	*0.72*	*0.407*	*1*	*1*	*2*	*2*	*2*	*2*
01091096N	*1SPTX16G.3*	*INST.*	*0.57*	*0.255*	*1*	*1*	*2*	*2*	*2*	*2*
01050005N	*1SPICX16N.3*	*INST.*	*0.51*	*0.204*	*1*	*1*	*2*	*2*	*2*	*2*

CABLE TRAY (SIZE)	CABLE TRAY USABLE AREA	TOTAL CABLE AREA	TOTAL NO. OF CABLES	ACTUAL FILL
A (6X12)	60	15.212	22	25.353
B (6X12)	60	15.212	22	25.353
PEN 3 (12" DIA.)	113.1	7.575	14	6.698
PEN 6 (12" DIA.)	113.1	7.575	14	6.698
PEN 11 (12" DIA.)	113.1	7.575	14	6.698
PEN 14 (12" DIA.)	113.1	7.575	14	6.698

NOTE: ITEMS IN **BOLD** TEXT REPRESENT ARMORED CABLES WITH AN OUTER CABLE JACKET MATERIAL.
ITEMS IN *ITALIC* TEXT REPRESENT ARMORED CABLES WITH NO OUTER JACKET MATERIAL.

1

"AS-BUILT"

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REVISION 1
DUKE POWER CURE TIME FIRE TEST
PAGE 2 OF 2
SLAB LAYOUT CABLE FILL

REV	DRWN	DSGN	VER	APP	DATE
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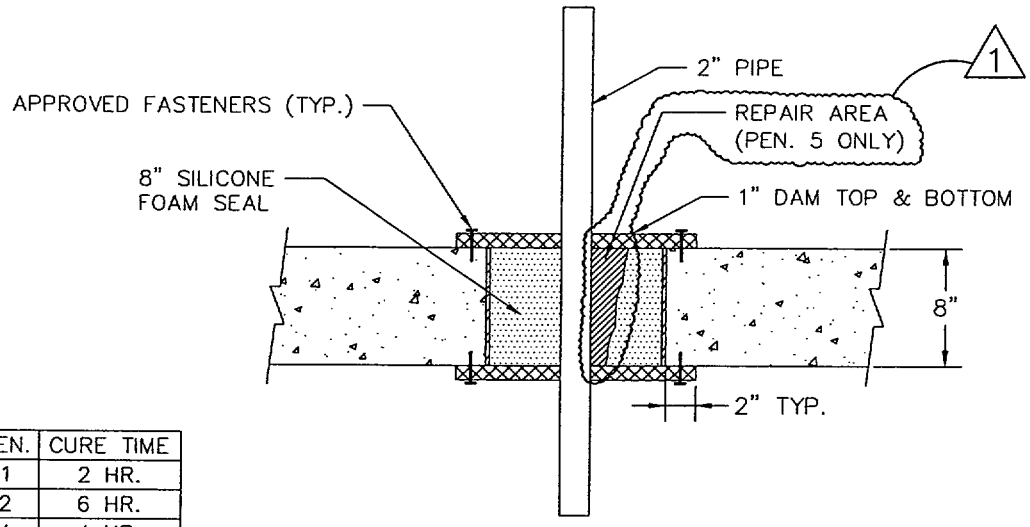
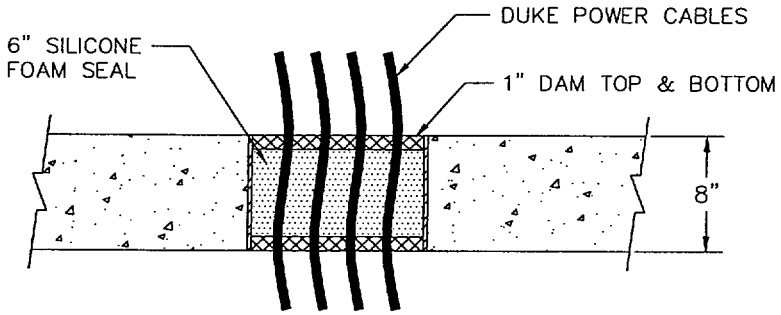


PEN.	CURE TIME
1	2 HR.
2	6 HR.
4	4 HR.
5	24 HR. *

* WITH REPAIR @ 4 HR CURE

SECTION A–A
(TYP. FOR PENS 1, 2, 4 & 5)



PEN.	CURE TIME
3	4 HR.
6	24 HR.

SECTION B–B
(TYP. FOR PENS 3 & 6)

1

"AS-BUILT"

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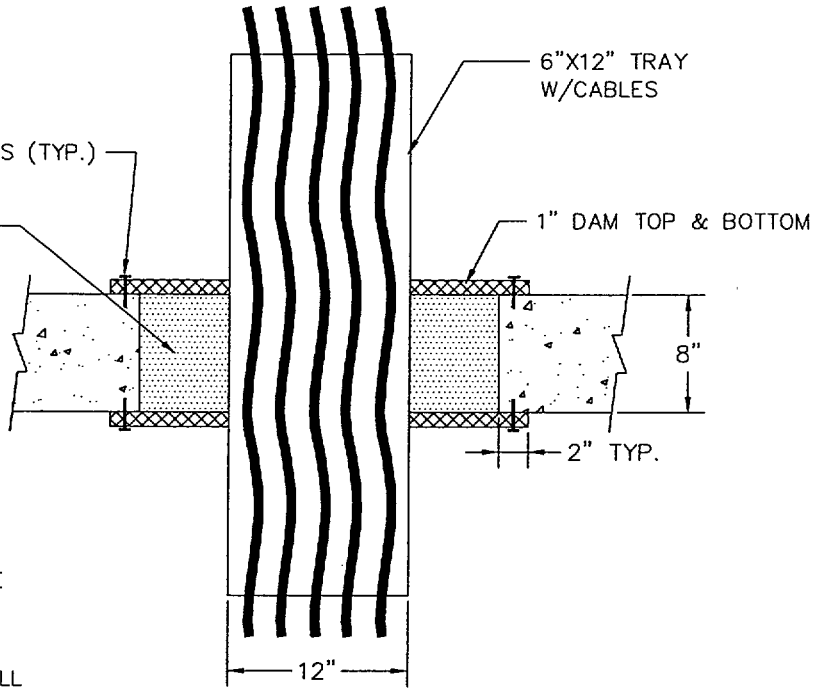
REVISION 1
DUKE POWER CURE TIME FIRE TEST
PAGE 1 OF 3
PENETRATION SEALS

1	ELT	LSG	RLD	LSG	5/17/96
REV	DRWN	DSGN	VER	APP	DATE

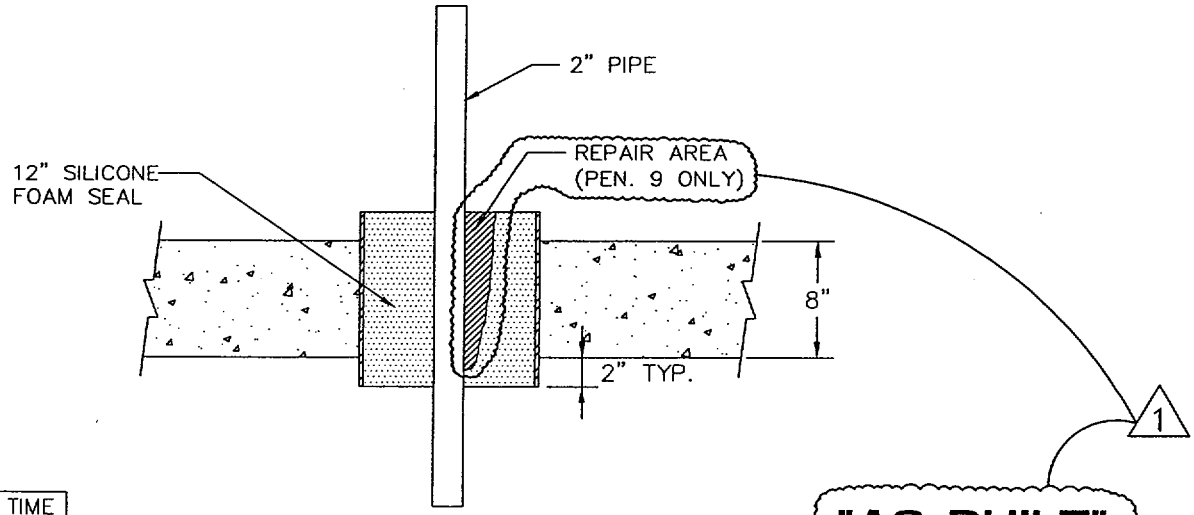


PEN.	CURE TIME
7	24 HR. *
8	24 HR. *1

* WITH REPAIR @ 2 HR CURE
*1 WITH REPAIR @ NO CURE

NOTE: A PORTION OF PEN. 7 WILL ALSO CONTAIN SILICONE FOAM WITH "UNACCEPTABLE" CELL STRUCTURE.

SECTION C–C
(TYP. FOR PENS 7 & 8)



PEN.	CURE TIME
9	24 HR. *
12	2 HR.

* WITH REPAIR @ NO CURE

SECTION D–D
(TYP. FOR PENS 9 & 12)

"AS-BUILT"

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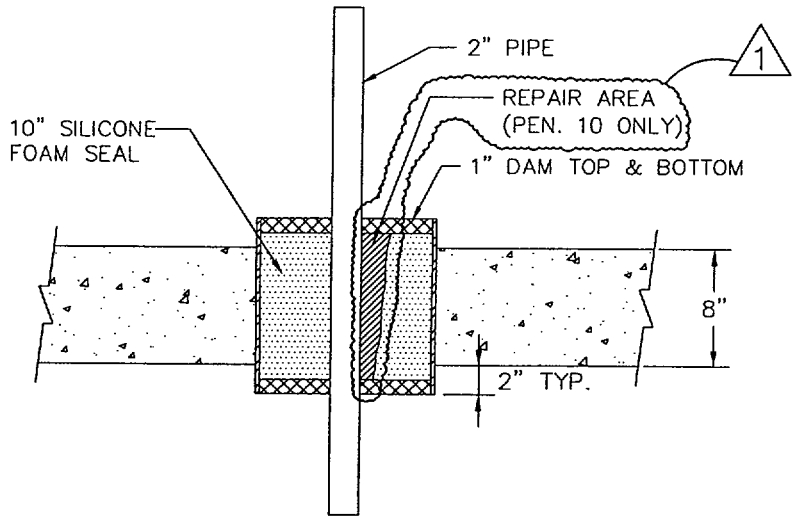
REVISION 1
DUKE POWER CURE TIME FIRE TEST
PAGE 2 OF 3
PENETRATION SEALS

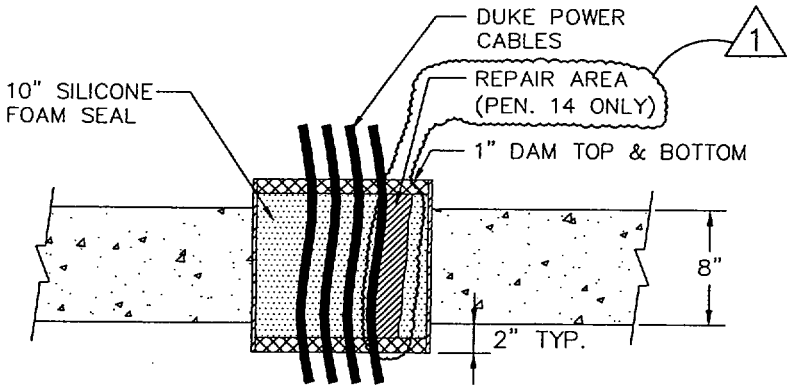
REV	DRWN	DSGN	VER	APP	DATE
1	ELT	LSG	RLD	LSG	5/17/00



PEN.	CURE TIME
10	24 HR. *
13	6 HR.

* WITH REPAIR @ 6 HR CURE

SECTION E–E
(TYP. FOR PENS 10 & 13)



PEN.	CURE TIME
11	24 HR.
14	24 HR. *

* WITH REPAIR @ NO CURE

SECTION F–F
(TYP. FOR PENS 11 & 14)

1

"AS-BUILT"

DOC. ID: 00003-23-0084-F16-002
REVISION 1
DUKE POWER CURE TIME FIRE TEST
PAGE 3 OF 3
PENETRATION SEALS

Appendix B

TEST PLAN

Experimental Three Hour Fire Resistance Test of Silicone Foam Penetration Seal Designs For Duke Power Company

OPL Project No. 14980-106206

TEST PLAN, Rev. 0

February 24, 2000

Prepared for:

Duke Engineering & Services, Inc. (DE&S)
6100 Southwest Blvd
Ft. Worth, TX 76109

ABSTRACT

This document consists of a Test Plan to describe the procedures and techniques to be utilized during the performance of the Experimental Three Hour Fire Resistance Test of Silicone Foam Penetration Seal Designs for Duke Power Company to evaluate the effects of reducing silicone foam cure time for penetration seals. The methodology necessary for the evaluation of all test configurations is described herein.

The details and instructions contained herein will be followed in the performance of this test project.

Deggary N. Priest
President

Date 2/24/00

TABLE OF CONTENTS

Experimental Three Hour Fire Resistance Test of Silicone Foam Penetration Seal Designs For Duke Power Company

TEST PLAN, Rev. 0

1.0 PURPOSE

The purpose of this test plan is to define the test methods and acceptance criteria for conducting a three-hour fire endurance and hose-stream test of various penetration seal configurations. This test plan also includes instructions for preparation of the test slab, installation of the penetration seal assemblies and documentation of test results.

2.0 OBJECTIVE

Newly installed or repaired silicone foam penetration seals typically are allowed to cure for at least 24-hours before being declared complete. The 24-hour cure time period is based on information provided by the silicone foam material manufacturer (Dow Corning®). According to manufacturer's product information, when Part A and Part B components of the silicone foam material are mixed a cure reaction takes place. During this reaction the silicone foam material cures or "snaps" to an expanded state. This reaction also results in the evolution of hydrogen gas. While gas generation is essentially completed during the first few minutes after the Part A and Part B components are mixed, hydrogen gas will continue to be released from the foam for at least 24-hours. The rate of release is dependent upon penetration size, seal design and ambient temperature, and the amount of hydrogen gas generated is based upon the amount of material used. Ultimately, because of the closed cell nature of the cured silicone foam, the hydrogen gas is released over a period of time by diffusion.

Because the silicone foam material cures or "snaps" to its final physical foam in a matter of minutes the physical seal is in place essentially minutes after material installation. However, because of the hydrogen gas evolution and diffusion process discussed above, the silicone foam material is allowed to further cure for at least 24-hours prior to being declared complete. More often than not repairs and/or modifications are made to existing penetration seals using limited quantities of new silicone foam material. Therefore, based on the manufacturer's product information many of these repair activities may result in the creation of a negligible amount of hydrogen gas. If this is the case, then many silicone foam seals could be declared complete almost immediately upon completion of the material installation process.

The objective of this test is to subject several silicone foam seals, each allowed to cure for a varying amount of time, to a standard fire endurance and hose-stream test to obtain performance data. Successful results of this test program will provide data that may be used to support shorter cure time requirements for silicone foam seals based on the amount of seal material used. The test assembly will be comprised of an 8" thick concrete slab, 156 inches long and 96 inches wide, and will contain fourteen (14) individual penetrations. The basic configurations to be tested include the following:

2.1 Four (4) 12" diameter by 8" long steel sleeves each containing a 2" pipe and all sealed with an 8" depth of silicone foam and 1" of ceramic damming material on both sides of the penetration. The cure times for each of these seals will be as follows:

- One with at least a 24-hour cure time
- One with an ~6-hour cure time
- One with an ~4-hour cure time
- One with an ~2-hour cure time

The penetration with the 24-hour cure time will have a simulated repair made in the area of the pipe penetration. The repair are will have an ~4-hour cure time.

These penetrations are referred to as **Penetrations 1, 2, 4 and 5** on test plan drawings.

2.2 Two (2) 12" diameter by 8" long steel sleeves both containing cabling and both sealed with a 6" depth of silicone foam and 1" of ceramic damming material on both sides of the penetration. The cure times for these seals will be as follows:

- One with at least a 24-hour cure time
- One with an ~4-hour cure time

These penetrations are referred to as **Penetrations 3 and 6** on test plan drawings.

2.3 Two (2) 12"x 24" blockouts both containing a 6" x 12" cable tray with cabling and both sealed with an 8" depth of silicone foam and 1" of ceramic damming material on both sides of the penetration. The cure times for the initial seal for both of these penetrations will be at least

24-hours. A simulated cable repair will be made to each seal with the repair area cure times being as follows:

- One with an ~2-hour cure time
- One with as little cure time as possible between the repair and initiation of the fire test (~ 15 to 30-minute cure time)

These penetrations are referred to as **Penetrations 7 and 8** on test plan drawings.

Additionally, a portion of the baseline seal for **Penetration 7** will be installed using silicone foam with "unacceptable" cell structure. The "unacceptable" cell structure material will be installed opposite the repair area to allow each condition to be evaluated separately. The "unacceptable" cell structure material will occupy approximately 25% of the total seal area.

2.4 Two (2) 12" diameter by 12" long steel sleeves each extending 2" past the slab on both sides of the barrier. Both sleeves will contain a 2" pipe and both will be sealed with a 12" depth of silicone foam and no permanent damming material. The cure times for each of these seals will be as follows:

- One with at least a 24-hour cure time
- One with an ~2-hour cure time

The penetration with the 24-hour cure time will have a simulated repair made in the area of the pipe penetration. The repair area cure time will be as short as possible between the repair and initiation of the fire test (~ 15 to 30-minute cure time).

These penetrations are referred to as **Penetrations 9 and 12** on test plan drawings.

2.5 Two (2) 12" diameter by 12" long steel sleeves each extending 2" past the slab on both sides of the barrier. Both sleeves will contain a 2" pipe and both will be sealed with a 10" depth of silicone foam and 1" of ceramic damming material on both sides of the penetration. The cure times for these seals will be as follows:

- One with at least a 24-hour cure time
- One with an ~6-hour cure time

The penetration with the 24-hour cure time will have a simulated repair made in the area of the pipe penetration. The repair area will have an ~6-hour cure time.

These penetrations are referred to as **Penetrations 10 and 13** on test plan drawings.

2.6 Two (2) 12" diameter by 12" long steel sleeves each extending 2" past the slab on both sides of the barrier. Both sleeves will contain cabling and both sealed with a 10" depth of silicone foam and 1" of ceramic damming material on both sides of the penetration. The cure time for both of these seals will be at least 24-hours.

A simulated cable repair will be made to one of these seals with the repair area cure time being as little as possible between the repair and initiation of the fire test (~ 15 to 30-minute cure time).

These penetrations are referred to as **Penetrations 11 and 14** on test plan drawings.

3.0 ACCEPTANCE CRITERIA

The results of this test shall be evaluated using the specific acceptance criteria committed to by each of the Duke Power nuclear generating stations. The specific acceptance criteria to be used is as follows:

- The IEEE-634 acceptance limit of 700°F is applicable to ONS and MNS electrical penetration seal designs. This limit applies to both penetrant temperatures and unexposed side surface temperatures.

- The IEEE-634 acceptance limit of 700°F is applicable to CNS electrical penetration seal designs for unexposed side cable temperatures only. The unexposed side surface temperature for CNS electrical penetration seals is limited to a temperature rise of 325°F (i.e., 325°F + initial temperature).

- The IEEE-634 acceptance limit for mechanical penetration seals shall be 680°F for all Duke Power stations. This temperature was selected because it represents the lowest temperature of any material normally found in close proximity to piping penetrations (Armstrong Armalok pipe insulation). This limit applies to both penetrating item temperatures and unexposed side surface temperatures.

4.0 REFERENCES

4.1 IEEE-634, "IEEE Standard Cable Penetration Fire Stop Qualification Test," 1978 Edition.

4.2 ASTM E-119-76, "Standard Test Methods for Test of Building Construction and Materials."

5.0 RESPONSIBILITIES

5.1 Duke Power

5.1.1 Provide concurrence of final test plan prior to initiation of test specimen construction activities.
5.1.2 Provide concurrence of any revisions to test plan during test specimen construction activities.
5.1.3 Supply site specific cable trays and cabling to be used in the test assembly.
5.1.4 Supply any site specific fasteners to be used in the test assembly.
5.1.5 Supply personnel to witness test assembly construction (at the discretion of Duke Power).
5.1.6 Supply personnel to witness performance of fire test (at the discretion of Duke Power).

5.2 Duke Engineering & Services (DE&S)

5.2.1 Provide engineering input to laboratory for formal test plan including test specimen drawings and necessary bill of materials.
5.2.2 Establish necessary sub-contract agreements with test facility and penetration seal installation contractor.
5.2.3 Coordinate overall test program.

5.3 Omega Point Laboratories, Inc. (OPL)

5.3.1 Prepare the test slab, including installation of penetrating items, and provide all required test instrumentation in accordance with the Laboratory's Quality Assurance and Quality Control Programs.

5.3.2 Provide thermocouple calibration and instrumentation. Provide storage temperature recorder and relative humidity instrumentation in Conditioning Room in Building C.
5.3.3 Provide all test article support assemblies (below and above the test assembly).
5.3.4 Supply, assemble, install and document the installation of all trays, conduits, pipes, supports, thermocouples, etc. associated with the test specimen.
5.3.5 Conduct the fire exposure and hose stream tests.
5.3.6 Inspect and document the physical conditions of all penetration seal assemblies following completion of hose stream test activities.
5.3.7 Document test parameters and provide a formal detailed written report of the test program and results.
5.3.8 Provide color digital and video photographic coverage of the test project.

5.4 Penetration Seal Installation Contractor

Provide seal and damming materials, installation personnel, quality control personnel and documentation of seal installation activities in accordance with the installer's Quality Assurance and Quality Control programs.

6.0 SPECIAL PRECAUTIONS

6.1 Precautions For Installation Of Seal Assemblies

Observe specific precautions recommended by seal material manufacturer and material safety data sheets.

6.2 Precautions For Conducting Fire Endurance Test

Proper safety precautions shall be exercised to preclude personnel from direct exposure to flame environment, hot objects, hazardous gases and all other related hazards.

7.0 PREREQUISITES

7.1 General Test Configuration Requirements

The test assembly, including slab layout, penetrating item locations and penetration seal configurations shall be as specified by DE&S.

7.2 Traceability Requirements

7.2.1 The cables used in this test program shall be traceable to the respective cable manufacturer and shall be supplied by Duke Power.

7.2.2 The seal materials used in this test program shall be traceable to the respective material manufacturer and shall be supplied by the selected penetration seal installation contractor.

7.2.3 All thermocouples used in this test program shall be traceable to the respective thermocouple manufacturer, shall have calibration certification and shall be supplied by the testing laboratory.

7.3 Dimensioned Drawings

All test articles shall conform to the dimensioned drawings supplied by DE&S. Any differences between designed and constructed/tested assemblies shall be noted in final drawings contained within the test report.

7.4 Test Configuration

All test articles shall be securely fastened to the test slab by the laboratory. All openings shall be sealed in accordance with test plan instructions and drawings.

7.5 Cable Loading Requirements

Cable loading shall be as prescribed in the final test plan and drawings.

7.6 Thermocouple Installation

All thermocouples used in this test program shall be as detailed in the final test plan and located as specified on approved drawings.

8.0 PROCEDURE

8.1 Fire Endurance Test

The test specimen shall be exposed to the standard time/temperature curve found in ASTM E-119, 1976 Edition (Reference 4.2) for three hours.

At not more than thirty-minute increments throughout the fire endurance test, visual observation of the test assembly shall be noted.

8.2 Water Hose Stream Test

Immediately following the fire endurance test, the expose surface of the test specimen shall be subjected to a water hose stream test (30° Fog Nozzle option) in accordance with the provisions of IEEE-634, 1978 Edition (Reference 4.1).

8.3 Post Test Examination

Following the water hose stream test, the test specimen shall be allowed to cool and subjected to visual and physical post test examinations. These examinations shall include but not necessarily be limited to the following:

- Observation of cable jacketing (blistering, splitting, etc.)
- Observation of seal conditions (integrity of damming boards, depth of seal material charring, etc.)
- Observation of silicone foam with "unacceptable" cell structure

9.0 DATA SYSTEMS

During the fire exposure period, the thermocouples will be scanned at one-minute intervals or less. Data storage for reporting purposes will be at one-minute intervals, although furnace thermocouples will be scanned every 15 seconds, to allow close control of the furnace.

10.0 FIRE TEST REPORT

The Laboratory will submit a report on the results of the test and thermocouple data. The Laboratory will assemble the final test report, containing the collected data and required quality control documentation. The test report shall be prepared in sufficient detail to summarize the total testing activity. The report shall include as a minimum:

- Date of test
- Location of test
- Description of test furnace and test articles

- Calibration documentation for all thermocouples
- Qualification and certification for seal installation personnel
- Test procedures used
- Acceptance criteria
- Provide quality control records for:
  - Test article construction
  - Qualification and certification for Laboratory testing and quality personnel
  - Identification and installation of seal materials
  - Thermocouple locations
  - Cable types, sizes and locations
  - Tray fill levels
- Computer printout and graphic results of the fire endurance test
- All raw data including thermocouple measurements
- Color digital photographic and videotape coverage of the test project
- Provide a chronological log (Event Log) of all activities from receipt of materials through final test report

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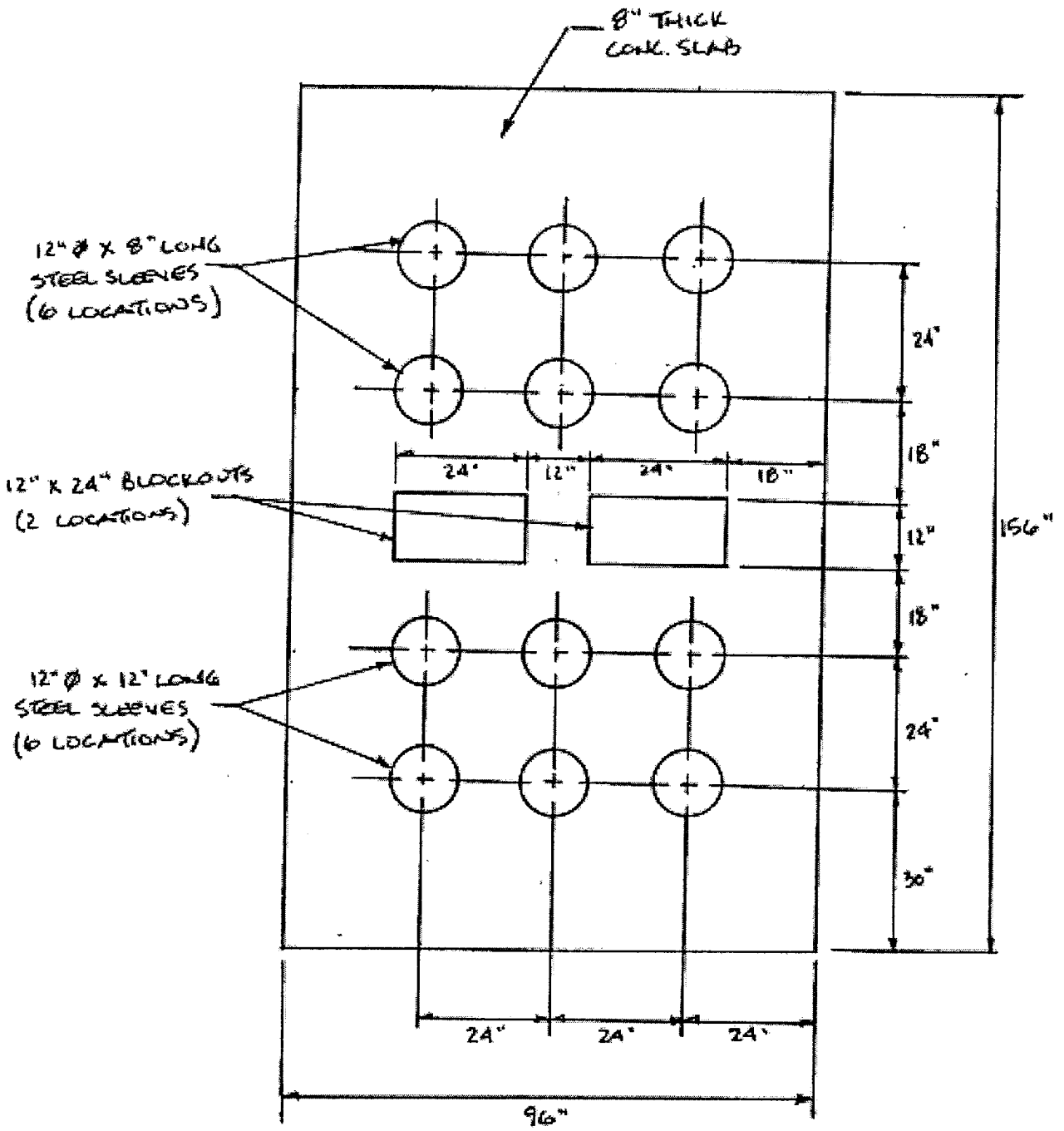
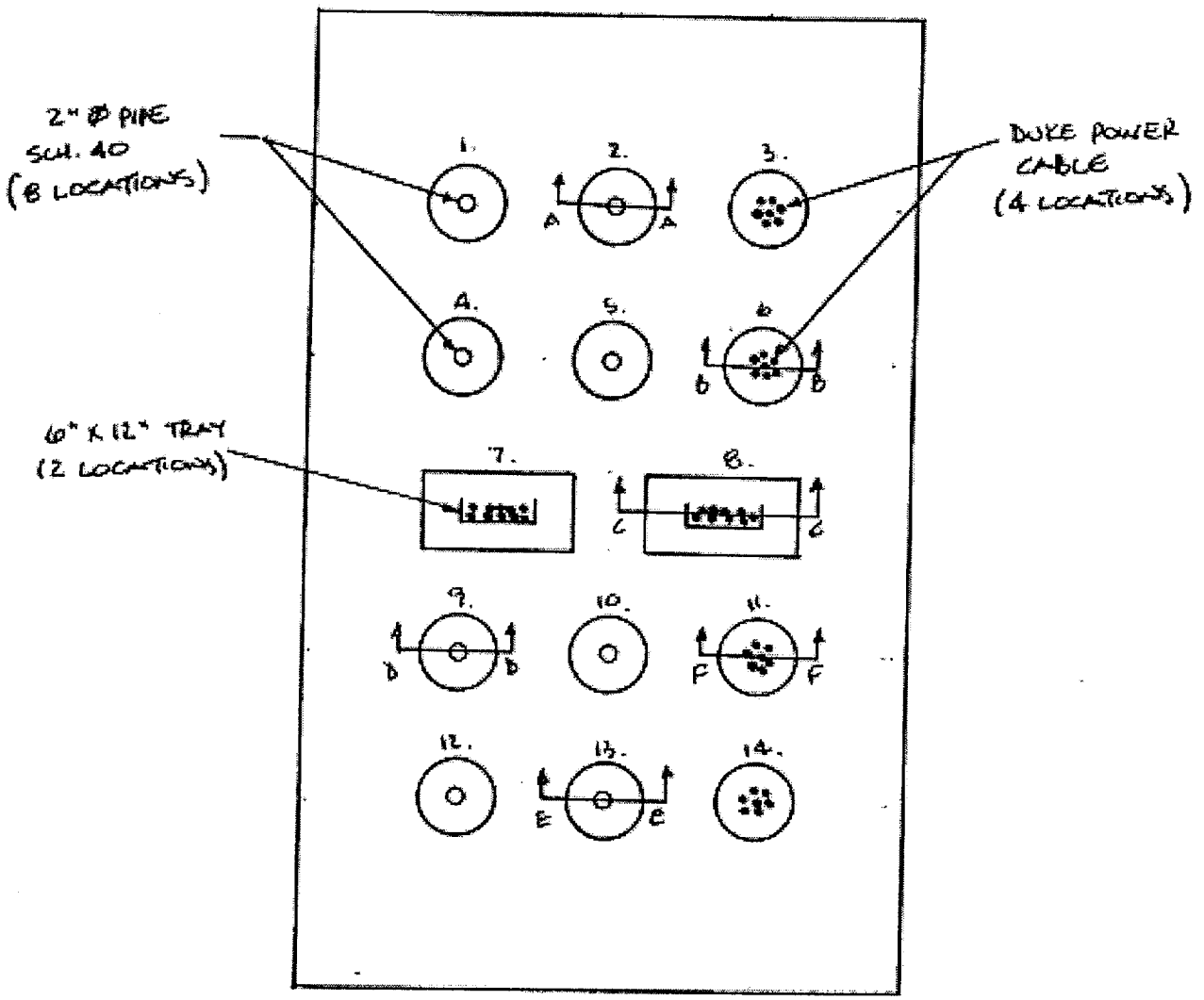
App. A



OMEGA POINT LABORATORIES

SLAB LAYOUT
1 OF 1

App. A

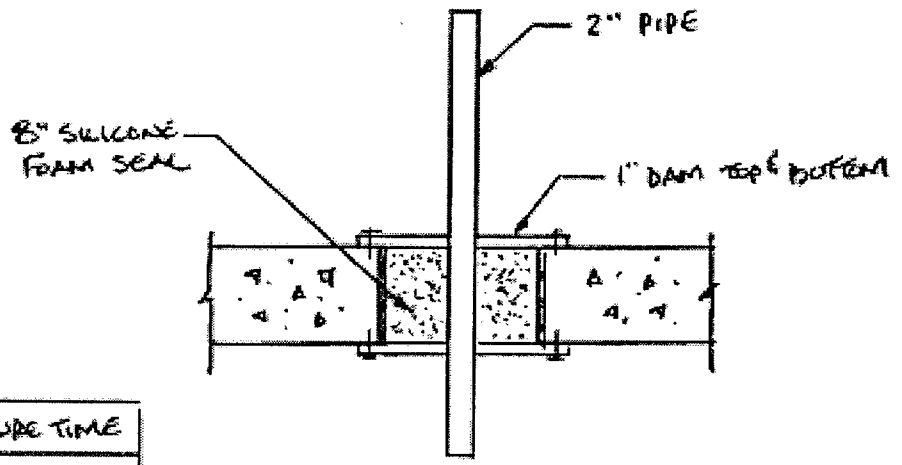


NOTES: 1. PIPE PROVIDED BY OPL
2. TRAYS & CABLES PROVIDED BY DUKE POWER
3. CABLE FILL TBD.

OMEGA POINT LABORATORIES

PENETRATING ITEMS
1 OF 1

App. A

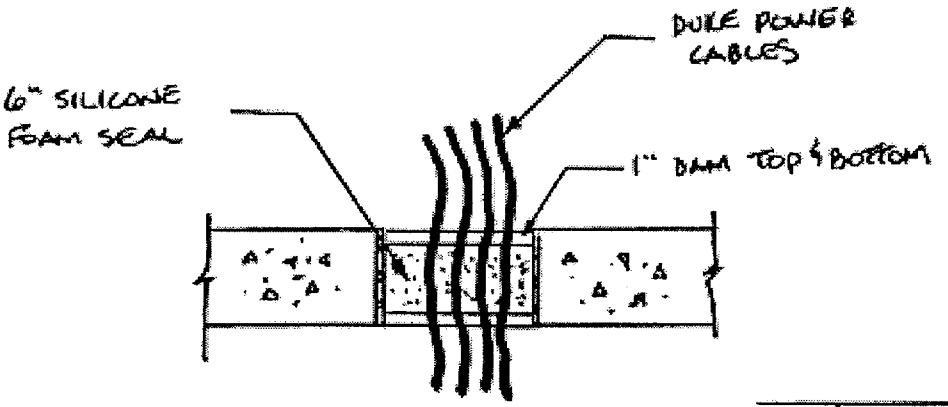


PEN.	CURE TIME
1	2 HR
2	6 HR
4	4 HR
5	24 HR*

* WITH REPAIR @ 4 HR CURE

SECTION A-A

(TYP. FOR PENS. 1, 2, 4 & 5)



PEN.	CURE TIME
3	4 HR
6	24 HR

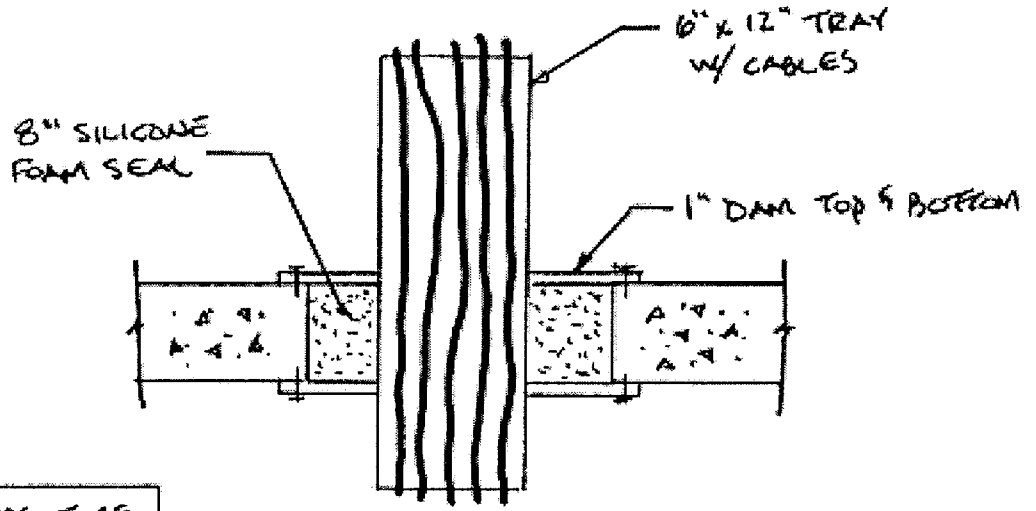
SECTION B-B

(TYP. FOR PENS. 3 & 6)

OMEGA POINT LABORATORIES

PENETRATION SEALS
1 OF 3

App. A



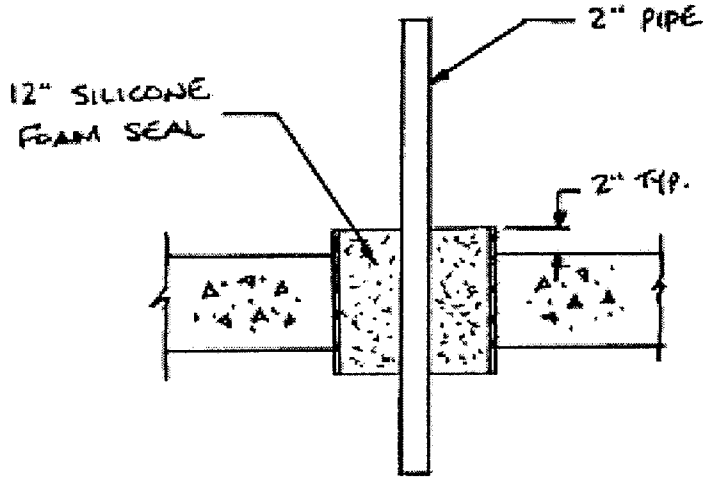
PEN.	CURE TIME
7	24 HR*
8	24 HR *1

SECTION C-C

(TYP. FOR PENS. 7 & 8)

* W/ REPAIR & 2 HR CURE

*1 W/ REPAIR & NO CURE



PEN.	CURE TIME
9	24 HR
12	2 HR

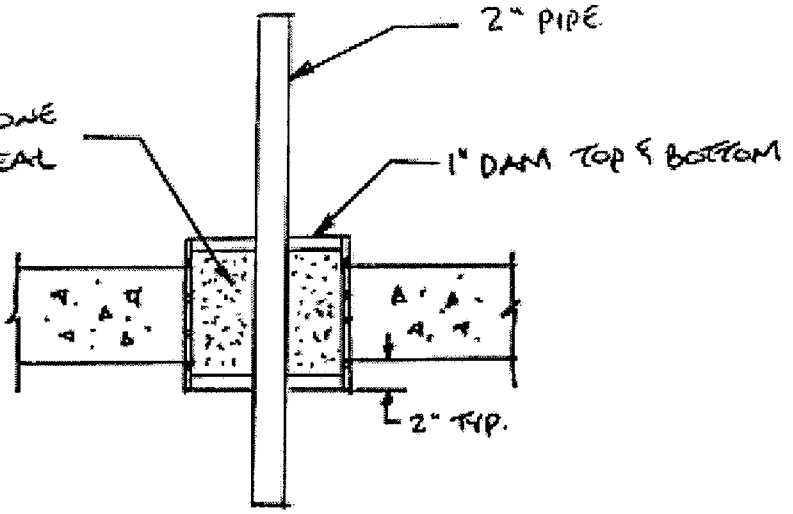
SECTION D-D

(TYP. FOR PENS. 9 & 12)

OMEGA POINT LABORATORIES

PENETRATION SEALS
2 OF 3

App. A

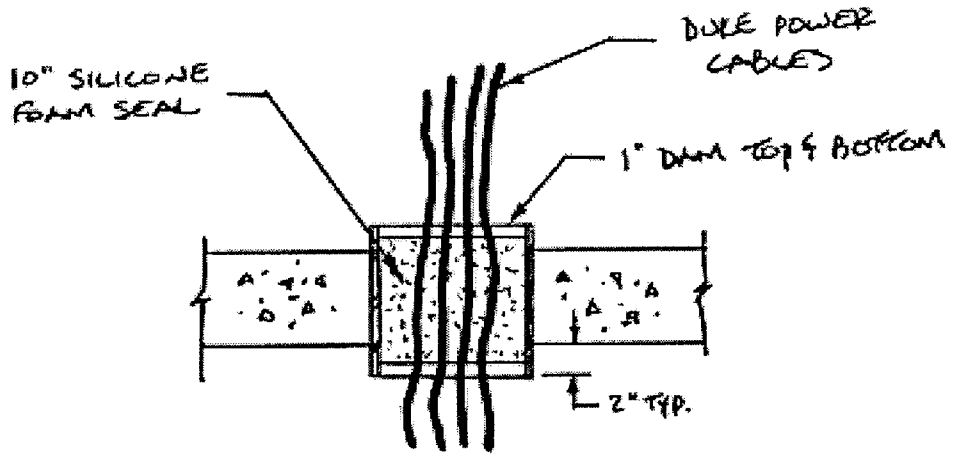


PEN.	CURE TIME
10	24 HR*
13	6 HR

* w/ REPAIR & LONG CURE

SECTION E-E

(TYP. FOR PENS. 10 & 13)



PEN.	CURE TIME
11	24 HR
14	24 HR*

* w/ REPAIR & NO CURE

SECTION F-F

(TYP. FOR PENS. 11 & 14)

OMEGA POINT LABORATORIES

PENETRATION SEALS

3 OF 3

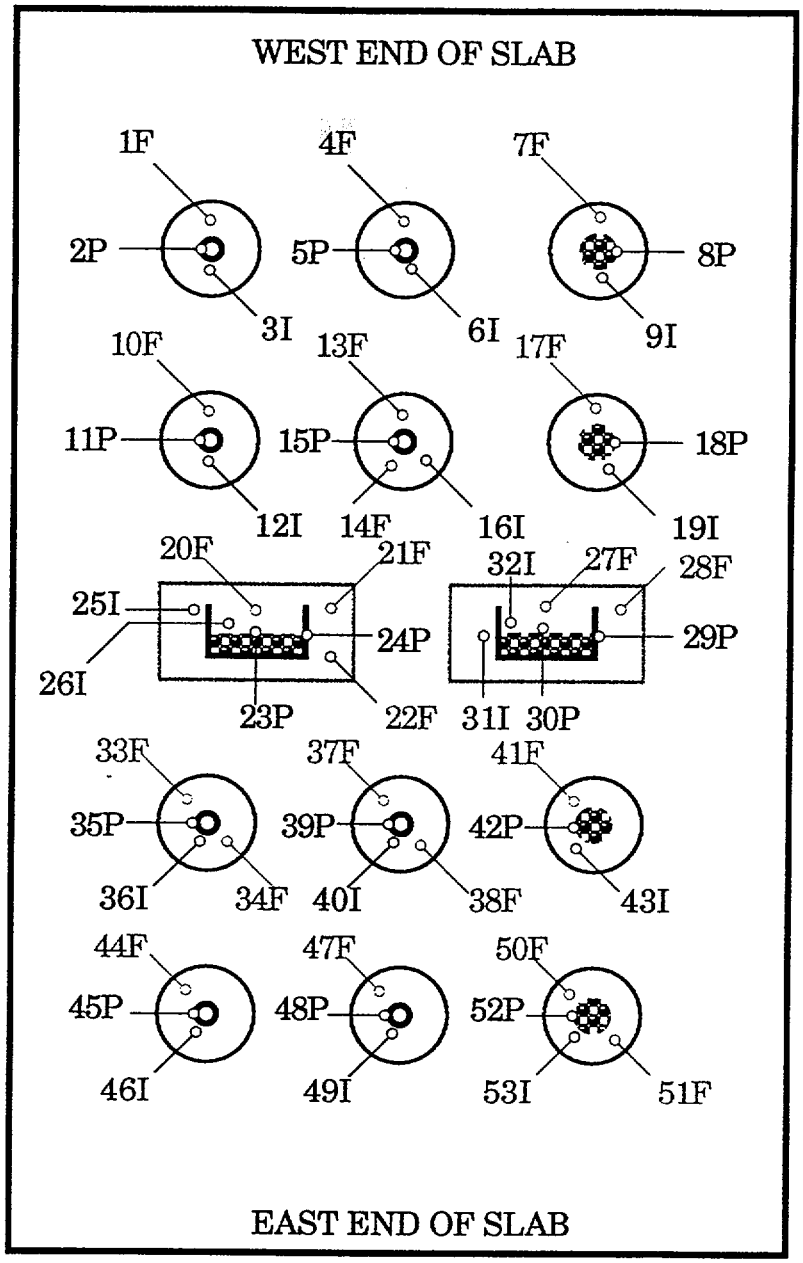
App. B.

Time Critical Sequence
Duke Power Cure Time Test

	Activity	Responsible Org.	Completion By
1.	Duke Power Issues DE&S P.O.	Duke Power	1/28/00 Close of Business
2.	DE&S Issues OPL P.O.	DE&S	1/31/00 Close of Business
3.	DE&S Issues Promatec P.O.	DE&S	2/10/00 Close of Business
4.	Pour test slab	OPL	2/28/00 Close of Business
5.	Attach penetrating items to slab	OPL	
6.	Pre-Run TC wires for ALL pens.	OPL	
7.	Install >24 hr cure time seals	Promatec	3/2/00 @ 1:00pm CST
8.	Install ~6 hr cure time seals	Promatec	3/2/00 @ 7:00am CST
9.	Install ~4 hr cure time seals	Promatec	3/2/00 @ 9:00am CST
10.	Install ~2 hr cure time seals	Promatec	3/2/00 @ 11:00am CST
11.	Place slab on furnace	OPL	3/2/00 @ ~11:15pm CST
12.	Attach TC leads and pads**	OPL	3/2/00 @ ~12:30pm CST
	***Except for Pen. 8, 9 & 14 repair areas.*		
13.	Perform Pen. 8, 9 & 14 repairs	Promatec	3/2/00 @ ~12:35pm CST
14.	Attach TC pads for Pen. 8, 9 & 14 repairs	OPL	3/2/00 @ ~12:45pm CST
15.	Start Fire Test	OPL	3/2/00 @ 1:00pm CST
16.	Hose Stream Test	OPL	3/2/00 Following Fire Test
17.	Post Test Examination	DE&S/OPL	3/3/00 9:00am CST

Appendix C

THERMOCOUPLE LOCATONS



Note:
Thermocouple designations are as follows:

"F" = On the surface of the firestop.
"P" = On the penetrant, 1" above surface.
"I" = On the seal surface, 1" from pen.

OMEGA POINT LABORATORIES, INC. Project No. 14980-106206
DUKE ENGINEERING & SERVICES INC.
Fig. 4 Thermocouple Locations
Drwn by: D.N.Priest Date: 2/28/00 OPL Approval: C Humphrey Date: 2/28/00 DESI Approval: L Gruber Date: 2/28/00

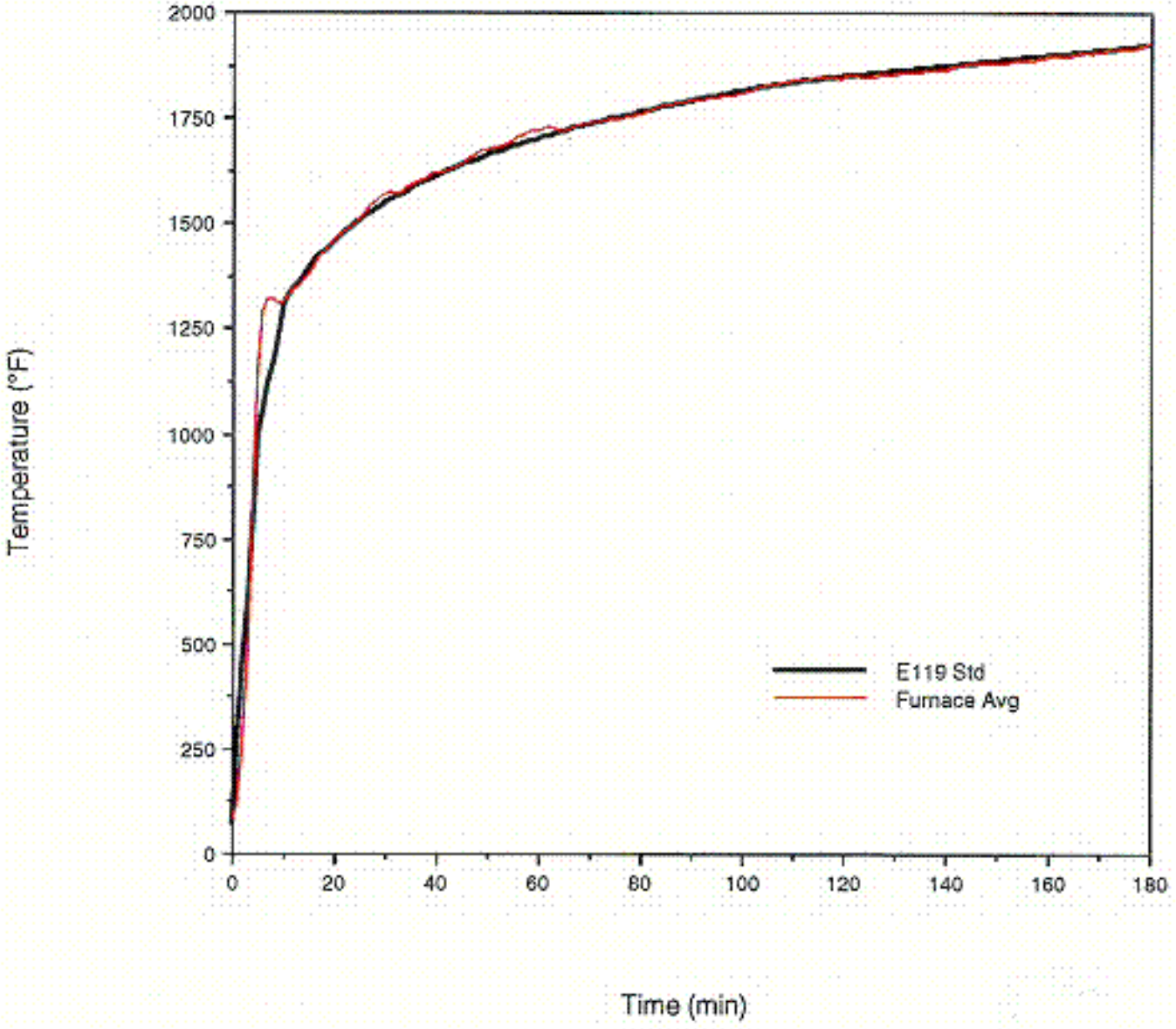
Scale: 1/2"=1'

OMEGA POINT LABORATORIES

Appendix D

TEST DATA

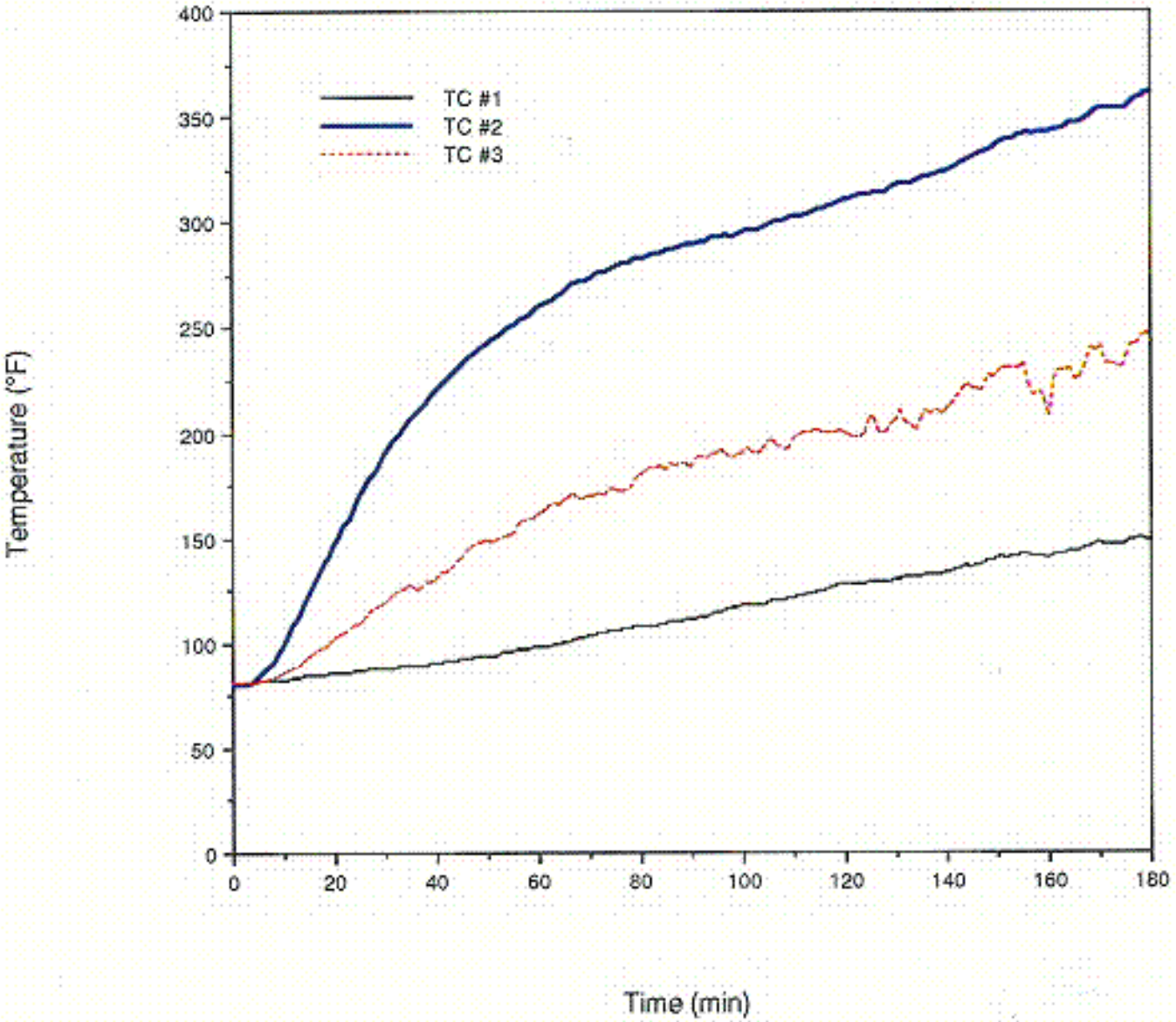
Project No. 14980-106206
Duke Engineering & Services, Inc.
Furnace Interior Temperatures



OMEGA POINT LABORATORIES

C1

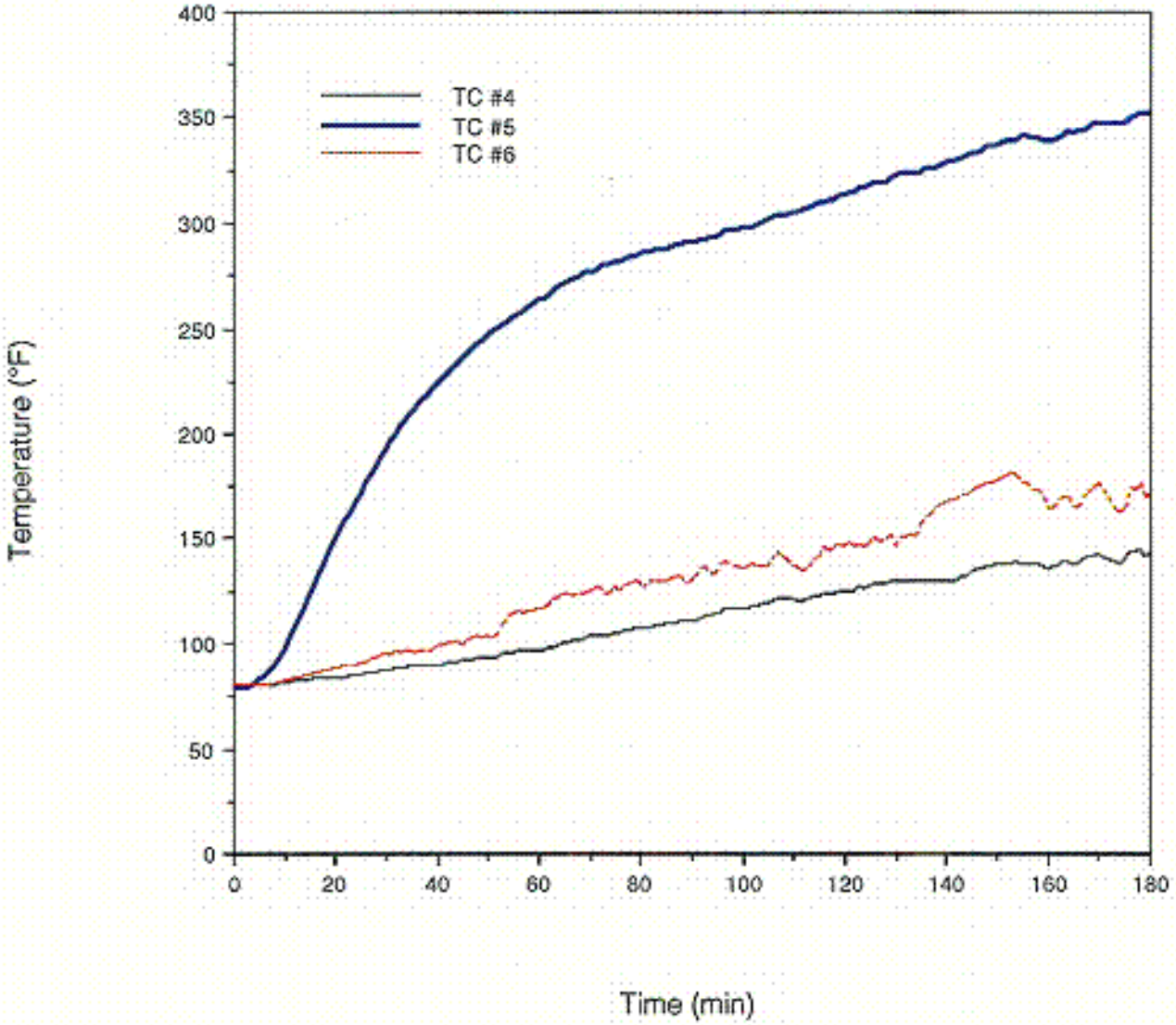
Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #1 Thermocouples



OMEGA POINT LABORATORIES

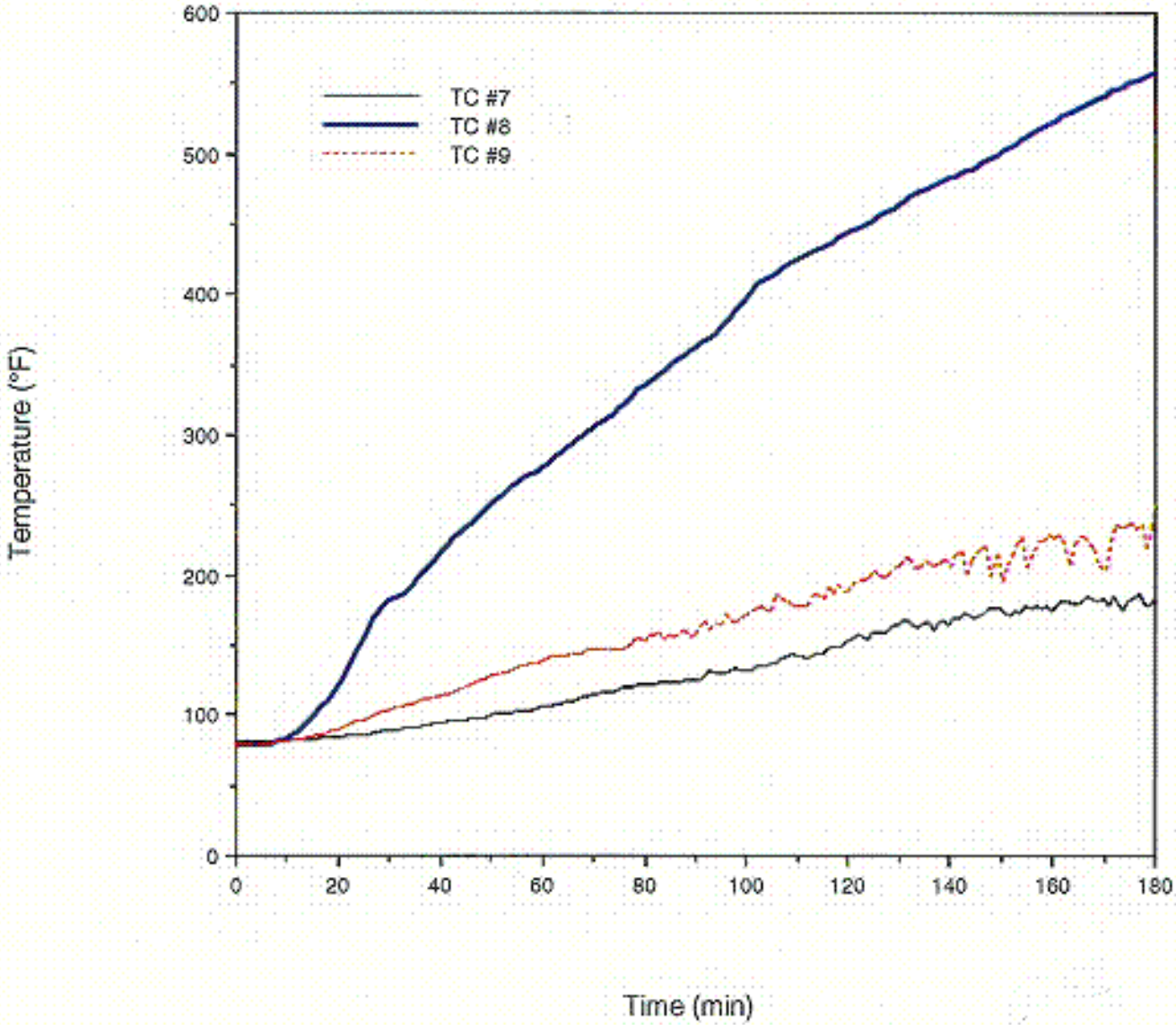
C2

Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #2 Thermocouples



OMEGA POINT LABORATORIES

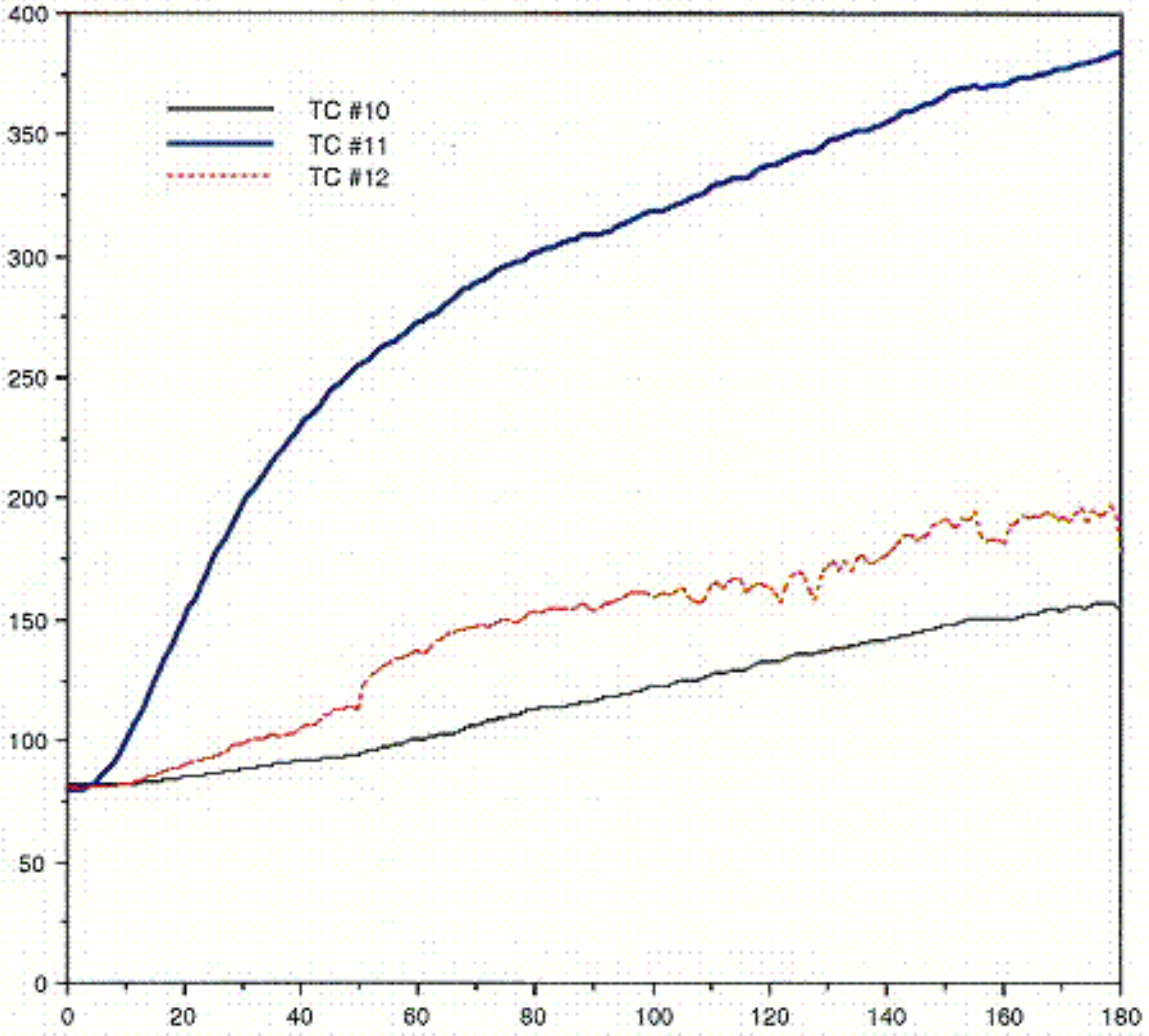
Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #3 Thermocouples



OMEGA POINT LABORATORIES

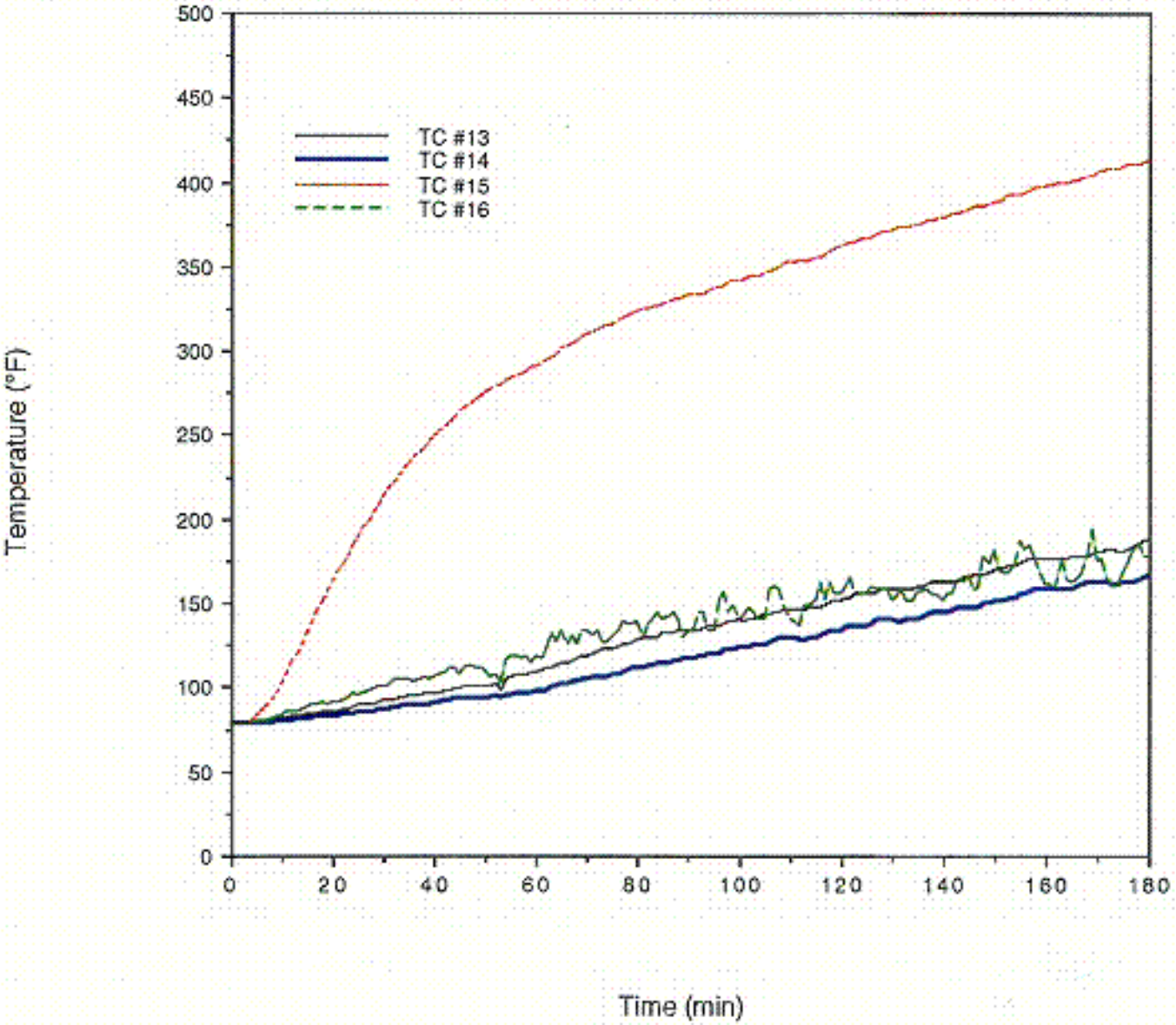
C4

Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #4 Thermocouples



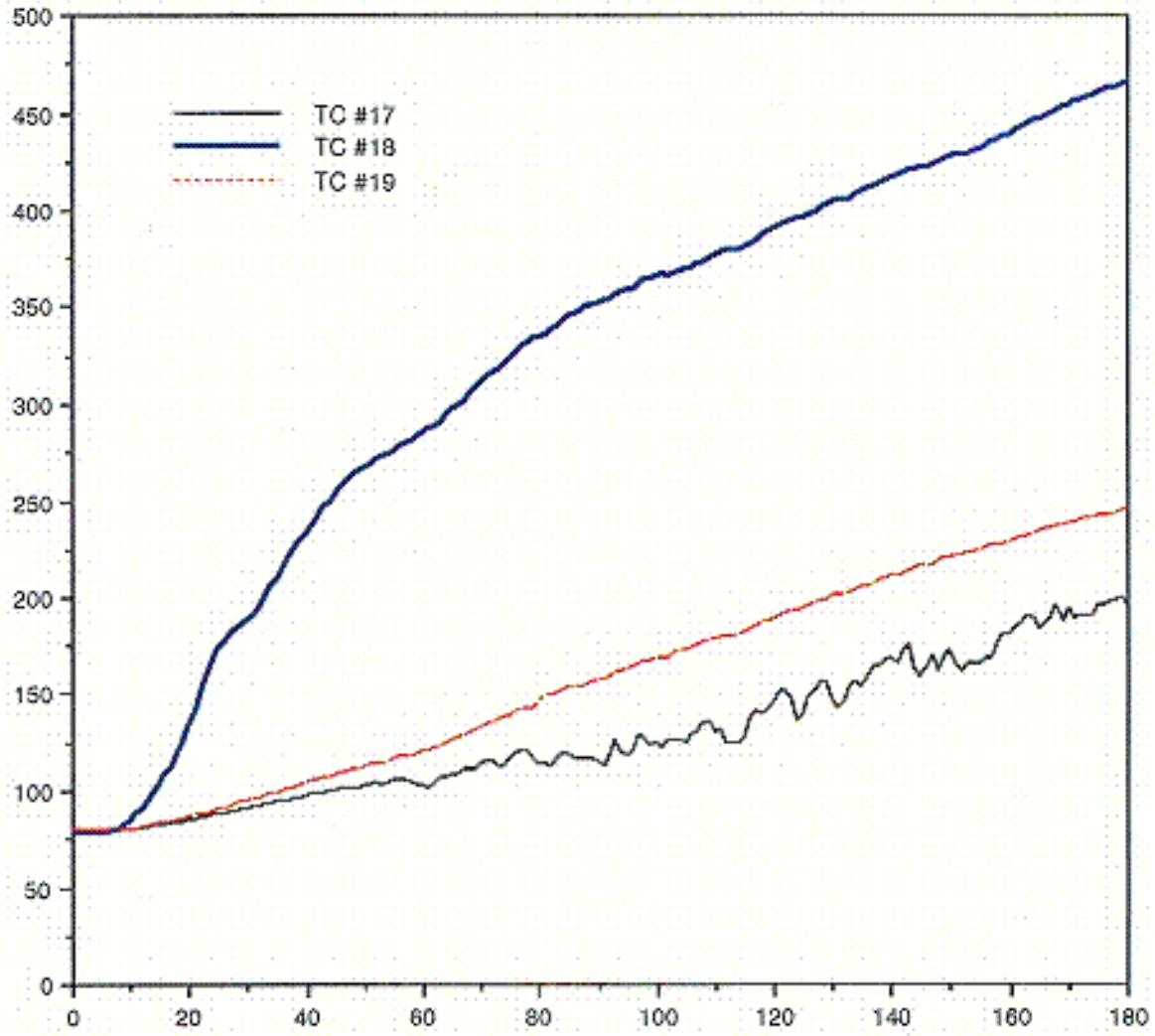
OMEGA POINT LABORATORIES

Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #5 Thermocouples



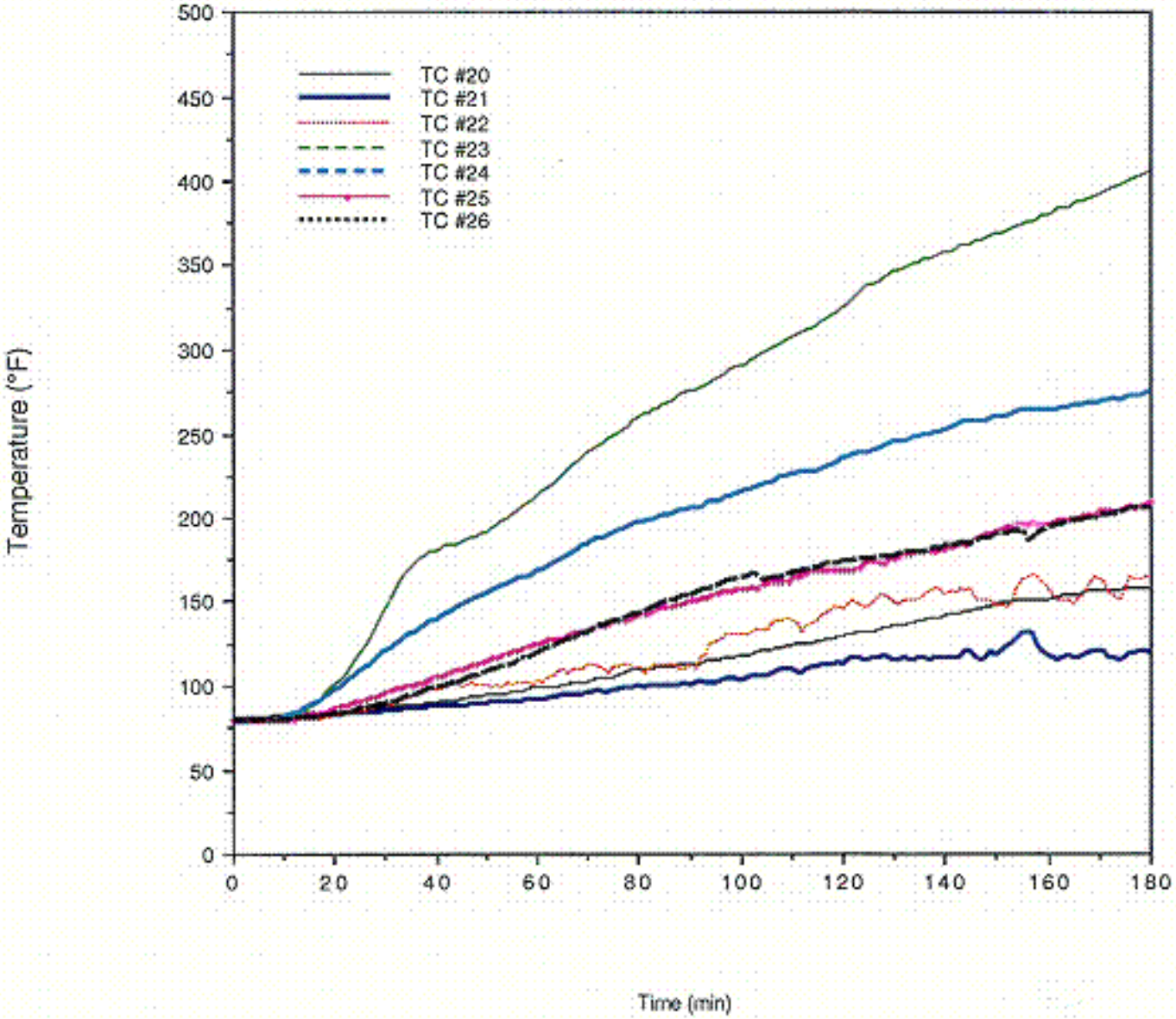
OMEGA POINT LABORATORIES

Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #6 Thermocouples



OMEGA POINT LABORATORIES

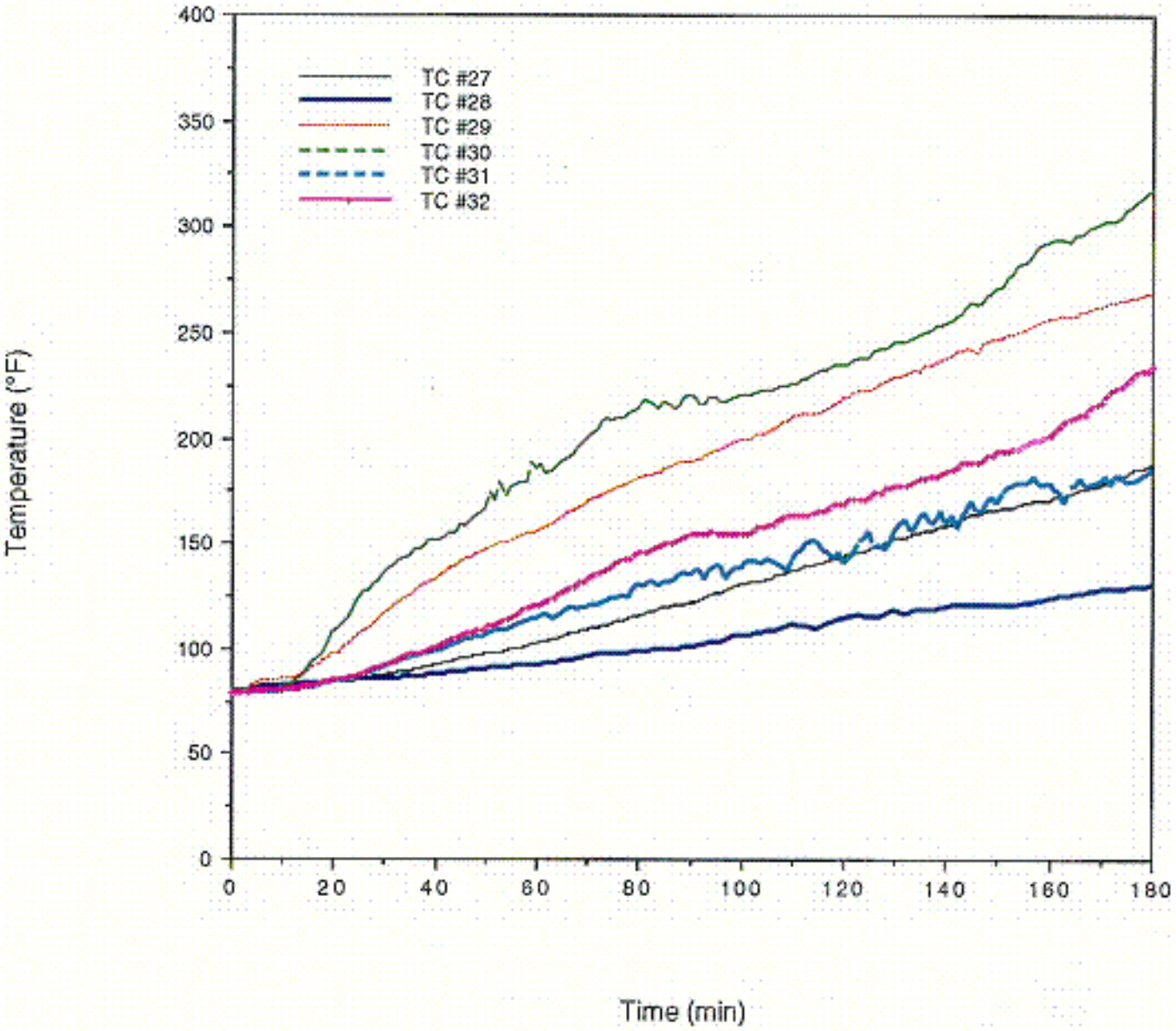
Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #7 Thermocouples



OMEGA POINT LABORATORIES

C8

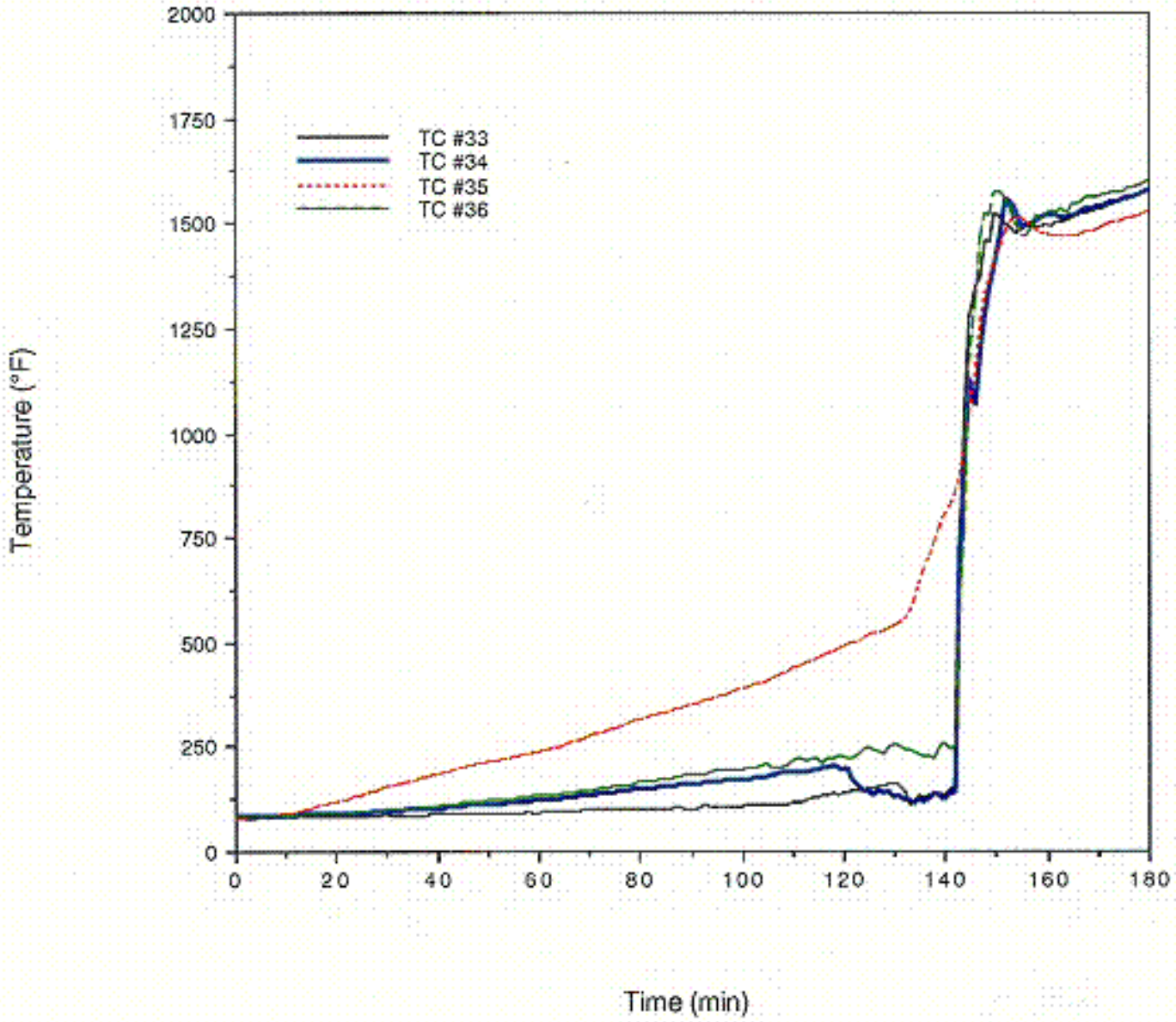
Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #8 Thermocouples



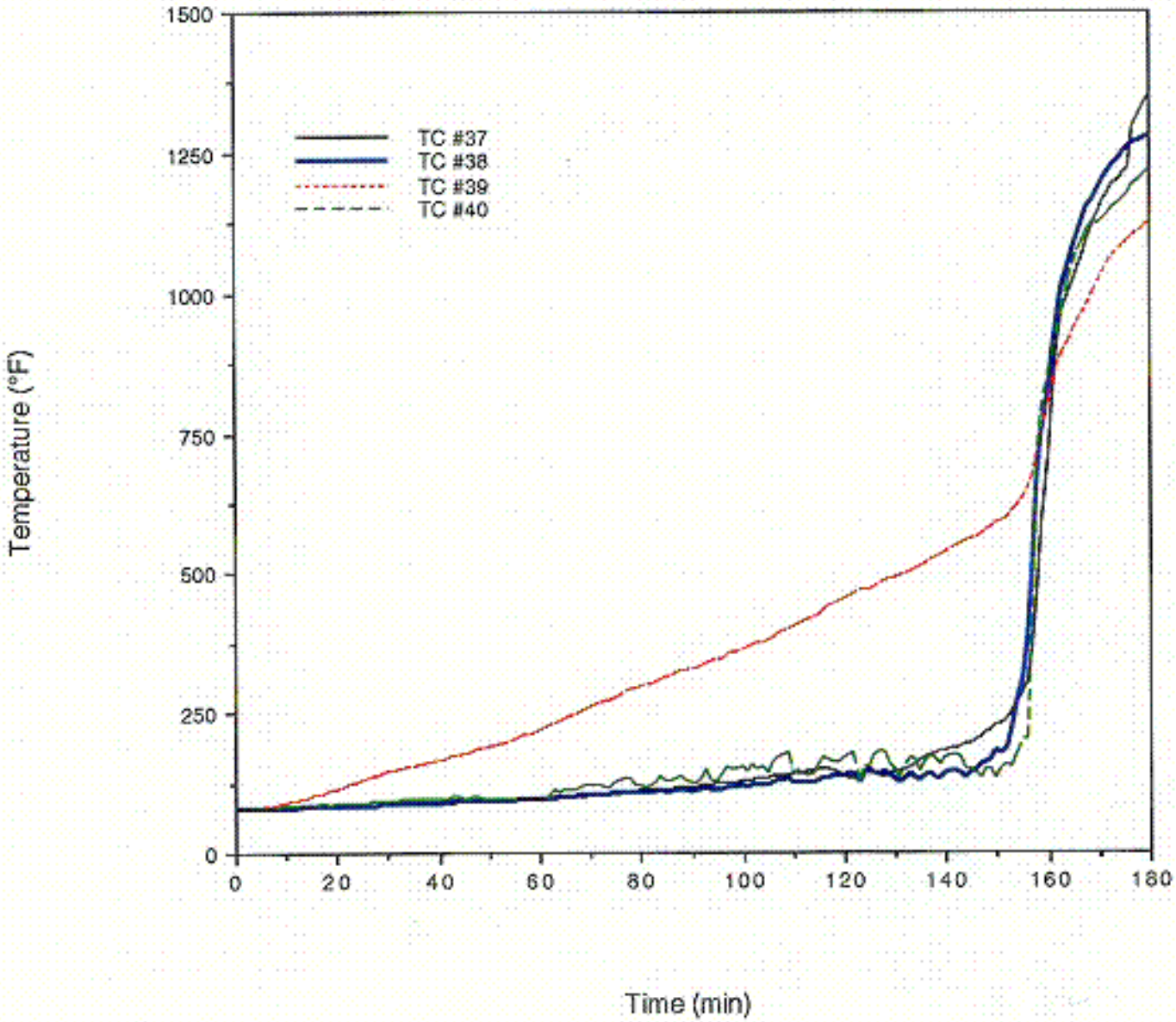
OMEGA POINT LABORATORIES

C9

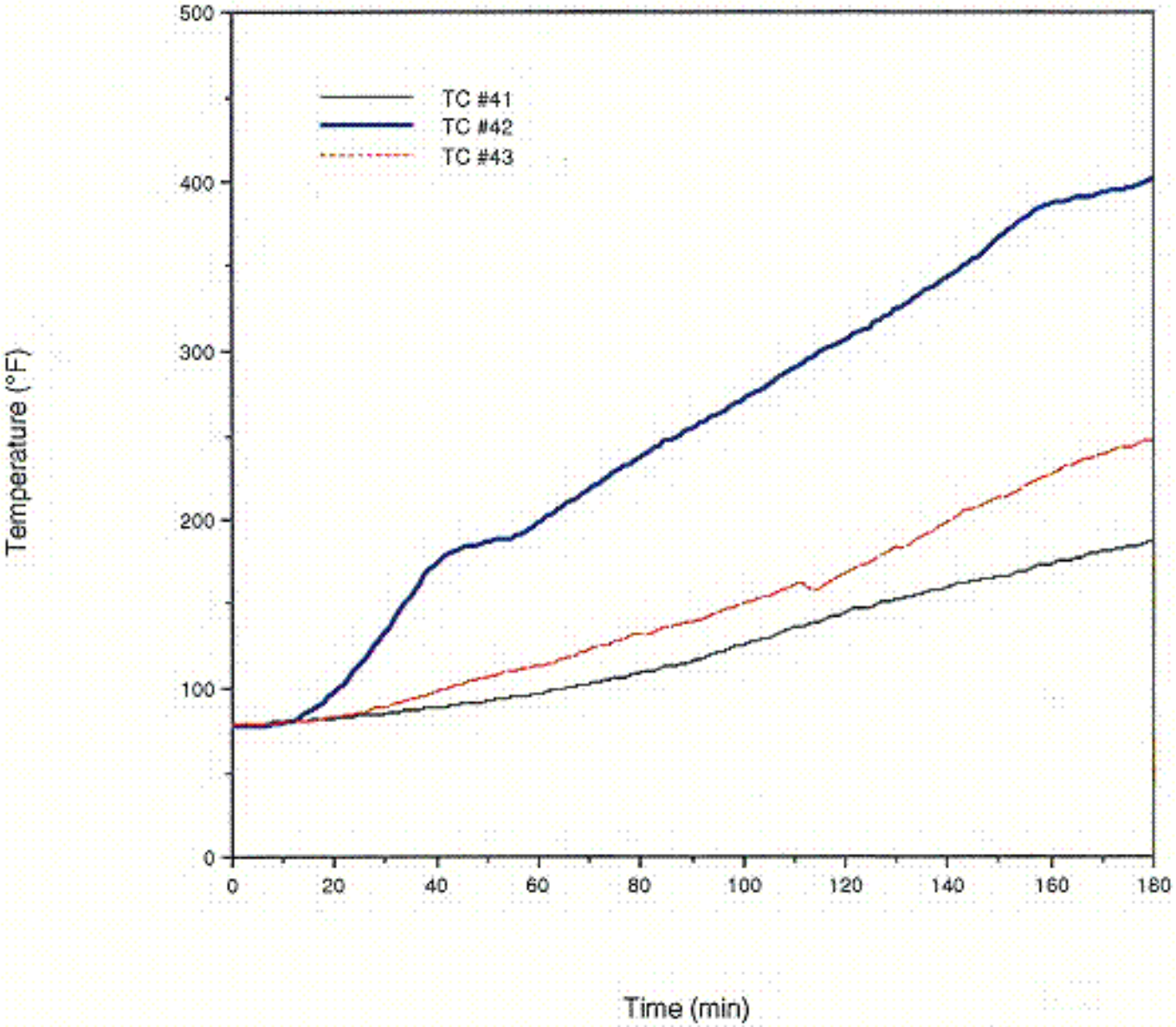
Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #9 Thermocouples



Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #10 Thermocouples

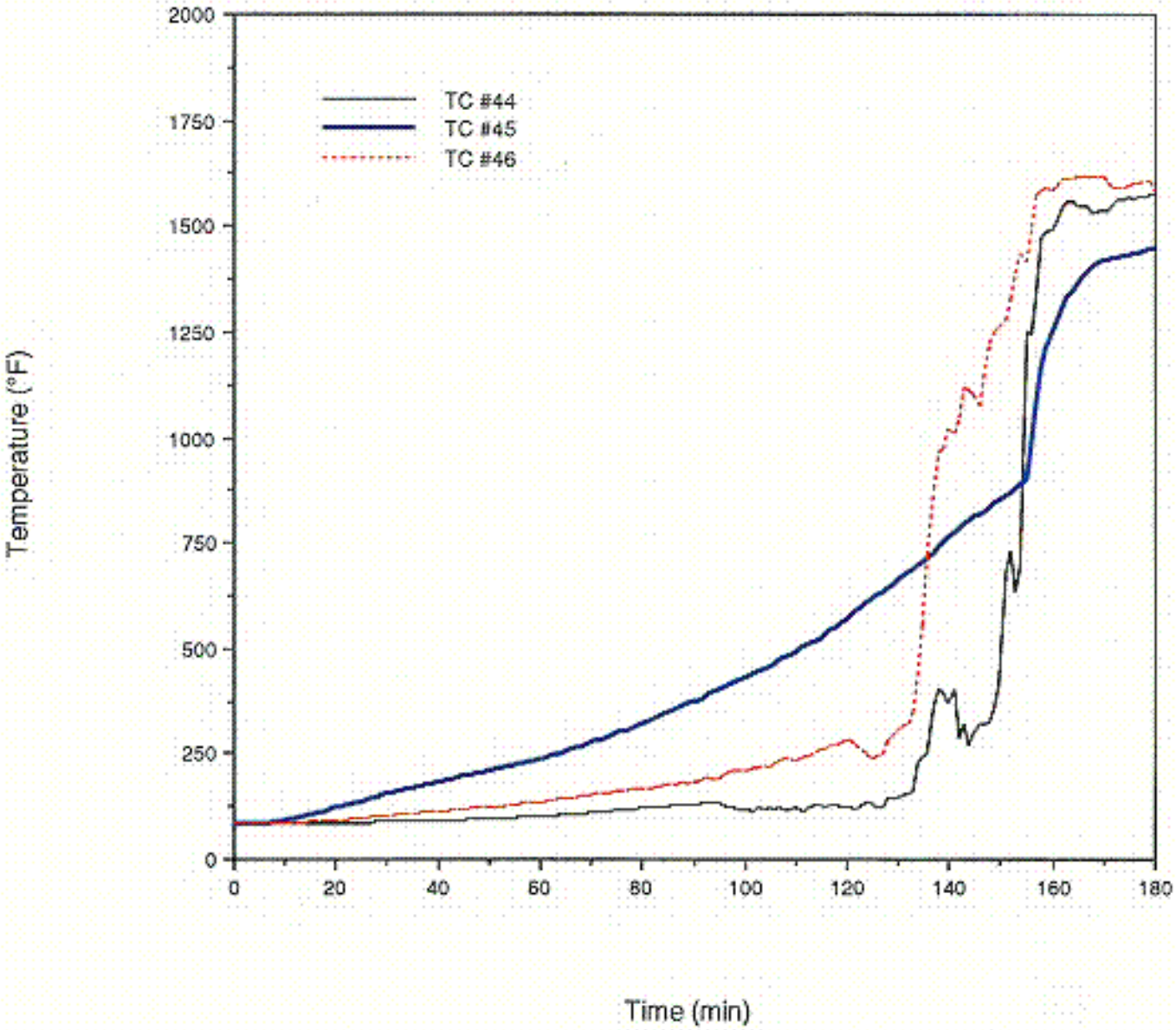


Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #11 Thermocouples



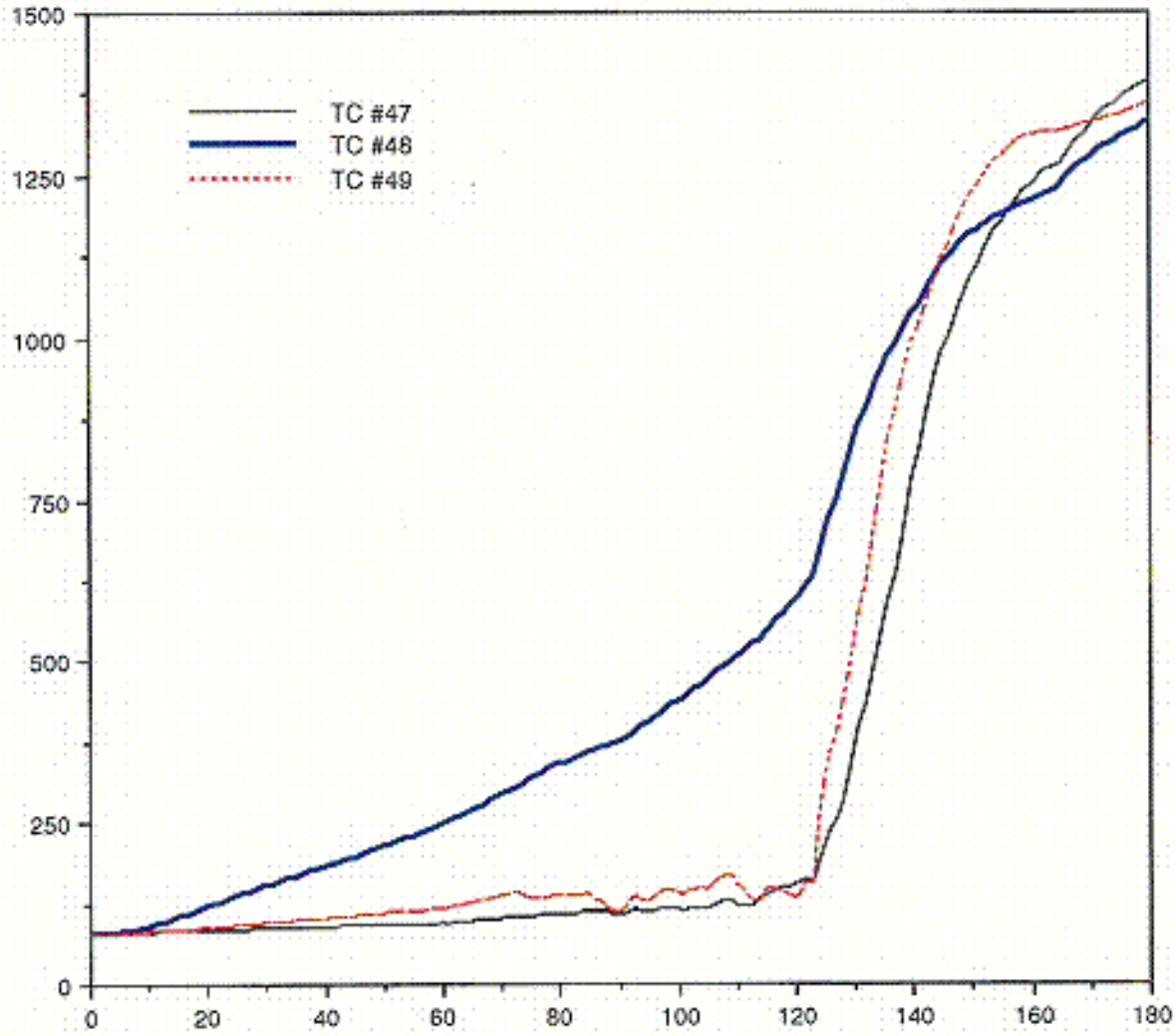
OMEGA POINT LABORATORIES

Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #12 Thermocouples



OMEGA POINT LABORATORIES

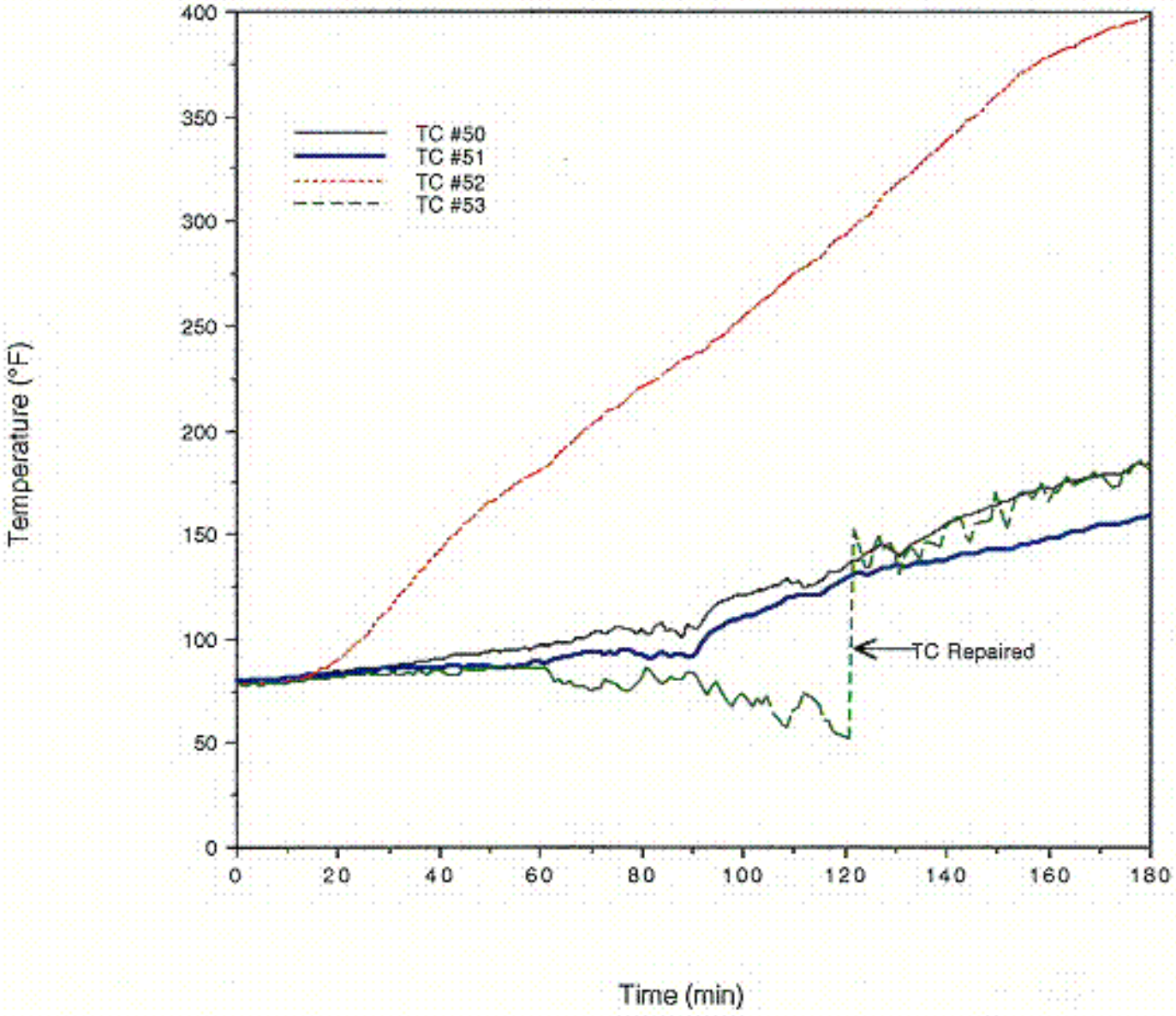
Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #13 Thermocouples



OMEGA POINT LABORATORIES

C14

Project No. 14980-106206
Duke Engineering & Services, Inc.
Penetration #14 Thermocouples



OMEGA POINT LABORATORIES

Time (min)	E119 Std Average (°F)	Furnace Average (°F)	Integration of Furnace Average (°F•min)	Integration of E119 Std Average (°F•min)	Error (%)	Pen. #1 TC #1 (°F)	Pen. #1 TC #2 (°F)
0	68	78	0	0	0.00%	81	80
1	254	110	26	93	-72.0%	81	80
2	441	215	121	372	-67.6%	81	80
3	627	496	408	838	-51.3%	81	80
4	814	885	1031	1490	-30.8%	81	81
5	1000	1153	1982	2328	-14.9%	81	83
6	1060	1290	3135	3290	-4.71%	82	85
7	1120	1320	4372	4312	1.39%	82	87
8	1180	1318	5623	5394	4.25%	82	90
9	1240	1308	6868	6536	5.08%	82	94
10	1307	1312	8110	7738	4.81%	82	98
11	1328	1327	9362	8984	4.21%	82	102
12	1347	1341	10628	10252	3.66%	83	107
13	1364	1354	11907	11539	3.19%	83	112
14	1381	1366	13199	12843	2.77%	84	117
15	1396	1378	14503	14163	2.40%	84	122
16	1410	1395	15822	15497	2.09%	84	126
17	1424	1419	17161	16846	1.87%	84	131
18	1436	1437	18521	18207	1.72%	84	137
19	1448	1452	19897	19581	1.61%	85	141
20	1459	1464	21287	20967	1.53%	85	146
21	1470	1472	22687	22363	1.45%	85	150
22	1480	1481	24096	23770	1.37%	85	155
23	1490	1493	25515	25187	1.30%	85	159
24	1499	1504	26945	26614	1.25%	86	164
25	1508	1515	28387	28049	1.20%	86	169
26	1517	1526	29839	29494	1.17%	86	173
27	1525	1539	31304	30947	1.15%	87	177
28	1533	1550	32780	32408	1.15%	87	181
29	1541	1563	34269	33877	1.16%	87	185
30	1549	1567	35766	35353	1.17%	88	189
31	1556	1571	37267	36837	1.17%	88	193
32	1563	1567	38768	38327	1.15%	88	196
33	1570	1574	40270	39825	1.12%	89	199
34	1576	1585	41782	41329	1.09%	89	203
35	1583	1592	43302	42840	1.08%	89	206
36	1589	1598	44829	44357	1.06%	89	208
37	1595	1601	46361	45880	1.05%	89	211
38	1601	1608	47897	47409	1.03%	89	214
39	1606	1615	49441	48944	1.01%	90	217
40	1612	1619	50990	50485	1.00%	90	219
41	1617	1616	52539	52032	0.98%	90	222

Duke Engineering Services, Inc. Project No. 14980-106206 March 2, 2000

Time (min)	E119 Std Average (°F)	Furnace Average (°F)	Integration of Furnace Average (°F•min)	Integration of E119 Std Average (°F•min)	Error (%)	Pen. #1 TC #1 (°F)	Pen. #1 TC #2 (°F)
42	1623	1622	54090	53583	0.95%	91	224
43	1628	1630	55648	55140	0.92%	91	227
44	1633	1636	57213	56702	0.90%	91	229
45	1638	1642	58784	58269	0.88%	92	232
46	1643	1649	60362	59841	0.87%	92	234
47	1648	1658	61947	61418	0.86%	92	236
48	1652	1665	63541	62999	0.86%	93	238
49	1657	1671	65141	64585	0.86%	93	240
50	1661	1675	66746	66176	0.86%	93	242
51	1666	1678	68354	67771	0.86%	93	244
52	1670	1681	69966	69370	0.86%	93	245
53	1674	1685	71581	70973	0.86%	95	247
54	1678	1690	73200	72581	0.85%	95	249
55	1682	1696	74825	74193	0.85%	95	250
56	1686	1704	76457	75809	0.85%	96	252
57	1690	1708	78095	77429	0.86%	96	254
58	1694	1716	79739	79053	0.87%	96	255
59	1698	1717	81388	80680	0.88%	97	257
60	1701	1720	83038	82311	0.88%	97	259
61	1705	1724	84692	83946	0.89%	98	260
62	1709	1728	86350	85584	0.90%	98	261
63	1712	1722	88007	87226	0.90%	99	263
64	1716	1719	89660	88872	0.89%	99	265
65	1719	1718	91310	90521	0.87%	100	266
66	1722	1722	92962	92173	0.86%	100	268
67	1726	1731	94621	93829	0.84%	101	270
68	1729	1733	96285	95487	0.84%	102	271
69	1732	1736	97951	97149	0.83%	102	272
70	1735	1737	99620	98815	0.81%	103	273
71	1738	1739	101290	100483	0.80%	103	274
72	1742	1741	102962	102155	0.79%	104	276
73	1745	1744	104636	103829	0.78%	104	276
74	1748	1744	106312	105507	0.76%	105	277
75	1751	1746	107989	107187	0.75%	105	278
76	1753	1747	109668	108871	0.73%	105	279
77	1756	1749	111348	110557	0.72%	106	280
78	1759	1752	113030	112247	0.70%	106	280
79	1762	1755	114716	113939	0.68%	107	282
80	1765	1759	116405	115634	0.67%	107	283
81	1768	1763	118098	117332	0.65%	107	283
82	1770	1768	119795	119032	0.64%	108	284
83	1773	1773	121498	120735	0.63%	108	285

OMEGA POINT LABORATORIES

Time (min)	E119 Std Average (°F)	Furnace Average (°F)	Integration of Furnace Average (°F•min)	Integration of E119 Std Average (°F•min)	Error (%)	Pen. #1 TC #1 (°F)	Pen. #1 TC #2 (°F)
84	1776	1776	123204	122441	0.62%	109	285
85	1778	1780	124914	124149	0.62%	109	286
86	1781	1781	126627	125860	0.61%	110	287
87	1783	1784	128341	127574	0.60%	110	287
88	1786	1786	130058	129290	0.59%	110	288
89	1788	1789	131778	131008	0.59%	111	289
90	1791	1790	133499	132729	0.58%	111	289
91	1793	1792	135222	134453	0.57%	111	289
92	1796	1791	136946	136179	0.56%	112	290
93	1798	1795	138671	137907	0.55%	112	290
94	1800	1796	140398	139637	0.54%	113	292
95	1803	1796	142126	141370	0.53%	114	292
96	1805	1799	143856	143105	0.52%	114	293
97	1807	1801	145588	144843	0.51%	115	294
98	1809	1803	147322	146583	0.50%	116	293
99	1812	1805	149058	148325	0.49%	116	294
100	1814	1807	150796	150069	0.48%	117	295
101	1816	1810	152536	151815	0.47%	117	296
102	1818	1812	154279	153564	0.47%	118	296
103	1820	1820	156027	155315	0.46%	118	296
104	1823	1823	157781	157068	0.45%	118	297
105	1825	1826	159537	158823	0.45%	119	298
106	1827	1828	161296	160580	0.45%	120	299
107	1829	1830	163057	162339	0.44%	120	300
108	1831	1832	164820	164100	0.44%	120	300
109	1833	1835	166586	165863	0.44%	121	301
110	1835	1838	168354	167628	0.43%	121	302
111	1836	1838	170124	169395	0.43%	122	303
112	1838	1839	171895	171164	0.43%	122	303
113	1839	1841	173667	172933	0.42%	123	304
114	1840	1843	175441	174704	0.42%	123	305
115	1841	1843	177216	176477	0.42%	124	306
116	1843	1843	178991	178250	0.42%	124	306
117	1844	1843	180766	180025	0.41%	125	307
118	1845	1843	182541	181801	0.41%	126	308
119	1846	1841	184315	183578	0.40%	127	309
120	1848	1846	186090	185357	0.40%	127	310
121	1849	1849	187870	187136	0.39%	127	310
122	1850	1848	189650	188917	0.39%	127	311
123	1851	1846	191429	190700	0.38%	127	312
124	1853	1845	193207	192483	0.38%	127	313
125	1854	1845	194984	194268	0.37%	128	313

Time (min)	E119 Std Average (°F)	Furnace Average (°F)	Integration of Furnace Average (°F•min)	Integration of E119 Std Average (°F•min)	Error (%)	Pen. #1 TC #1 (°F)	Pen. #1 TC #2 (°F)
126	1855	1846	196761	196054	0.36%	128	314
127	1856	1848	198540	197841	0.35%	128	314
128	1858	1848	200320	199630	0.35%	129	314
129	1859	1850	202101	201419	0.34%	129	316
130	1860	1852	203884	203210	0.33%	130	317
131	1861	1854	205669	205003	0.33%	130	318
132	1863	1854	207455	206796	0.32%	131	318
133	1864	1856	209242	208591	0.31%	131	318
134	1865	1856	211030	210387	0.31%	131	319
135	1866	1857	212819	212184	0.30%	131	320
136	1868	1860	214609	213983	0.29%	132	321
137	1869	1861	216402	215782	0.29%	132	321
138	1870	1860	218194	217583	0.28%	132	322
139	1871	1860	219986	219386	0.27%	132	323
140	1873	1863	221780	221189	0.27%	133	324
141	1874	1868	223577	222994	0.26%	133	325
142	1875	1873	225380	224801	0.26%	134	326
143	1877	1874	227185	226608	0.25%	135	328
144	1878	1876	228992	228417	0.25%	136	329
145	1879	1876	230800	230227	0.25%	135	330
146	1880	1877	232609	232038	0.25%	136	331
147	1882	1878	234418	233851	0.24%	136	332
148	1883	1877	236228	235664	0.24%	138	333
149	1884	1878	238037	237479	0.23%	139	335
150	1885	1879	239848	239296	0.23%	140	337
151	1887	1877	241658	241113	0.23%	141	338
152	1888	1879	243468	242932	0.22%	140	339
153	1889	1882	245280	244752	0.22%	141	339
154	1890	1884	247095	246573	0.21%	141	341
155	1892	1884	248911	248396	0.21%	142	341
156	1893	1884	250727	250219	0.20%	142	342
157	1894	1886	252544	252044	0.20%	141	341
158	1895	1888	254363	253871	0.19%	141	342
159	1897	1889	256184	255698	0.19%	141	342
160	1898	1892	258006	257527	0.19%	140	342
161	1899	1895	259832	259357	0.18%	141	343
162	1900	1895	261659	261188	0.18%	142	344
163	1902	1894	263485	263021	0.18%	142	345
164	1903	1895	265312	264854	0.17%	143	347
165	1904	1898	267140	266689	0.17%	143	347
166	1905	1901	268972	268526	0.17%	143	347
167	1907	1904	270806	270363	0.16%	144	348

Time (min)	E119 Std Average (°F)	Furnace Average (°F)	Integration of Furnace Average (°F•min)	Integration of E119 Std Average (°F•min)	Error (%)	Pen. #1 TC #1 (°F)	Pen. #1 TC #2 (°F)
168	1908	1903	272642	272202	0.16%	145	350
169	1909	1904	274477	274042	0.16%	146	352
170	1910	1904	276313	275883	0.16%	147	353
171	1912	1906	278150	277726	0.15%	146	354
172	1913	1909	279990	279569	0.15%	146	354
173	1914	1910	281831	281414	0.15%	146	354
174	1915	1912	283674	283261	0.15%	146	354
175	1917	1913	285519	285108	0.14%	146	354
176	1918	1910	287362	286957	0.14%	148	356
177	1919	1913	289206	288807	0.14%	149	358
178	1921	1916	291052	290658	0.14%	150	359
179	1922	1921	292903	292511	0.13%	148	361
180	1923	1928	294759	294365	0.13%	149	361
Max Temp:						150	361
Max Allowed:						700	700

Time (min)	Pen. #1 TC #3 (°F)	Pen. #2 TC #4 (°F)	Pen. #2 TC #5 (°F)	Pen. #2 TC #6 (°F)	Pen. #3 TC #7 (°F)	Pen. #3 TC #8 (°F)	Pen. #3 TC #9 (°F)	Pen. #4 TC #10 (°F)
0	81	80	79	80	80	78	79	81
1	81	80	79	80	80	78	79	81
2	81	80	79	80	80	78	79	81
3	81	80	79	80	80	78	79	81
4	81	80	80	80	80	78	79	81
5	81	80	82	80	80	78	79	81
6	82	80	84	80	80	79	79	81
7	82	80	86	80	80	79	79	81
8	83	80	89	81	80	80	80	81
9	84	81	93	81	81	81	80	82
10	85	81	97	82	81	82	80	82
11	86	81	102	82	81	85	81	82
12	88	82	107	83	81	87	82	82
13	89	82	112	84	82	90	82	83
14	91	82	117	85	82	93	83	83
15	93	82	122	85	82	97	84	83
16	94	83	127	86	82	101	85	83
17	96	83	133	86	83	105	86	84
18	98	83	138	87	83	109	87	84
19	100	84	143	87	83	114	88	84
20	102	84	148	88	84	120	89	85
21	103	84	153	88	84	125	90	85
22	104	84	158	89	85	131	92	85
23	106	85	162	89	85	138	93	85
24	109	85	167	90	85	145	95	86
25	109	85	171	91	86	153	96	86
26	111	86	176	91	86	161	98	86
27	114	86	180	93	87	168	99	87
28	116	86	184	93	87	173	101	87
29	118	87	188	94	88	177	102	87
30	119	87	192	95	88	180	103	88
31	121	87	196	94	89	182	104	88
32	123	88	199	96	89	184	105	88
33	125	88	203	95	90	186	106	89
34	125	88	206	96	90	189	107	89
35	127	89	209	96	91	192	108	89
36	125	89	212	95	91	197	109	90
37	125	89	215	96	92	201	110	90
38	129	89	218	97	92	205	111	90
39	128	89	221	97	93	210	112	91
40	130	90	223	99	93	214	113	91
41	133	90	226	99	94	218	114	91

Time (min)	Pen. #1 TC #3 (°F)	Pen. #2 TC #4 (°F)	Pen. #2 TC #5 (°F)	Pen. #2 TC #6 (°F)	Pen. #3 TC #7 (°F)	Pen. #3 TC #8 (°F)	Pen. #3 TC #9 (°F)	Pen. #4 TC #10 (°F)
42	133	91	228	100	95	222	115	92
43	135	91	231	100	95	226	116	92
44	139	91	233	101	96	229	118	93
45	140	92	235	99	96	233	120	93
46	143	92	238	101	97	236	121	93
47	145	92	240	102	97	239	123	93
48	147	93	242	103	98	242	124	94
49	147	93	244	102	98	246	125	94
50	148	93	246	103	99	249	127	94
51	147	93	248	102	100	252	128	95
52	148	93	250	103	100	255	129	96
53	150	95	252	109	101	259	129	96
54	151	95	253	113	101	262	131	97
55	151	95	255	114	102	265	133	97
56	155	96	257	115	102	268	134	98
57	157	96	258	114	103	269	135	98
58	158	96	260	115	103	271	136	99
59	159	97	261	115	104	273	137	100
60	161	97	263	117	105	276	138	100
61	162	97	264	116	105	278	140	100
62	164	98	265	118	106	282	141	101
63	166	98	267	121	107	285	141	101
64	165	99	269	121	108	287	141	102
65	167	100	270	123	109	290	142	103
66	168	100	272	123	109	293	144	103
67	171	101	273	122	111	296	144	104
68	168	101	274	123	112	299	144	105
69	168	102	276	124	113	302	146	106
70	170	103	276	125	114	304	146	106
71	170	103	277	126	115	306	146	107
72	171	104	279	127	116	309	146	108
73	170	104	280	123	116	312	146	108
74	173	104	280	124	116	314	147	109
75	173	105	281	127	118	318	147	109
76	172	105	281	125	119	321	146	110
77	172	106	282	127	120	324	149	110
78	173	106	283	128	120	328	151	111
79	177	107	284	129	121	332	155	112
80	179	107	285	129	121	334	152	112
81	181	107	286	126	121	338	156	113
82	183	107	286	129	121	340	156	113
83	183	108	287	129	122	343	158	113

Time (min)	Pen. #1 TC #3 (°F)	Pen. #2 TC #4 (°F)	Pen. #2 TC #5 (°F)	Pen. #2 TC #6 (°F)	Pen. #3 TC #7 (°F)	Pen. #3 TC #8 (°F)	Pen. #3 TC #9 (°F)	Pen. #4 TC #10 (°F)
84	184	108	287	130	123	345	153	114
85	182	109	287	130	123	348	156	114
86	185	109	288	131	122	351	155	115
87	184	109	289	132	123	354	158	115
88	185	110	290	132	125	357	161	116
89	185	110	291	128	125	360	155	116
90	183	110	291	129	124	362	157	116
91	187	111	291	132	125	365	162	117
92	188	112	292	135	127	367	167	118
93	187	113	292	136	131	369	161	118
94	189	113	293	133	130	372	165	118
95	189	114	293	133	129	377	164	119
96	192	114	294	138	130	380	172	119
97	190	116	296	139	131	383	167	120
98	187	116	296	136	133	388	166	120
99	190	116	296	137	131	392	168	121
100	189	117	298	135	132	396	170	122
101	193	117	298	137	132	402	174	122
102	191	118	298	138	135	407	175	122
103	190	118	299	137	135	409	177	122
104	192	119	300	136	135	411	174	123
105	195	119	301	136	136	413	174	124
106	196	120	302	140	137	415	185	124
107	194	121	303	143	140	418	183	125
108	192	121	303	141	141	421	180	125
109	192	121	304	140	144	423	177	126
110	196	121	305	137	141	424	177	127
111	198	120	305	136	142	426	178	128
112	199	120	306	134	140	428	177	128
113	200	121	307	137	141	429	184	128
114	201	122	308	140	143	431	186	129
115	201	122	309	141	143	433	183	129
116	199	123	309	146	147	434	191	129
117	199	123	311	143	148	436	186	130
118	200	124	311	146	148	439	192	131
119	201	125	313	147	149	441	188	132
120	200	125	313	146	152	444	187	132
121	198	125	314	148	153	445	193	132
122	197	125	314	146	156	446	196	132
123	197	127	316	147	155	448	196	133
124	200	126	317	146	153	450	198	134
125	207	127	318	147	158	452	203	135

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Time (min)	Pen. #1 TC #3 (°F)	Pen. #2 TC #4 (°F)	Pen. #2 TC #5 (°F)	Pen. #2 TC #6 (°F)	Pen. #3 TC #7 (°F)	Pen. #3 TC #8 (°F)	Pen. #3 TC #9 (°F)	Pen. #4 TC #10 (°F)
126	206	128	319	150	159	455	199	135
127	200	128	319	148	158	457	198	135
128	199	128	319	149	159	459	199	135
129	204	129	321	152	164	461	204	137
130	205	129	322	146	164	464	207	137
131	210	129	323	151	167	466	211	138
132	205	129	323	150	167	468	211	138
133	203	129	323	152	163	470	205	138
134	201	129	324	151	162	473	205	139
135	206	130	324	157	166	474	209	139
136	210	130	326	160	165	476	206	140
137	208	129	326	161	161	478	206	140
138	210	129	326	165	165	479	208	141
139	208	129	327	166	167	481	211	141
140	211	129	328	167	163	482	205	141
141	213	130	329	168	168	483	213	142
142	216	130	329	168	169	485	217	142
143	221	132	331	171	172	487	200	143
144	223	132	332	171	170	488	209	143
145	220	134	333	173	169	490	214	144
146	221	135	333	174	171	492	219	144
147	219	135	334	175	173	494	220	145
148	227	137	336	176	175	496	197	146
149	226	137	337	177	176	498	215	147
150	228	138	337	178	175	501	194	148
151	231	138	338	179	173	503	206	148
152	230	138	339	180	171	505	213	148
153	230	138	339	181	174	507	222	149
154	230	139	339	180	173	509	227	150
155	233	138	341	177	177	512	205	150
156	223	138	341	176	176	514	216	150
157	217	138	340	173	177	516	223	150
158	219	138	340	173	176	518	224	150
159	215	137	339	169	178	520	228	150
160	207	135	339	164	174	522	225	150
161	225	136	339	165	177	524	228	150
162	229	137	340	168	180	526	225	150
163	229	139	341	170	180	528	206	151
164	231	139	343	170	179	530	222	152
165	225	138	342	165	179	532	227	152
166	226	138	343	165	180	534	226	152
167	231	140	344	170	184	536	222	153

OMEGA POINT LABORATORIES

Time (min)	Pen. #1 TC #3 (°F)	Pen. #2 TC #4 (°F)	Pen. #2 TC #5 (°F)	Pen. #2 TC #6 (°F)	Pen. #3 TC #7 (°F)	Pen. #3 TC #8 (°F)	Pen. #3 TC #9 (°F)	Pen. #4 TC #10 (°F)
168	240	141	345	172	183	537	218	154
169	238	141	347	174	181	539	206	154
170	242	142	347	176	182	541	203	153
171	233	141	347	173	178	543	223	154
172	233	140	347	169	184	545	235	155
173	232	139	347	163	179	546	233	155
174	230	138	347	162	174	548	234	154
175	236	140	347	165	180	550	237	155
176	242	143	349	174	182	551	232	156
177	242	143	350	173	186	553	236	156
178	246	145	352	176	179	554	218	156
179	247	141	352	169	178	556	234	157
180	243	142	352	172	182	557	249	154
Max Temp:	247	145	352	181	186	557	249	157
Max Allowed:	700	700	700	700	700	700	700	700

Time (min)	Pen. #4 TC #11 (°F)	Pen. #4 TC #12 (°F)	Pen. #5 TC #13 (°F)	Pen. #5 TC #14 (°F)	Pen. #5 TC #15 (°F)	Pen. #5 TC #16 (°F)	Pen. #6 TC #17 (°F)	Pen. #6 TC #18 (°F)
0	79	80	79	79	78	79	78	78
1	79	80	79	79	78	79	78	78
2	79	79	79	78	78	79	78	78
3	79	79	79	78	79	79	78	78
4	81	80	79	79	80	79	79	78
5	82	80	80	79	83	80	79	78
6	85	80	80	79	85	80	79	78
7	87	80	80	79	88	80	79	79
8	90	80	80	79	92	81	79	80
9	94	81	81	80	97	82	80	82
10	98	82	81	80	102	83	80	84
11	102	82	81	80	107	85	80	87
12	107	83	82	80	114	85	81	90
13	112	84	82	81	120	86	81	94
14	118	85	83	81	126	87	82	98
15	123	85	84	81	132	88	82	103
16	128	86	84	81	138	89	82	108
17	133	87	84	82	145	89	83	113
18	139	88	85	82	151	91	84	119
19	144	88	85	82	157	89	84	125
20	149	89	86	83	162	91	85	133
21	154	90	86	83	168	91	85	141
22	159	91	87	84	173	92	86	150
23	164	92	87	84	178	94	86	159
24	169	93	88	84	184	96	87	166
25	174	93	89	85	189	95	87	172
26	178	94	89	85	194	96	88	177
27	183	95	89	85	198	98	89	181
28	187	97	90	86	204	99	89	183
29	192	98	91	87	208	101	90	185
30	196	98	92	87	213	101	91	187
31	200	99	92	87	217	100	92	190
32	204	100	92	88	222	104	92	195
33	207	100	94	88	226	105	93	200
34	211	100	94	89	230	105	93	205
35	214	102	95	89	233	105	94	210
36	217	101	95	89	237	103	95	215
37	220	101	95	90	240	105	95	220
38	224	103	96	90	243	106	96	224
39	226	103	96	90	246	104	96	229
40	229	105	96	91	249	106	97	233
41	232	106	97	91	252	107	98	237

Time (min)	Pen. #4 TC #11 (°F)	Pen. #4 TC #12 (°F)	Pen. #5 TC #13 (°F)	Pen. #5 TC #14 (°F)	Pen. #5 TC #15 (°F)	Pen. #5 TC #16 (°F)	Pen. #6 TC #17 (°F)	Pen. #6 TC #18 (°F)
42	235	106	98	92	255	109	98	241
43	237	107	98	92	258	111	99	246
44	240	110	99	93	261	111	100	249
45	243	110	99	93	264	108	100	253
46	246	112	100	93	266	111	101	257
47	248	112	100	94	269	113	102	260
48	250	113	101	94	271	112	102	263
49	252	113	101	94	273	111	102	266
50	254	112	101	94	275	110	103	267
51	256	122	101	94	277	106	103	269
52	258	127	102	95	279	107	104	271
53	260	128	98	94	280	102	103	272
54	262	130	104	95	282	116	104	274
55	263	131	106	95	284	118	105	276
56	265	133	107	96	285	118	105	278
57	267	133	107	96	287	117	105	280
58	268	134	108	96	288	118	104	281
59	270	135	109	97	290	114	103	283
60	272	137	109	98	291	119	103	285
61	273	136	110	98	293	117	101	287
62	275	138	111	98	295	124	103	288
63	276	141	112	100	296	132	107	291
64	278	141	113	100	298	127	107	294
65	280	143	114	102	301	134	108	297
66	282	144	115	102	303	126	108	299
67	284	145	116	103	305	131	111	302
68	286	146	117	103	306	126	111	305
69	287	147	118	104	308	133	111	308
70	289	147	119	105	310	134	114	311
71	290	148	120	106	311	131	115	314
72	291	147	121	106	313	134	115	316
73	293	148	122	106	314	127	113	318
74	294	149	122	106	315	127	112	321
75	295	150	123	107	316	130	117	323
76	296	149	124	108	318	133	119	326
77	297	149	125	109	319	139	120	330
78	298	150	126	110	321	138	120	332
79	300	152	127	111	322	138	116	334
80	301	153	128	111	324	139	114	334
81	302	152	129	112	325	130	114	336
82	303	154	129	113	325	138	112	338
83	303	154	129	113	326	140	116	340

Time (min)	Pen. #4 TC #11 (°F)	Pen. #4 TC #12 (°F)	Pen. #5 TC #13 (°F)	Pen. #5 TC #14 (°F)	Pen. #5 TC #15 (°F)	Pen. #5 TC #16 (°F)	Pen. #6 TC #17 (°F)	Pen. #6 TC #18 (°F)
84	304	154	130	114	327	144	119	342
85	305	154	132	115	328	140	119	345
86	306	154	132	115	329	142	116	347
87	306	154	132	116	330	145	116	348
88	308	156	133	116	331	141	117	350
89	309	155	134	117	332	130	116	351
90	309	153	134	117	333	132	115	352
91	309	154	134	117	333	135	113	353
92	310	156	134	118	333	144	118	354
93	310	157	135	119	334	145	126	356
94	312	158	137	120	336	133	120	358
95	313	159	137	120	337	134	118	359
96	314	161	136	120	337	152	121	359
97	315	161	138	122	339	157	129	362
98	316	161	139	123	341	145	128	364
99	317	161	139	123	341	149	123	364
100	318	159	140	124	342	141	124	366
101	318	160	139	124	343	143	122	367
102	319	161	140	124	344	148	126	366
103	320	160	141	125	344	144	126	367
104	321	161	142	125	345	141	126	368
105	322	163	143	126	347	140	125	370
106	323	160	143	127	347	159	129	370
107	324	158	144	128	349	160	130	372
108	325	156	145	129	350	159	134	373
109	325	158	146	130	352	149	136	376
110	328	164	146	129	352	141	130	377
111	329	165	146	129	353	139	131	378
112	330	162	146	128	354	137	125	379
113	331	165	146	128	353	149	124	379
114	332	166	147	129	354	149	124	380
115	332	166	147	129	355	152	128	381
116	332	161	148	131	356	163	137	382
117	333	163	149	132	358	151	141	384
118	335	164	150	134	359	163	140	387
119	336	164	152	134	361	155	142	389
120	337	163	152	134	362	156	145	390
121	337	161	153	136	363	160	150	392
122	338	156	153	136	364	165	152	393
123	339	163	155	137	365	154	146	395
124	340	167	155	136	366	156	136	396
125	342	170	155	137	367	155	138	396

Time (min)	Pen. #4 TC #11 (°F)	Pen. #4 TC #12 (°F)	Pen. #5 TC #13 (°F)	Pen. #5 TC #14 (°F)	Pen. #5 TC #15 (°F)	Pen. #5 TC #16 (°F)	Pen. #6 TC #17 (°F)	Pen. #6 TC #18 (°F)
126	343	168	156	138	368	160	148	397
127	343	162	156	140	369	158	152	399
128	343	158	158	140	370	159	156	401
129	345	170	158	140	371	158	156	403
130	347	172	158	140	372	151	148	404
131	348	174	158	139	373	154	142	405
132	348	170	158	139	373	158	147	405
133	349	174	159	141	373	152	155	406
134	350	170	159	141	374	151	156	408
135	351	175	160	141	375	157	154	410
136	352	176	160	142	376	157	157	411
137	352	173	161	143	377	158	164	412
138	353	173	162	144	378	156	164	414
139	354	175	162	144	379	154	167	415
140	355	176	162	144	379	152	168	417
141	356	179	162	145	380	156	166	418
142	357	181	163	146	381	156	173	419
143	359	184	163	147	382	164	175	420
144	359	185	165	148	383	163	163	421
145	360	182	165	147	384	167	159	422
146	361	184	166	148	385	159	165	422
147	362	184	166	148	385	158	170	423
148	363	188	167	150	386	178	162	425
149	365	190	168	150	387	173	168	426
150	366	192	170	152	388	182	173	427
151	368	190	171	152	389	170	165	429
152	368	187	171	152	391	168	161	429
153	369	192	172	153	392	168	166	429
154	369	191	172	153	393	174	166	430
155	370	195	174	155	393	187	166	432
156	369	185	175	156	394	182	168	433
157	369	182	176	157	396	184	168	435
158	370	183	176	158	397	177	175	436
159	370	183	176	159	397	167	181	438
160	370	181	176	159	398	161	181	439
161	371	188	176	159	398	161	185	441
162	373	189	176	159	399	159	186	443
163	374	193	176	159	399	176	191	444
164	374	192	176	159	400	164	189	446
165	374	193	177	159	401	162	183	447
166	375	192	177	160	401	164	186	448
167	375	194	178	161	402	167	189	450

Time (min)	Pen. #4 TC #11 (°F)	Pen. #4 TC #12 (°F)	Pen. #5 TC #13 (°F)	Pen. #5 TC #14 (°F)	Pen. #5 TC #15 (°F)	Pen. #5 TC #16 (°F)	Pen. #6 TC #17 (°F)	Pen. #6 TC #18 (°F)
168	376	194	178	162	403	179	196	451
169	377	191	179	162	404	194	188	453
170	377	193	181	163	406	175	194	454
171	377	189	181	163	406	176	189	456
172	378	193	182	162	408	165	191	456
173	379	196	182	161	408	160	190	458
174	379	189	181	161	408	161	191	459
175	380	195	181	162	409	168	196	460
176	380	193	182	163	410	173	196	461
177	381	193	183	163	411	181	197	463
178	382	197	185	164	411	186	199	463
179	383	193	187	165	412	178	200	465
180	383	177	187	166	413	178	196	466
Max Temp:	383	197	187	166	413	194	200	466
Max Allowed:	700	700	700	700	700	700	700	700

Duke Engineering Services, Inc. Project No. 14980-106206 March 2, 2000

Time (min)	Pen. #6 TC #19 (°F)	Pen. #7 TC #20 (°F)	Pen. #7 TC #21 (°F)	Pen. #7 TC #22 (°F)	Pen. #7 TC #23 (°F)	Pen. #7 TC #24 (°F)	Pen. #7 TC #25 (°F)	Pen. #7 TC #26 (°F)
0	79	81	79	78	78	78	79	80
1	79	81	79	78	78	78	79	80
2	79	81	79	78	78	78	79	80
3	79	81	79	78	78	78	79	80
4	79	81	79	78	78	79	79	80
5	79	81	79	78	78	79	79	80
6	79	81	79	79	79	79	79	80
7	79	81	79	79	78	79	79	80
8	79	82	80	79	79	79	79	80
9	80	82	80	79	79	80	79	80
10	80	82	80	79	80	81	80	80
11	80	82	80	79	80	82	80	80
12	81	82	81	79	81	83	80	81
13	82	82	81	80	82	84	81	81
14	82	82	81	80	84	86	82	81
15	83	83	81	80	86	87	82	81
16	83	83	81	80	88	89	83	81
17	84	83	81	80	91	91	84	82
18	85	83	82	81	94	93	84	82
19	85	83	82	81	97	95	85	82
20	86	84	82	82	100	97	86	83
21	87	84	82	82	103	99	87	83
22	87	84	83	82	106	102	88	84
23	88	84	83	83	110	104	89	84
24	89	84	83	84	114	106	90	85
25	90	85	83	84	118	108	91	86
26	91	85	84	85	123	111	92	86
27	92	85	84	85	128	113	93	87
28	93	85	84	87	133	115	93	88
29	94	86	84	87	138	118	95	89
30	95	86	85	89	144	120	96	89
31	96	86	85	88	150	122	97	91
32	96	87	85	90	156	124	98	91
33	97	87	85	91	162	126	98	92
34	98	87	86	92	166	129	100	93
35	99	88	86	93	170	131	100	94
36	100	88	86	94	173	132	101	95
37	101	88	86	95	175	134	102	96
38	102	89	86	96	177	136	103	97
39	103	89	87	97	179	138	104	98
40	104	89	87	97	180	139	105	99
41	105	90	87	97	181	141	106	100

Duke Engineering Services, Inc. Project No. 14980-106206 March 2, 2000

Time (min)	Pen. #6 TC #19 (°F)	Pen. #7 TC #20 (°F)	Pen. #7 TC #21 (°F)	Pen. #7 TC #22 (°F)	Pen. #7 TC #23 (°F)	Pen. #7 TC #24 (°F)	Pen. #7 TC #25 (°F)	Pen. #7 TC #26 (°F)
42	105	90	87	98	183	142	107	100
43	107	91	87	100	183	144	108	101
44	107	91	88	101	184	146	109	102
45	108	92	88	99	185	148	110	103
46	109	92	88	100	186	149	111	104
47	110	93	89	101	187	151	112	105
48	111	93	89	100	188	152	113	106
49	111	93	89	100	190	154	114	107
50	112	94	89	100	191	155	115	108
51	114	94	90	99	193	156	116	109
52	114	95	90	100	195	158	117	110
53	114	95	90	99	197	159	118	111
54	115	95	90	101	199	160	119	112
55	116	96	91	100	201	162	120	113
56	118	96	91	101	203	163	121	114
57	118	96	91	102	205	164	122	116
58	118	97	92	102	208	165	123	117
59	119	98	92	100	210	166	124	118
60	120	98	92	103	213	168	125	119
61	121	98	92	101	215	169	126	120
62	122	98	92	104	217	170	127	122
63	123	98	93	106	219	172	127	123
64	125	99	93	108	222	174	128	124
65	126	100	94	109	225	176	128	126
66	127	100	94	107	228	177	130	127
67	129	101	95	110	231	179	131	128
68	130	102	95	109	233	181	132	130
69	131	102	95	110	235	183	132	131
70	133	102	96	112	238	184	133	132
71	134	103	96	112	240	186	134	133
72	136	104	97	111	242	187	135	135
73	137	104	96	109	244	188	136	136
74	138	104	96	107	246	189	137	137
75	139	104	97	111	248	190	138	138
76	141	106	97	111	250	192	138	139
77	142	107	98	113	252	193	139	140
78	143	108	98	112	254	195	140	141
79	143	109	99	110	257	196	141	142
80	146	109	100	111	259	197	142	143
81	149	109	99	107	261	197	143	144
82	149	110	100	110	262	198	144	145
83	151	110	100	112	264	199	145	146

OMEGA POINT LABORATORIES

Time (min)	Pen. #6 TC #19 (°F)	Pen. #7 TC #20 (°F)	Pen. #7 TC #21 (°F)	Pen. #7 TC #22 (°F)	Pen. #7 TC #23 (°F)	Pen. #7 TC #24 (°F)	Pen. #7 TC #25 (°F)	Pen. #7 TC #26 (°F)
84	152	111	100	113	265	200	146	148
85	153	111	100	113	267	201	146	149
86	154	111	100	112	269	202	147	150
87	154	111	100	113	270	203	148	151
88	155	112	100	110	272	204	148	152
89	156	112	101	109	274	204	149	153
90	157	113	100	112	275	205	150	154
91	158	113	101	110	276	206	151	155
92	159	113	103	116	277	206	152	156
93	161	114	102	118	278	207	152	157
94	162	115	102	125	280	209	153	158
95	163	115	102	126	282	210	155	159
96	164	115	103	128	283	210	156	160
97	166	116	104	130	285	212	156	161
98	167	117	104	130	287	213	156	163
99	167	117	104	130	289	214	157	163
100	168	118	103	130	290	215	157	164
101	168	118	104	130	291	216	158	165
102	169	118	105	131	293	217	159	166
103	171	119	105	133	295	218	158	167
104	172	120	105	133	297	219	160	163
105	173	120	106	133	298	220	161	163
106	174	121	107	137	300	221	162	164
107	175	122	108	138	301	222	162	165
108	177	122	109	139	303	224	162	165
109	178	123	109	140	305	225	162	166
110	178	123	109	138	307	226	164	167
111	179	124	108	137	308	226	165	167
112	180	124	107	132	310	227	166	168
113	180	124	109	135	311	227	167	169
114	181	125	111	137	312	227	168	170
115	182	126	111	139	314	227	169	170
116	183	126	113	143	316	229	169	171
117	185	127	112	143	318	230	169	172
118	187	128	113	146	320	232	169	173
119	188	129	114	146	322	233	169	173
120	189	129	113	145	324	235	169	174
121	191	130	115	148	326	236	169	174
122	192	130	116	150	329	237	169	174
123	193	131	116	148	333	238	170	175
124	193	131	115	147	335	238	172	175
125	194	132	115	147	338	239	174	176

Time (min)	Pen. #6 TC #19 (°F)	Pen. #7 TC #20 (°F)	Pen. #7 TC #21 (°F)	Pen. #7 TC #22 (°F)	Pen. #7 TC #23 (°F)	Pen. #7 TC #24 (°F)	Pen. #7 TC #25 (°F)	Pen. #7 TC #26 (°F)
126	196	132	117	149	339	240	174	176
127	197	133	116	153	340	241	173	177
128	198	134	118	154	343	243	173	177
129	199	134	116	152	344	244	175	177
130	201	135	115	149	346	245	176	177
131	201	136	115	148	347	245	177	178
132	201	136	117	151	348	245	178	179
133	203	137	115	151	349	246	178	179
134	204	137	115	151	350	248	179	180
135	205	138	117	151	351	248	180	180
136	206	139	116	154	353	249	180	180
137	207	140	115	156	354	250	180	181
138	209	140	116	158	355	251	180	182
139	210	140	117	157	356	251	181	181
140	211	141	116	154	357	252	181	183
141	211	142	116	156	358	253	182	184
142	212	142	116	155	359	255	183	184
143	214	143	117	158	361	256	185	185
144	215	144	120	156	361	257	184	185
145	216	144	120	157	362	257	185	184
146	216	145	117	150	364	257	187	186
147	217	145	115	150	365	258	189	187
148	219	146	117	150	366	258	190	188
149	220	147	120	150	367	259	191	188
150	221	148	118	147	368	260	192	190
151	222	149	120	148	369	260	193	191
152	222	149	123	147	370	260	194	191
153	223	149	124	148	371	261	194	192
154	223	150	127	157	372	263	196	192
155	224	151	131	163	374	264	196	192
156	226	150	131	164	375	264	196	186
157	227	151	132	166	376	264	197	188
158	228	151	125	164	377	264	196	191
159	228	151	121	161	379	265	196	192
160	229	151	118	158	380	265	196	194
161	230	152	116	154	381	265	197	194
162	231	152	115	151	383	265	198	196
163	232	153	117	150	383	266	198	196
164	233	153	118	151	384	266	199	198
165	234	154	117	148	386	267	199	198
166	235	154	116	152	387	267	200	199
167	236	155	118	154	388	267	201	199

Time (min)	Pen. #6 TC #19 (°F)	Pen. #7 TC #20 (°F)	Pen. #7 TC #21 (°F)	Pen. #7 TC #22 (°F)	Pen. #7 TC #23 (°F)	Pen. #7 TC #24 (°F)	Pen. #7 TC #25 (°F)	Pen. #7 TC #26 (°F)
168	237	156	119	159	389	268	202	200
169	237	156	121	164	390	269	202	199
170	239	156	120	163	392	269	204	201
171	239	156	120	162	393	270	204	201
172	240	156	117	155	394	270	204	202
173	241	156	116	154	396	271	203	203
174	241	156	115	150	397	270	204	203
175	242	157	117	156	399	271	205	204
176	243	157	119	164	400	272	207	205
177	243	158	119	163	402	273	206	206
178	244	158	120	163	403	273	207	206
179	245	158	121	164	404	274	208	206
180	245	158	119	164	405	275	210	206
Max Temp:	245	158	132	166	405	275	210	206
Max Allowed:	700	700	700	700	700	700	700	700

OMEGA POINT LABORATORIES

Duke Engineering Services, Inc. Project No. 14980-106206 March 2, 2000

Time (min)	Pen. #8 TC #27 (°F)	Pen. #8 TC #28 (°F)	Pen. #8 TC #29 (°F)	Pen. #8 TC #30 (°F)	Pen. #8 TC #31 (°F)	Pen. #8 TC #32 (°F)	Pen. #9 TC #33 (°F)	Pen. #9 TC #34 (°F)
0	80	79	79	79	79	79	79	84
1	80	79	79	79	79	79	79	84
2	80	79	79	79	79	79	79	84
3	80	79	80	79	79	79	79	84
4	81	80	82	79	79	80	79	84
5	81	80	83	79	79	80	80	84
6	82	81	84	80	79	80	80	84
7	82	81	84	80	79	80	80	84
8	82	81	84	80	79	80	80	84
9	82	81	84	80	79	80	80	84
10	82	82	85	81	80	80	80	84
11	82	82	85	82	80	81	81	84
12	83	82	86	83	80	81	81	84
13	83	82	87	85	80	81	81	85
14	83	83	88	87	81	82	81	85
15	83	83	89	90	81	82	81	85
16	83	83	91	93	81	82	81	85
17	83	83	92	95	82	83	81	86
18	84	83	94	98	83	84	81	86
19	84	83	95	102	83	84	81	86
20	84	84	97	107	84	85	82	87
21	84	84	98	110	84	85	81	87
22	85	84	101	112	85	86	82	87
23	85	84	102	114	85	87	82	88
24	85	84	104	118	86	87	82	89
25	85	85	106	123	87	88	82	89
26	86	85	108	127	88	89	83	90
27	86	85	110	127	89	90	83	91
28	87	85	112	130	89	91	83	92
29	87	86	114	132	90	91	83	92
30	87	86	116	135	91	92	85	93
31	88	86	118	138	92	93	83	94
32	88	86	120	139	93	94	84	95
33	89	86	122	141	93	95	84	95
34	89	87	124	143	95	96	84	96
35	89	87	125	144	95	97	84	97
36	90	87	127	147	96	98	84	97
37	90	87	129	147	96	98	84	98
38	91	87	130	148	98	99	84	99
39	91	88	132	151	98	100	85	100
40	92	88	133	151	99	101	85	100
41	92	88	135	151	99	102	85	101

OMEGA POINT LABORATORIES

Duke Engineering Services, Inc. Project No. 14980-106206 March 2, 2000

Time (min)	Pen. #8 TC #27 (°F)	Pen. #8 TC #28 (°F)	Pen. #8 TC #29 (°F)	Pen. #8 TC #30 (°F)	Pen. #8 TC #31 (°F)	Pen. #8 TC #32 (°F)	Pen. #9 TC #33 (°F)	Pen. #9 TC #34 (°F)
42	93	88	136	152	100	103	85	102
43	93	89	138	154	101	104	86	104
44	94	89	139	155	102	105	86	105
45	95	89	141	159	103	106	86	106
46	95	89	142	158	104	107	87	107
47	95	90	143	160	104	107	87	108
48	96	90	145	162	105	108	87	108
49	96	90	146	164	105	109	87	109
50	97	90	147	167	106	111	88	110
51	97	91	148	174	107	111	88	111
52	98	91	149	170	108	112	88	112
53	98	91	150	179	109	113	88	112
54	99	91	150	172	109	114	88	113
55	100	91	151	176	110	115	89	114
56	100	92	152	178	111	116	90	116
57	100	92	153	179	112	118	90	116
58	101	92	154	179	113	119	91	117
59	102	92	155	188	114	120	90	118
60	102	92	156	185	114	121	90	119
61	103	92	157	187	115	122	91	120
62	103	93	158	183	116	123	91	121
63	104	93	159	184	114	124	92	123
64	104	93	161	186	115	126	92	123
65	105	94	162	188	116	127	93	125
66	106	94	164	190	118	128	94	127
67	107	94	165	192	119	129	95	128
68	107	95	167	195	118	131	95	129
69	108	95	168	197	119	132	96	131
70	109	96	170	200	119	134	96	132
71	110	96	171	202	120	135	97	134
72	110	97	172	204	120	136	97	135
73	111	97	173	208	122	137	96	136
74	111	97	174	209	123	138	96	137
75	112	97	175	208	124	140	98	139
76	113	97	176	209	124	141	97	141
77	113	98	178	209	125	142	99	142
78	114	98	179	211	124	143	99	144
79	115	99	180	213	128	145	100	146
80	115	99	181	214	130	146	99	147
81	116	99	182	218	129	146	97	147
82	117	99	182	217	131	147	99	148
83	117	100	183	216	132	148	99	149

Time (min)	Pen. #8 TC #27 (°F)	Pen. #8 TC #28 (°F)	Pen. #8 TC #29 (°F)	Pen. #8 TC #30 (°F)	Pen. #8 TC #31 (°F)	Pen. #8 TC #32 (°F)	Pen. #9 TC #33 (°F)	Pen. #9 TC #34 (°F)
84	118	100	183	214	129	149	101	151
85	119	100	185	217	131	150	100	153
86	119	100	186	216	131	150	100	153
87	120	100	187	214	133	151	102	155
88	120	100	188	215	135	152	103	157
89	121	101	189	219	136	153	101	158
90	122	101	189	220	135	154	100	158
91	122	101	190	219	137	154	101	159
92	123	102	190	216	137	154	103	161
93	124	102	192	216	133	155	109	163
94	125	103	193	219	137	156	104	163
95	126	103	194	219	139	155	104	163
96	126	103	195	217	139	154	106	166
97	127	104	196	217	133	155	106	168
98	128	105	197	218	136	155	106	169
99	129	106	198	219	138	155	105	168
100	130	106	199	220	138	154	106	168
101	130	106	199	220	141	155	108	170
102	131	106	200	220	141	156	108	172
103	131	107	202	221	141	158	108	173
104	132	107	202	222	140	158	109	175
105	133	108	203	222	143	159	109	177
106	133	108	204	223	141	159	108	180
107	135	109	205	224	140	161	109	183
108	135	110	207	225	139	162	109	186
109	136	111	208	225	137	163	111	188
110	137	112	210	226	142	163	113	187
111	137	111	210	226	146	163	113	189
112	138	111	211	228	147	163	114	187
113	139	111	211	228	150	163	122	188
114	139	110	212	230	151	164	128	191
115	140	110	212	231	150	165	128	192
116	140	111	213	232	147	166	131	195
117	141	112	214	232	146	167	132	197
118	143	113	216	234	143	169	136	201
119	143	114	217	234	146	169	134	195
120	144	114	219	234	140	169	136	194
121	145	115	219	234	143	171	138	196
122	145	115	221	237	145	171	140	171
123	146	116	222	238	151	171	143	156
124	146	115	222	238	152	171	145	145
125	147	115	223	238	156	172	147	142

Time (min)	Pen. #8 TC #27 (°F)	Pen. #8 TC #28 (°F)	Pen. #8 TC #29 (°F)	Pen. #8 TC #30 (°F)	Pen. #8 TC #31 (°F)	Pen. #8 TC #32 (°F)	Pen. #9 TC #33 (°F)	Pen. #9 TC #34 (°F)
126	148	115	224	241	148	174	149	133
127	148	115	226	242	149	174	152	140
128	150	116	227	242	147	176	155	139
129	150	117	228	243	150	176	157	141
130	152	118	229	245	156	177	159	127
131	152	117	229	246	159	177	159	134
132	152	116	230	246	161	178	140	119
133	153	117	231	247	156	179	110	120
134	154	118	232	248	158	180	115	109
135	155	118	231	249	162	181	129	124
136	156	118	234	250	164	181	125	117
137	156	118	235	251	159	182	131	128
138	157	118	236	253	161	182	134	137
139	158	119	237	253	165	183	138	131
140	158	119	238	254	159	184	130	123
141	159	120	239	255	163	185	146	139
142	160	120	241	257	157	186	148	137
143	161	120	241	259	162	188	731	722
144	162	120	242	262	165	188	1036	909
145	163	120	242	264	170	188	1273	1130
146	163	120	240	263	164	189	1348	1064
147	164	120	244	264	166	190	1369	1184
148	165	121	245	267	170	192	1457	1279
149	166	120	247	269	172	192	1451	1343
150	166	121	247	271	169	194	1523	1393
151	167	121	248	272	174	194	1512	1482
152	167	121	249	276	176	194	1495	1556
153	167	121	249	277	178	195	1492	1552
154	168	121	250	282	179	195	1472	1534
155	169	122	251	283	179	197	1484	1492
156	169	122	252	284	179	198	1489	1497
157	170	122	253	287	182	199	1490	1496
158	170	123	254	290	179	200	1492	1503
159	170	123	255	292	177	201	1488	1510
160	170	124	256	293	179	202	1495	1516
161	172	124	256	294	175	204	1493	1517
162	172	125	257	294	174	206	1503	1519
163	172	125	258	294	169	208	1504	1513
164	173	125	258	293	176	209	1505	1514
165	174	126	257	296	178	210	1514	1519
166	175	126	260	296	181	212	1516	1520
167	175	126	260	297	178	212	1521	1527

Duke Engineering Services, Inc. Project No. 14980-106206 March 2, 2000

Time (min)	Pen. #8 TC #27 (°F)	Pen. #8 TC #28 (°F)	Pen. #8 TC #29 (°F)	Pen. #8 TC #30 (°F)	Pen. #8 TC #31 (°F)	Pen. #8 TC #32 (°F)	Pen. #9 TC #33 (°F)	Pen. #9 TC #34 (°F)
168	176	127	261	299	178	215	1525	1532
169	176	127	262	300	179	216	1528	1532
170	178	128	262	301	180	217	1536	1537
171	179	128	263	302	182	220	1536	1542
172	180	128	264	303	177	222	1542	1546
173	181	128	264	303	182	224	1547	1549
174	181	128	265	305	182	225	1551	1553
175	182	128	265	308	179	227	1554	1555
176	184	129	266	309	180	229	1557	1559
177	185	129	266	311	180	231	1562	1563
178	185	129	267	313	182	232	1566	1568
179	186	129	268	316	183	232	1570	1573
180	187	130	268	317	185	235	1576	1577
Max Temp:	187	130	268	317	185	235	1576	1577
Max Allowed:	700	700	700	700	700	700	700	700

OMEGA POINT LABORATORIES

Time (min)	Pen. #9 TC #35 (°F)	Pen. #9 TC #36 (°F)	Pen. #10 TC #37 (°F)	Pen. #10 TC #38 (°F)	Pen. #10 TC #39 (°F)	Pen. #10 TC #40 (°F)	Pen. #11 TC #41 (°F)
0	79	83	79	79	78	79	78
1	79	83	79	79	78	79	78
2	79	82	79	79	78	79	78
3	80	82	79	79	79	79	78
4	80	82	79	79	79	79	78
5	81	82	79	79	80	80	78
6	82	82	79	79	81	80	78
7	83	82	79	79	82	80	78
8	84	83	79	79	84	80	79
9	86	83	79	80	85	81	79
10	88	83	80	80	87	81	79
11	90	84	80	80	89	82	80
12	92	84	80	80	91	82	80
13	95	84	80	81	93	82	80
14	98	85	81	81	96	83	80
15	101	85	81	81	98	84	80
16	104	85	81	81	101	84	81
17	107	86	81	82	104	85	81
18	110	86	82	82	107	85	81
19	114	87	82	82	110	84	81
20	117	88	82	82	113	85	81
21	120	89	82	82	116	85	82
22	123	89	82	83	119	87	82
23	127	90	83	83	122	87	82
24	130	91	83	83	125	87	82
25	134	92	83	83	128	87	83
26	137	92	84	84	131	87	83
27	141	93	84	84	134	89	84
28	144	94	84	84	137	90	84
29	148	95	85	85	140	91	84
30	151	96	85	85	143	92	84
31	154	97	85	85	145	89	85
32	158	98	86	86	148	92	85
33	161	99	86	86	150	93	85
34	164	100	86	87	152	94	86
35	167	101	86	87	154	94	86
36	170	102	86	87	157	93	86
37	173	103	86	87	158	94	86
38	176	104	87	87	161	95	87
39	179	105	87	87	162	93	87
40	182	106	87	88	164	94	88
41	185	107	87	88	166	95	88

Time (min)	Pen. #9 TC #35 (°F)	Pen. #9 TC #36 (°F)	Pen. #10 TC #37 (°F)	Pen. #10 TC #38 (°F)	Pen. #10 TC #39 (°F)	Pen. #10 TC #40 (°F)	Pen. #11 TC #41 (°F)
42	188	108	88	89	168	96	88
43	191	109	88	89	171	98	89
44	195	111	89	90	173	100	89
45	198	113	89	90	176	94	90
46	201	113	89	90	178	96	90
47	203	114	90	91	181	98	91
48	206	115	90	91	183	97	91
49	209	116	91	91	185	96	91
50	211	118	91	91	188	95	92
51	214	119	91	92	190	94	92
52	216	120	92	92	193	96	93
53	219	122	92	92	195	93	93
54	221	122	92	92	199	96	93
55	223	123	92	92	202	96	94
56	226	125	93	93	205	96	94
57	228	127	94	93	208	96	95
58	231	128	94	94	211	96	95
59	234	129	95	94	215	94	96
60	236	130	95	94	218	96	96
61	239	131	96	95	221	94	96
62	242	132	96	95	225	100	97
63	246	133	97	96	230	109	98
64	249	133	97	97	234	107	98
65	253	135	98	98	239	110	99
66	257	137	99	99	243	109	100
67	261	139	99	100	247	112	100
68	265	140	100	101	251	115	101
69	269	142	100	101	255	118	101
70	273	143	101	102	259	118	102
71	277	145	102	103	263	119	103
72	281	147	102	104	266	120	103
73	285	149	103	104	270	116	104
74	289	150	104	104	273	116	104
75	293	151	104	105	277	123	105
76	297	152	104	106	281	126	106
77	302	154	105	107	286	132	106
78	306	156	106	108	290	130	107
79	310	159	107	107	293	120	108
80	314	162	109	107	296	120	108
81	318	165	109	105	298	114	109
82	321	165	110	106	302	119	109
83	324	167	111	107	305	124	110

Time (min)	Pen. #9 TC #35 (°F)	Pen. #9 TC #36 (°F)	Pen. #10 TC #37 (°F)	Pen. #10 TC #38 (°F)	Pen. #10 TC #39 (°F)	Pen. #10 TC #40 (°F)	Pen. #11 TC #41 (°F)
84	328	169	112	109	309	134	111
85	331	170	112	108	313	129	112
86	334	172	113	108	315	129	112
87	338	174	114	109	319	132	113
88	342	176	115	110	323	134	114
89	345	181	115	109	325	126	114
90	348	181	116	108	328	125	115
91	350	182	117	109	330	123	116
92	355	182	119	111	333	132	117
93	359	183	119	114	338	146	118
94	363	187	120	111	341	126	119
95	367	190	122	111	344	127	120
96	371	193	123	113	347	138	121
97	375	191	124	116	352	152	122
98	380	193	124	117	356	150	123
99	384	194	125	117	359	148	124
100	387	194	127	118	362	152	125
101	390	197	127	117	364	144	126
102	394	197	129	120	368	156	127
103	398	199	130	120	373	150	127
104	402	202	131	120	376	151	129
105	407	206	132	119	379	138	129
106	412	198	134	124	384	161	130
107	418	199	135	127	390	168	132
108	424	199	136	129	395	174	133
109	430	205	137	130	400	177	134
110	436	215	138	123	404	141	135
111	441	218	140	124	407	144	135
112	446	219	141	122	411	141	136
113	449	216	143	122	415	135	137
114	455	221	145	122	420	138	138
115	460	220	146	126	425	155	138
116	465	208	147	133	432	168	140
117	471	218	148	133	438	166	141
118	477	219	142	134	443	161	142
119	482	225	138	135	448	160	143
120	487	225	134	137	453	170	144
121	492	221	131	139	457	171	145
122	496	220	131	140	460	177	146
123	501	229	136	125	467	127	147
124	508	239	138	140	468	151	147
125	513	244	141	147	469	154	147

Time (min)	Pen. #9 TC #35 (°F)	Pen. #9 TC #36 (°F)	Pen. #10 TC #37 (°F)	Pen. #10 TC #38 (°F)	Pen. #10 TC #39 (°F)	Pen. #10 TC #40 (°F)	Pen. #11 TC #41 (°F)
126	518	240	139	139	474	174	148
127	523	238	137	140	479	179	150
128	528	232	135	143	483	176	150
129	534	245	139	135	487	158	151
130	539	254	144	130	491	146	152
131	545	250	145	123	493	133	152
132	554	241	150	131	497	157	153
133	569	243	151	140	503	168	154
134	595	238	156	131	507	164	155
135	633	228	165	127	511	145	155
136	670	225	170	137	515	162	156
137	705	227	172	138	521	171	157
138	739	220	175	133	527	164	158
139	772	245	179	131	531	156	158
140	800	260	180	141	536	170	159
141	829	240	183	144	542	171	160
142	855	252	184	144	546	171	161
143	896	607	187	141	551	168	162
144	969	767	192	132	555	150	162
145	1049	1160	194	138	559	146	163
146	1155	1314	201	149	564	141	163
147	1265	1462	207	157	569	132	164
148	1332	1526	213	159	574	147	165
149	1372	1517	218	163	579	148	165
150	1413	1571	226	181	586	133	166
151	1449	1571	231	177	592	154	166
152	1481	1556	238	185	597	155	166
153	1500	1535	250	219	607	152	167
154	1513	1503	263	264	618	172	168
155	1510	1468	287	312	632	203	169
156	1500	1466	303	380	650	201	170
157	1492	1486	370	493	670	403	171
158	1483	1519	465	652	707	692	172
159	1476	1509	587	742	756	784	172
160	1472	1525	704	819	800	849	173
161	1468	1528	816	886	837	891	174
162	1469	1525	908	949	868	923	175
163	1470	1536	965	1006	893	967	176
164	1469	1524	997	1046	914	1020	176
165	1469	1547	1020	1075	932	1047	177
166	1471	1545	1043	1102	948	1072	177
167	1474	1553	1065	1127	962	1091	178

Time (min)	Pen. #9 TC #35 (°F)	Pen. #9 TC #36 (°F)	Pen. #10 TC #37 (°F)	Pen. #10 TC #38 (°F)	Pen. #10 TC #39 (°F)	Pen. #10 TC #40 (°F)	Pen. #11 TC #41 (°F)
168	1479	1559	1095	1150	977	1111	179
169	1482	1560	1124	1167	1001	1124	180
170	1487	1562	1143	1183	1019	1122	181
171	1490	1568	1161	1198	1035	1130	181
172	1495	1567	1177	1212	1050	1140	181
173	1499	1575	1190	1226	1063	1150	182
174	1503	1573	1202	1238	1075	1160	182
175	1507	1574	1211	1249	1085	1169	183
176	1511	1581	1221	1257	1093	1177	184
177	1515	1584	1294	1264	1101	1190	184
178	1519	1591	1320	1269	1109	1199	185
179	1524	1592	1337	1274	1119	1208	186
180	1528	1601	1350	1279	1127	1216	186
Max Temp:	1528	1601	1350	1279	1127	1216	186
Max Allowed:	700	700	700	700	700	700	700

OMEGA POINT LABORATORIES

Time (min)	Pen. #11 TC #42 (°F)	Pen. #11 TC #43 (°F)	Pen. #12 TC #44 (°F)	Pen. #12 TC #45 (°F)	Pen. #12 TC #46 (°F)	Pen. #13 TC #47 (°F)	Pen. #13 TC #48 (°F)
0	77	77	81	79	80	79	78
1	77	78	81	80	81	79	78
2	77	78	81	80	81	79	78
3	77	78	81	80	81	79	79
4	77	78	81	80	81	79	79
5	77	78	81	81	81	79	80
6	77	78	81	82	81	80	81
7	77	78	81	83	81	80	82
8	78	78	81	85	81	80	84
9	78	78	81	86	82	80	86
10	78	79	82	88	82	80	88
11	79	79	82	91	83	80	90
12	80	79	82	93	83	81	93
13	81	79	82	96	84	81	95
14	83	80	82	99	84	81	98
15	85	80	82	102	85	81	102
16	86	80	82	104	85	82	105
17	89	81	82	108	86	82	108
18	91	81	83	111	87	82	112
19	94	82	83	114	88	82	115
20	96	82	83	118	89	82	118
21	100	82	83	121	89	82	122
22	102	83	83	124	90	83	125
23	106	84	83	127	91	83	129
24	109	84	84	131	93	84	132
25	113	85	84	134	93	84	135
26	116	85	84	138	95	84	138
27	120	86	84	141	96	84	141
28	124	87	85	144	97	85	145
29	128	88	85	148	98	85	148
30	132	88	85	151	99	85	151
31	136	89	85	154	100	85	154
32	141	90	86	157	102	86	157
33	145	91	86	161	103	86	161
34	149	92	86	164	104	86	163
35	154	93	86	167	105	86	166
36	158	93	87	170	106	86	169
37	162	94	87	172	107	87	172
38	167	95	87	176	107	87	175
39	170	96	87	178	108	87	178
40	173	97	88	181	109	87	180
41	176	98	88	183	111	87	183

Time (min)	Pen. #11 TC #42 (°F)	Pen. #11 TC #43 (°F)	Pen. #12 TC #44 (°F)	Pen. #12 TC #45 (°F)	Pen. #12 TC #46 (°F)	Pen. #13 TC #47 (°F)	Pen. #13 TC #48 (°F)
42	178	99	89	186	112	88	186
43	180	100	89	189	113	89	189
44	181	101	90	192	115	89	192
45	182	102	90	195	116	89	195
46	183	103	91	197	116	89	199
47	184	104	91	200	118	90	202
48	184	104	92	202	118	90	205
49	185	105	92	205	120	90	208
50	186	106	93	208	121	90	212
51	186	107	94	210	122	90	215
52	187	107	94	213	123	91	218
53	187	108	94	215	123	90	221
54	188	109	95	217	124	91	224
55	188	109	95	220	125	91	228
56	190	110	96	223	127	91	231
57	191	111	97	226	129	91	234
58	193	111	98	229	130	92	238
59	195	112	98	232	129	92	242
60	197	112	99	235	132	93	245
61	199	113	99	238	133	92	249
62	201	114	100	241	135	93	253
63	203	114	101	245	138	95	258
64	205	116	102	248	140	95	263
65	207	117	103	252	141	96	267
66	209	118	104	257	143	97	272
67	211	118	105	261	145	98	277
68	213	120	105	265	146	98	282
69	215	121	106	269	147	99	286
70	217	122	108	273	150	100	292
71	219	123	109	277	152	101	296
72	221	124	109	282	153	102	301
73	223	125	110	286	155	102	306
74	225	125	111	289	155	103	310
75	227	127	113	294	157	104	316
76	229	127	114	299	159	104	321
77	231	129	115	304	160	105	326
78	232	130	116	309	164	106	331
79	234	131	117	315	165	106	336
80	236	131	118	320	166	107	340
81	238	132	118	325	163	106	343
82	240	132	119	330	165	106	346
83	242	133	120	334	169	107	350

Time (min)	Pen. #11 TC #42 (°F)	Pen. #11 TC #43 (°F)	Pen. #12 TC #44 (°F)	Pen. #12 TC #45 (°F)	Pen. #12 TC #46 (°F)	Pen. #13 TC #47 (°F)	Pen. #13 TC #48 (°F)
84	243	134	122	339	172	109	354
85	246	135	123	345	175	109	359
86	247	136	124	349	174	109	363
87	248	137	125	354	178	110	367
88	250	137	126	360	179	110	366
89	252	138	126	366	177	108	369
90	254	139	126	370	179	107	375
91	255	140	128	374	180	107	380
92	257	140	130	380	188	110	382
93	258	141	131	387	193	114	390
94	260	143	131	393	188	110	397
95	261	144	131	398	187	110	403
96	263	145	124	404	196	111	409
97	264	146	119	411	204	116	416
98	267	147	119	417	209	116	424
99	269	148	113	423	210	115	430
100	270	149	114	428	208	116	436
101	272	150	113	433	207	113	441
102	274	151	109	438	213	116	448
103	275	152	118	444	212	116	455
104	277	153	114	450	219	116	461
105	279	154	121	456	212	115	468
106	281	155	115	463	226	119	475
107	283	156	118	469	231	123	483
108	285	158	116	476	233	126	491
109	287	159	115	483	233	127	498
110	289	160	120	490	230	119	505
111	291	161	115	496	233	120	511
112	292	161	111	502	239	120	518
113	294	159	118	508	242	119	524
114	296	158	124	516	252	132	532
115	298	158	125	523	255	136	541
116	300	160	122	531	260	141	552
117	301	162	127	540	267	144	562
118	303	164	126	549	271	147	572
119	304	166	121	558	275	149	582
120	306	167	118	567	277	153	591
121	307	168	122	576	279	157	601
122	309	170	114	586	271	162	613
123	311	172	127	595	259	158	629
124	312	173	130	606	247	185	658
125	313	174	130	615	238	208	691

Time (min)	Pen. #11 TC #42 (°F)	Pen. #11 TC #43 (°F)	Pen. #12 TC #44 (°F)	Pen. #12 TC #45 (°F)	Pen. #12 TC #46 (°F)	Pen. #13 TC #47 (°F)	Pen. #13 TC #48 (°F)
126	316	176	123	623	241	233	721
127	318	178	123	632	247	255	749
128	320	179	140	639	281	280	777
129	321	181	142	648	289	315	805
130	324	183	143	658	302	357	834
131	325	182	148	668	310	398	862
132	327	183	151	677	319	437	887
133	329	185	159	687	347	475	910
134	332	187	224	697	433	515	931
135	333	189	241	702	554	553	951
136	335	190	248	712	716	593	969
137	337	192	360	726	879	634	987
138	339	194	400	740	963	680	1002
139	341	196	396	753	969	729	1018
140	343	197	365	764	1020	779	1034
141	345	200	402	775	1008	827	1049
142	347	201	283	784	1046	870	1065
143	349	204	320	792	1116	910	1080
144	351	205	269	799	1110	944	1094
145	353	206	297	809	1100	973	1108
146	355	207	316	816	1073	999	1120
147	358	208	318	824	1161	1023	1131
148	360	210	326	832	1221	1046	1141
149	363	211	358	842	1247	1069	1150
150	366	212	412	850	1258	1091	1158
151	368	213	680	858	1275	1111	1165
152	371	214	730	867	1325	1130	1171
153	373	215	628	875	1387	1147	1177
154	375	217	691	886	1437	1162	1182
155	378	219	1247	897	1413	1176	1187
156	380	220	1246	987	1497	1190	1191
157	382	222	1343	1082	1574	1202	1195
158	384	223	1468	1160	1583	1213	1200
159	385	225	1483	1213	1589	1224	1205
160	386	226	1493	1251	1586	1234	1209
161	387	228	1513	1278	1592	1243	1213
162	387	229	1537	1303	1611	1252	1218
163	388	231	1555	1329	1613	1256	1222
164	389	232	1554	1349	1613	1260	1226
165	390	233	1546	1365	1615	1266	1234
166	390	234	1544	1381	1617	1277	1244
167	391	235	1546	1394	1617	1290	1253

Time (min)	Pen. #11 TC #42 (°F)	Pen. #11 TC #43 (°F)	Pen. #12 TC #44 (°F)	Pen. #12 TC #45 (°F)	Pen. #12 TC #46 (°F)	Pen. #13 TC #47 (°F)	Pen. #13 TC #48 (°F)
168	391	236	1531	1405	1614	1303	1261
169	392	237	1535	1412	1614	1313	1269
170	393	238	1536	1417	1614	1324	1276
171	393	239	1535	1421	1601	1334	1283
172	394	240	1551	1424	1587	1343	1289
173	394	241	1560	1426	1589	1351	1294
174	395	242	1563	1429	1591	1358	1300
175	396	242	1565	1432	1594	1365	1306
176	396	243	1561	1435	1598	1372	1311
177	397	244	1568	1438	1601	1378	1316
178	399	246	1569	1442	1606	1383	1321
179	400	247	1573	1444	1606	1388	1326
180	401	247	1572	1446	1585	1392	1331
Max Temp:	401	247	1573	1446	1617	1392	1331
Max Allowed:	700	700	700	700	700	700	700

Time (min)	Pen. #13 TC #49 (°F)	Pen. #14 TC #50 (°F)	Pen. #14 TC #51 (°F)	Pen. #14 TC #52 (°F)	Pen. #14 TC #53 (°F)	Lab Ambient (°F)	Furnace Probe #1 (°F)
0	79	79	79	78	78	81	78
1	79	79	80	78	78	80	108
2	79	79	79	78	77	81	187
3	79	79	80	78	78	80	367
4	79	79	80	78	78	81	659
5	79	80	80	78	77	82	940
6	80	80	80	78	78	82	1128
7	80	80	80	78	78	82	1211
8	80	80	80	78	78	82	1244
9	80	81	80	78	78	82	1262
10	80	81	81	79	78	82	1284
11	81	81	81	79	79	83	1308
12	81	81	81	80	79	82	1327
13	81	82	81	80	79	83	1341
14	82	82	82	81	80	83	1354
15	83	82	82	82	80	82	1366
16	83	82	82	84	80	82	1381
17	84	82	82	85	80	82	1400
18	84	83	82	86	80	82	1418
19	85	83	82	88	81	82	1434
20	85	84	82	89	81	82	1445
21	86	83	82	91	81	81	1455
22	87	84	83	93	82	82	1469
23	87	84	83	95	82	82	1487
24	88	85	83	98	82	82	1503
25	89	85	83	100	82	82	1516
26	89	85	84	102	83	83	1528
27	90	85	84	105	82	82	1541
28	91	86	84	108	82	82	1554
29	92	86	85	111	82	82	1568
30	93	87	85	113	82	83	1575
31	93	87	84	116	83	82	1582
32	94	87	85	119	82	83	1583
33	95	88	85	122	82	83	1591
34	96	88	85	125	83	82	1601
35	97	88	86	128	82	82	1611
36	98	89	85	131	84	82	1619
37	98	89	86	133	83	82	1623
38	99	89	86	136	82	82	1632
39	100	90	86	139	84	83	1642
40	100	90	86	141	84	83	1649
41	101	90	86	144	83	82	1649

Time (min)	Pen. #13 TC #49 (°F)	Pen. #14 TC #50 (°F)	Pen. #14 TC #51 (°F)	Pen. #14 TC #52 (°F)	Pen. #14 TC #53 (°F)	Lab Ambient (°F)	Furnace Probe #1 (°F)
42	102	91	87	147	82	83	1655
43	103	92	87	149	82	83	1662
44	104	92	87	151	82	83	1667
45	104	92	86	154	85	83	1674
46	105	92	87	156	84	83	1680
47	106	92	87	158	84	83	1690
48	107	92	87	161	84	83	1699
49	108	93	87	163	84	84	1706
50	108	93	87	165	86	83	1711
51	109	94	86	166	87	83	1713
52	110	93	86	168	86	84	1715
53	109	94	85	170	87	83	1719
54	111	94	87	171	85	83	1726
55	112	94	86	173	86	84	1734
56	113	94	87	174	86	84	1742
57	113	95	87	176	86	85	1748
58	114	94	88	177	85	84	1755
59	115	95	89	179	86	84	1756
60	116	96	89	180	85	84	1760
61	117	96	88	182	86	83	1765
62	118	96	89	183	83	83	1768
63	121	98	90	186	79	83	1763
64	123	98	90	189	80	84	1760
65	125	97	91	191	78	85	1758
66	127	98	91	193	79	86	1761
67	129	100	92	195	77	86	1767
68	131	100	92	197	77	86	1767
69	133	100	93	200	77	87	1770
70	136	102	93	202	75	86	1771
71	137	103	93	204	76	88	1773
72	138	103	93	205	76	88	1775
73	138	102	92	208	80	87	1776
74	135	103	93	209	79	86	1778
75	132	105	92	210	78	86	1780
76	130	105	94	212	76	86	1782
77	132	104	94	214	74	86	1784
78	132	104	94	216	75	86	1785
79	137	102	92	219	78	86	1788
80	137	104	92	220	80	86	1792
81	135	102	91	221	85	85	1797
82	137	102	90	222	84	85	1802
83	136	105	91	224	81	85	1807

Time (min)	Pen. #13 TC #49 (°F)	Pen. #14 TC #50 (°F)	Pen. #14 TC #51 (°F)	Pen. #14 TC #52 (°F)	Pen. #14 TC #53 (°F)	Lab Ambient (°F)	Furnace Probe #1 (°F)
84	137	107	93	226	78	86	1810
85	141	103	92	228	79	87	1812
86	129	104	91	229	81	85	1815
87	129	103	92	231	80	86	1817
88	121	100	92	233	80	85	1820
89	111	106	91	235	83	86	1821
90	110	105	91	235	83	87	1822
91	114	104	92	237	82	86	1825
92	126	106	96	237	78	87	1823
93	135	112	101	239	72	87	1827
94	128	114	103	242	77	87	1830
95	127	116	104	243	79	86	1828
96	132	117	105	244	74	87	1832
97	140	118	107	247	69	86	1832
98	143	119	108	250	67	86	1833
99	142	120	109	251	71	87	1835
100	140	120	110	253	73	88	1836
101	137	121	111	255	71	87	1840
102	145	122	111	258	67	88	1843
103	145	123	112	260	71	88	1846
104	148	123	113	262	68	88	1850
105	143	124	114	263	72	88	1853
106	153	125	115	265	64	87	1855
107	159	125	116	268	61	87	1858
108	163	127	117	270	58	88	1860
109	167	128	119	272	57	88	1863
110	152	126	119	274	65	89	1866
111	150	127	120	276	67	88	1867
112	135	124	120	277	73	88	1868
113	127	125	120	278	72	87	1871
114	129	125	120	280	71	88	1875
115	144	127	121	282	68	89	1873
116	148	128	122	284	60	87	1872
117	142	131	124	287	60	89	1873
118	140	132	125	289	55	87	1870
119	134	131	126	291	54	89	1871
120	130	134	128	293	53	88	1872
121	135	136	129	295	52	88	1872
122	158	137	130	297	152	89	1871
123	151	137	131	299	146	87	1868
124	249	140	130	301	134	87	1868
125	307	141	130	303	134	88	1869

Duke Engineering Services, Inc. Project No. 14980-106206 March 2, 2000

Time (min)	Pen. #13 TC #49 (°F)	Pen. #14 TC #50 (°F)	Pen. #14 TC #51 (°F)	Pen. #14 TC #52 (°F)	Pen. #14 TC #53 (°F)	Lab Ambient (°F)	Furnace Probe #1 (°F)
126	354	143	131	306	144	88	1871
127	392	145	133	309	149	88	1871
128	430	145	134	312	143	89	1871
129	472	143	134	314	146	89	1870
130	519	141	135	317	141	90	1871
131	570	139	135	319	130	89	1872
132	622	141	134	320	138	88	1874
133	676	145	135	322	144	88	1875
134	731	146	136	324	141	87	1877
135	786	147	136	327	137	88	1879
136	837	148	136	329	146	88	1882
137	883	149	136	331	146	87	1883
138	923	151	137	333	145	89	1884
139	959	152	137	335	144	89	1884
140	989	154	137	337	152	88	1885
141	1016	156	138	340	154	87	1886
142	1041	157	139	342	158	87	1887
143	1066	158	140	344	158	86	1889
144	1091	159	140	347	149	88	1891
145	1116	159	140	349	146	88	1891
146	1140	160	140	350	155	88	1891
147	1163	161	141	352	156	89	1894
148	1184	162	142	355	156	87	1895
149	1202	163	142	357	157	88	1896
150	1218	163	142	359	170	88	1895
151	1232	165	143	362	159	87	1895
152	1245	165	143	364	152	87	1897
153	1258	167	143	366	161	89	1899
154	1269	168	144	368	168	88	1901
155	1279	169	145	370	170	87	1902
156	1287	170	145	372	170	87	1903
157	1294	170	146	374	167	87	1905
158	1301	171	146	375	170	86	1906
159	1307	172	147	377	174	86	1906
160	1310	172	148	378	166	86	1908
161	1312	171	148	379	170	86	1909
162	1314	173	148	380	170	86	1910
163	1315	174	149	381	173	86	1911
164	1315	175	150	382	177	88	1912
165	1316	175	151	383	173	88	1916
166	1318	175	151	385	174	87	1918
167	1320	176	151	386	175	87	1919

Time (min)	Pen. #13 TC #49 (°F)	Pen. #14 TC #50 (°F)	Pen. #14 TC #51 (°F)	Pen. #14 TC #52 (°F)	Pen. #14 TC #53 (°F)	Lab Ambient (°F)	Furnace Probe #1 (°F)
168	1323	176	152	387	176	86	1920
169	1326	178	153	388	180	86	1922
170	1328	178	154	389	178	86	1922
171	1330	179	154	390	177	86	1922
172	1332	179	155	391	174	87	1923
173	1335	179	155	392	172	88	1925
174	1338	179	155	392	173	87	1926
175	1341	180	156	393	181	86	1927
176	1345	181	156	394	179	86	1925
177	1349	183	157	395	182	85	1927
178	1353	184	158	396	185	86	1930
179	1357	183	158	397	183	87	1934
180	1362	184	159	398	181	86	1937
Max Temp:	1362	184	159	398	185		
Max Allowed:	700	700	700	700	700		

OMEGA POINT LABORATORIES

Time (min)	Furnace Probe #2 (°F)	Furnace Probe #3 (°F)	Furnace Probe #4 (°F)	Furnace Probe #5 (°F)	Furnace Probe #6 (°F)	Furnace Probe #7 (°F)	Furnace Probe #8 (°F)
0	78	78	77	78	78	78	80
1	95	97	89	107	112	100	171
2	151	162	150	272	236	179	385
3	320	357	413	927	532	433	622
4	613	644	893	1424	1003	876	967
5	912	913	1195	1597	1233	1209	1222
6	1110	1101	1318	1611	1342	1367	1344
7	1198	1186	1340	1506	1334	1409	1374
8	1235	1220	1334	1436	1306	1403	1362
9	1252	1234	1320	1392	1279	1385	1337
10	1273	1251	1318	1387	1262	1381	1338
11	1296	1274	1330	1396	1262	1390	1361
12	1314	1295	1344	1409	1269	1404	1369
13	1328	1313	1358	1427	1276	1412	1380
14	1341	1328	1369	1441	1283	1418	1393
15	1352	1339	1378	1453	1291	1427	1415
16	1368	1353	1391	1476	1307	1443	1440
17	1388	1372	1413	1514	1332	1467	1469
18	1407	1388	1431	1532	1350	1483	1490
19	1422	1402	1445	1549	1365	1496	1500
20	1432	1414	1458	1571	1380	1503	1505
21	1441	1426	1470	1576	1390	1509	1507
22	1454	1439	1484	1578	1398	1516	1511
23	1471	1455	1495	1586	1405	1525	1522
24	1486	1470	1509	1591	1415	1532	1525
25	1498	1482	1523	1604	1427	1539	1528
26	1510	1496	1537	1623	1436	1546	1534
27	1524	1509	1547	1639	1448	1555	1549
28	1537	1528	1566	1638	1457	1564	1556
29	1553	1544	1577	1661	1468	1574	1557
30	1559	1554	1580	1660	1473	1577	1559
31	1566	1561	1581	1655	1477	1580	1568
32	1565	1563	1577	1635	1474	1575	1561
33	1573	1573	1585	1640	1480	1580	1571
34	1583	1584	1595	1669	1487	1588	1576
35	1593	1594	1603	1668	1495	1595	1581
36	1602	1603	1609	1666	1499	1600	1587
37	1606	1609	1615	1664	1502	1602	1589
38	1613	1616	1623	1672	1508	1607	1596
39	1620	1622	1635	1677	1512	1613	1597
40	1625	1628	1638	1677	1518	1616	1599
41	1625	1629	1633	1668	1520	1616	1591

Time (min)	Furnace Probe #2 (°F)	Furnace Probe #3 (°F)	Furnace Probe #4 (°F)	Furnace Probe #5 (°F)	Furnace Probe #6 (°F)	Furnace Probe #7 (°F)	Furnace Probe #8 (°F)
42	1631	1634	1636	1678	1524	1621	1595
43	1639	1642	1643	1690	1530	1626	1604
44	1645	1648	1651	1703	1537	1634	1607
45	1649	1654	1661	1704	1543	1639	1614
46	1653	1659	1673	1712	1550	1644	1618
47	1663	1670	1681	1725	1555	1649	1627
48	1672	1676	1695	1725	1561	1656	1635
49	1678	1682	1701	1731	1566	1661	1642
50	1680	1685	1706	1734	1571	1667	1645
51	1682	1690	1706	1738	1575	1671	1648
52	1684	1693	1710	1741	1581	1673	1653
53	1685	1696	1713	1744	1585	1680	1660
54	1694	1701	1718	1749	1589	1684	1661
55	1702	1707	1724	1756	1593	1689	1665
56	1711	1713	1731	1767	1598	1693	1673
57	1716	1719	1735	1765	1603	1698	1681
58	1723	1724	1741	1782	1609	1703	1690
59	1724	1726	1743	1781	1611	1705	1687
60	1728	1730	1746	1786	1615	1709	1690
61	1732	1734	1750	1789	1619	1713	1693
62	1735	1739	1753	1796	1623	1717	1695
63	1731	1737	1745	1780	1621	1712	1690
64	1728	1733	1739	1778	1619	1710	1688
65	1726	1733	1739	1778	1617	1708	1685
66	1729	1736	1746	1782	1624	1713	1689
67	1737	1746	1748	1797	1630	1721	1701
68	1739	1748	1745	1804	1634	1725	1703
69	1743	1751	1746	1807	1636	1727	1709
70	1743	1754	1747	1806	1637	1728	1711
71	1745	1754	1748	1812	1640	1730	1711
72	1747	1756	1751	1811	1642	1733	1715
73	1748	1756	1753	1815	1644	1735	1721
74	1750	1756	1753	1812	1646	1736	1719
75	1752	1759	1755	1819	1648	1738	1721
76	1753	1760	1757	1812	1650	1740	1723
77	1755	1763	1758	1816	1652	1742	1724
78	1756	1765	1761	1820	1654	1744	1727
79	1760	1769	1764	1824	1658	1747	1733
80	1764	1771	1769	1828	1662	1751	1735
81	1769	1775	1773	1830	1665	1755	1740
82	1773	1781	1780	1835	1669	1760	1748
83	1778	1786	1785	1837	1673	1764	1752

Duke Engineering Services, Inc. Project No. 14980-106206 March 2, 2000

Time (min)	Furnace Probe #2 (°F)	Furnace Probe #3 (°F)	Furnace Probe #4 (°F)	Furnace Probe #5 (°F)	Furnace Probe #6 (°F)	Furnace Probe #7 (°F)	Furnace Probe #8 (°F)
84	1782	1790	1788	1841	1676	1767	1757
85	1784	1795	1793	1841	1680	1771	1761
86	1786	1795	1794	1839	1682	1774	1765
87	1788	1801	1795	1844	1685	1776	1766
88	1790	1802	1799	1845	1688	1779	1768
89	1792	1801	1800	1854	1691	1782	1768
90	1792	1800	1803	1857	1693	1784	1771
91	1795	1802	1804	1854	1696	1787	1774
92	1792	1800	1804	1853	1697	1788	1772
93	1797	1805	1807	1859	1699	1791	1778
94	1798	1805	1808	1860	1700	1791	1775
95	1798	1805	1811	1855	1702	1793	1778
96	1801	1808	1812	1860	1704	1794	1778
97	1802	1814	1815	1859	1707	1796	1783
98	1803	1815	1817	1864	1709	1798	1785
99	1805	1814	1820	1865	1711	1801	1788
100	1807	1817	1823	1868	1713	1803	1789
101	1812	1819	1825	1871	1715	1806	1792
102	1813	1820	1828	1871	1718	1808	1793
103	1817	1830	1835	1885	1724	1815	1805
104	1822	1835	1838	1888	1728	1819	1806
105	1825	1836	1840	1891	1731	1822	1810
106	1827	1838	1842	1893	1734	1825	1812
107	1829	1840	1846	1890	1736	1826	1814
108	1830	1842	1847	1893	1739	1829	1815
109	1833	1847	1846	1899	1741	1831	1817
110	1838	1848	1849	1901	1743	1835	1821
111	1838	1849	1851	1900	1745	1836	1820
112	1839	1848	1852	1899	1746	1837	1820
113	1841	1849	1855	1902	1748	1840	1823
114	1844	1851	1855	1903	1750	1841	1824
115	1842	1851	1854	1906	1751	1843	1826
116	1842	1852	1855	1902	1752	1842	1825
117	1841	1853	1854	1902	1754	1843	1826
118	1839	1853	1855	1898	1756	1844	1827
119	1838	1852	1853	1897	1755	1843	1822
120	1841	1855	1857	1909	1757	1847	1827
121	1842	1859	1860	1915	1761	1851	1834
122	1840	1857	1859	1914	1762	1852	1831
123	1837	1855	1858	1908	1762	1851	1832
124	1837	1851	1856	1907	1762	1851	1831
125	1837	1849	1858	1901	1762	1850	1832

Time (min)	Furnace Probe #2 (°F)	Furnace Probe #3 (°F)	Furnace Probe #4 (°F)	Furnace Probe #5 (°F)	Furnace Probe #6 (°F)	Furnace Probe #7 (°F)	Furnace Probe #8 (°F)
126	1839	1848	1857	1906	1764	1853	1833
127	1838	1847	1857	1910	1767	1857	1835
128	1838	1846	1857	1907	1770	1859	1838
129	1838	1846	1857	1912	1773	1861	1839
130	1840	1847	1858	1914	1777	1863	1842
131	1842	1848	1861	1920	1778	1868	1846
132	1844	1848	1861	1913	1780	1868	1848
133	1845	1850	1862	1910	1782	1871	1849
134	1846	1850	1860	1913	1783	1872	1849
135	1847	1849	1860	1915	1786	1872	1850
136	1850	1848	1860	1918	1793	1880	1853
137	1848	1847	1858	1920	1799	1882	1853
138	1847	1846	1857	1919	1795	1881	1854
139	1846	1845	1856	1917	1797	1880	1853
140	1848	1847	1859	1923	1797	1884	1859
141	1852	1850	1864	1939	1802	1891	1864
142	1855	1854	1869	1947	1809	1895	1869
143	1856	1856	1873	1941	1815	1895	1870
144	1858	1858	1874	1943	1815	1898	1873
145	1860	1858	1874	1946	1812	1896	1875
146	1861	1859	1873	1947	1815	1895	1872
147	1863	1860	1874	1949	1815	1897	1873
148	1860	1860	1874	1943	1817	1897	1873
149	1862	1860	1874	1946	1817	1898	1873
150	1863	1861	1876	1946	1820	1899	1874
151	1862	1860	1874	1934	1822	1896	1873
152	1862	1859	1875	1946	1822	1897	1875
153	1865	1860	1875	1954	1822	1904	1877
154	1866	1862	1877	1955	1824	1908	1880
155	1868	1864	1879	1953	1824	1907	1879
156	1869	1865	1878	1950	1825	1903	1876
157	1869	1865	1878	1957	1825	1906	1879
158	1871	1867	1880	1961	1826	1911	1882
159	1872	1868	1882	1960	1829	1912	1883
160	1874	1869	1884	1962	1832	1918	1885
161	1876	1873	1888	1967	1835	1920	1889
162	1877	1874	1889	1961	1841	1919	1890
163	1879	1876	1890	1952	1843	1915	1888
164	1880	1876	1889	1957	1844	1914	1888
165	1882	1878	1891	1962	1847	1917	1891
166	1884	1880	1894	1972	1845	1921	1895
167	1886	1882	1898	1978	1848	1924	1897

Time (min)	Furnace Probe #2 (°F)	Furnace Probe #3 (°F)	Furnace Probe #4 (°F)	Furnace Probe #5 (°F)	Furnace Probe #6 (°F)	Furnace Probe #7 (°F)	Furnace Probe #8 (°F)
168	1886	1883	1898	1964	1850	1925	1896
169	1889	1886	1900	1963	1854	1924	1898
170	1889	1886	1900	1958	1857	1924	1897
171	1890	1887	1901	1965	1857	1927	1901
172	1890	1888	1903	1980	1856	1930	1904
173	1891	1890	1905	1979	1857	1933	1904
174	1893	1891	1906	1981	1859	1933	1906
175	1893	1892	1908	1988	1857	1934	1907
176	1892	1892	1907	1974	1857	1931	1906
177	1893	1893	1908	1981	1861	1933	1908
178	1898	1896	1912	1978	1868	1937	1911
179	1901	1899	1916	1985	1874	1945	1916
180	1906	1904	1921	2006	1874	1955	1923

Max Temp:
Max Allowed:

OMEGA POINT LABORATORIES

Appendix E

QUALITY ASSURANCE

Duke Engineering & Services
A Duke Energy Company

6100 Southwest Boulevard, Suite 400
Fort Worth, TX 76109

817 738-0300
Fax 817 737-1100

February 28, 2000
00003-23-0084-D01-003

Mr. Deggary Priest
Omega Point Laboratories, Inc.
16015 Shady Falls Road
Elmendorf, TX 78112-9784

Subject: Duke Power Cure Time Fire Test

Reference: OPL Project No. 14980-106206

Dear Deg:

The purpose of this letter is to provide concurrence that the 4' lengths of 6" x 12" cable tray received from Duke Power Company on February 25, 2000 are acceptable for use as-is in the upcoming fire endurance test. The cable tray segments are to be positioned such that the cable trays (and associated cables) extend approximately 1 foot below the 8" thick test slab and 28" above the test slab. Testing standard IEEE-634 (1978 Ed.) stipulates that penetrating items, such as cable trays, should extend 1 foot below the test slab and 3 feet above the test slab. However, reducing the distance that the cable trays extend on the unexposed side of the test slab from 3 feet to 28" is acceptable for the purposes of this test.

Additionally, the use of a single thermocouple on each penetration seal assembly to record unexposed side cable temperatures is acceptable provided the thermocouple is positioned on the largest cable size being tested. Placement of a thermocouple at this location will preclude the need to place a thermocouple on each "type" of cable being tested as implied by IEEE-634 (1978 Ed.).

Should you have any questions or concerns regarding these matters, please contact me at (817) 737-1157.

Sincerely,

Scott Groesbeck
Project Manager,
Fire Protection & Hazards Analysis Services

Training Roster

DE&S Project: 00003.23.0084, "Duke Power Cure Time Fire Test"

OPL Project: 14980-106206

Training Date: February 28, 2000

Training Instructor: Scott Groesbeck (DE&S) LSGroesbeck

Training Description: Classroom training provided to personnel responsible for providing penetration seal materials, installation and quality verification of specific fire barrier penetration seal test assemblies. During this training session, the following documents were reviewed in detail:

- OPL Project No.: 14980-106206, "Test Plan," R.0
- DE&S Doc. No.: 00003-23-0084-F16-001, "Duke Power Cure Time Fire Test – Slab Layout," R.0
- DE&S Doc. No.: 00003-23-0084-F16-002, "Duke Power Cure Time Fire Test – Penetration Seals," R.0
- DE&S Doc. No.: 00003-23-0084-F16-003, "Duke Power Cure Time Fire Test – Installation Instructions," R.0

Name (Printed)	Signature	Company	Date
Michael Jordan	Michael Jordan	Promatec	2-28-00
Cleda Patton	Cleda Patton	Omega Pt. Labs	2-28-00
Michael Murphy	Michael Murphy	Promatec	2/28/00
Bernard F. Haese BERNARD F. HAESE	Bernard F. Haese	Promatec	2/28/00

DE&S Duke Engineering & Services

FORM DPR-3.4A
PAGE 1 OF 1
REVISION 1

TECHNICAL DOCUMENT COVER SHEET

DOCUMENT NUMBER:	00003-23-0084-F16-003	REV:	0
DOCUMENT TITLE:	Duke Power Cure Time Fire Test - Installation Instructions		
PROJECT NAME:	Cure time Fire Test		
PROJECT NUMBER:	00003-23-0084	CLIENT:	Duke Power

QA CONDITION 3

This is the initial issue of this technical document for construction. This technical document provides installation and quality verification instructions for the test specimen. These instructions are intended to be used in conjunction with approved drawings.

This technical document contains this cover page (page 1), pages 2-6 and 42 pages of appendicies (for a total of 48 pages).

DESIGN VERIFICATION METHOD:

- ☒ Design Review
- ☐ Alternate Calculation
- ☐ Qualification Testing

	Preparer	Verifier	Approver
Signature	LSGroesbeck	CA Gibson	LSGroesbeck
Printed Name	L.S. Groesbeck	C.A. Gibson	L.S. Groesbeck
Date	2/24/00	2/24/00	2/24/00

1.0 PURPOSE

The purpose of this document is to provide general instructions for the installation and verification of penetration seal assemblies for Omega Point Laboratories (OPL) Project No. 14980-106206 (Reference 2.1).

2.0 REFERENCES

2.1 OPL Project No. 14980-106206, "Experimental Three Hour Fire Resistance Test of Silicone Foam Penetration Seal Designs For Duke Power Company"

2.2 DE&S Technical Document 00003-23-0065-F16-001, "Duke Cure Time Fire Test – Slab Layout Drawings"

2.3 DE&S Technical Document 00003-23-0065-F16-002, "Duke Power Cure Time Fire Test – Penetration Seals"

3.0 PREREQUISITES

3.1 Prior to initiation of penetration seal installation activities, all installation and quality verification personnel shall receive training to this procedure, as well as training to the references specified in section 2.0.

Step 3.1 Completed: _____ 2/28/00
DE&S Project Manager Date

4.0 LIMITATIONS AND PRECAUTIONS

4.1 Standard precautions shall be taken when working with penetration seal materials to ensure a safe work environment is maintained.

4.2 Manufacturer's precautions should be followed when working with penetration seal materials. Refer to section 7.0 for a complete list of manufacturer's product information sheets supplied as appendices to this procedure.

5.0 INSTALLATION INSTRUCTIONS

The following installation instructions shall be used in conjunction with approved drawings (Reference 2.3) to construct the penetration seal test assemblies. Variances from these instructions shall not be allowed unless prior approval is obtained from the DE&S Project Manager. Approved variances from these instructions shall be documented in construction notes, quality verification records and/or on as-built drawings and included in the final test report.

5.1 Drop-In Anchors

¼" HDI Hilti® Drop-In Anchors (also referred to as drop-ins) shall be installed in accordance with the following instructions.

5.1.1 The minimum edge distance for drop-ins shall be 1".

5.1.2 Drop-Ins shall be spaced a maximum of 14" on centers.

5.1.3 Using a 3/8" diameter masonry bit, drill hole a minimum of 1" deep.

5.1.4 Install drop-in into hole and "set" using proper setting tool.

5.1.5 Screw in desired length of ¼" threaded rod. Steel washers and nuts shall be used to attach damming board to threaded rods. As an option, ¼" bolts of the desired length may be used in place of threaded rods. Bolts shall be installed with washers.

Additional information associated with Hilti® Drop-In Anchors is contained in the manufacturer's product information contained in Appendix C of this procedure.

5.2 Tapcon® Screws

1/4" x 2-1/4" long Tapcon® masonry screws shall be installed in accordance with the following instructions.

5.2.1 The minimum edge distance for Tapcon® screws shall be 1".

5.2.2 Tapcon® screws shall be spaced a maximum of 14" on centers.

5.2.3 Using a 3/16" diameter masonry bit, drill Tapcon® screw hole a minimum of 1-1/2" deep.

5.2.4 Install a 1" round steel washer on the Tapcon® screw and tighten until washer is snug against damming board surface and damming board is securely in place.

CAUTION:	If Tapcon® screw is difficult to insert, the hole size needs to be slightly enlarged to prevent screw from shearing.

Additional information associated with Tapcon® screws is contained in the manufacturer's product information contained in Appendix D of this procedure.

5.3 Permanent Damming

Permanent damming boards requiring the use of mechanical fasteners, per approved drawings (Reference 2.3), shall be installed in accordance with the fastener instructions provided above. Either Hiltil® Drop-In Anchors, Tapcon® Screws or combinations of both fastener types may be used to secure damming boards in place.

Permanent damming boards that do not designate the use of mechanical fasteners shall be installed in accordance with the following instructions:

5.3.1 Damming board shall be installed in two (2) pieces. Each piece shall be cut slightly oversized to ensure a snug fit.

5.3.2 Openings cut to accommodate penetrating items shall be filled by tightly packing ceramic fiber in place. Ceramic fiber material may be in bulk and/or blanket form.

5.4 Dow Corning® 3-6548 Silicone RTV Foam

Dow Corning® 3-6548 Silicone RTV Foam may be installed using pre-packaged kits (i.e., Semkits or Pro-Kits), manual pours from hand-mixed batches or injected using dispensing equipment. Pre-packaged kits shall be mixed and dispensed in accordance with kit instructions. Manual pours from hand-mixed batches shall be formulated and installed consistent with the instructions provided below for dispensing equipment.

Dow Corning® 3-6548 Silicone RTV Foam installed using dispensing equipment shall be in accordance with the standard practices followed depending upon the type of dispensing equipment used and the following instructions:

CAUTION:	Silicone foam density and cell structure quality verifications should be performed prior to installing large quantities of foam to ensure desired quality of foam is obtained and to avoid excessive waste.

5.8.1 Dow Corning® 3-6548 Silicone RTV Foam, Parts A and B, shall be thoroughly mixed at a 1:1 ratio (either by weight or volume).

EXCEPTION:	Silicone foam intentionally installed with "unacceptable" cell structure (Appendix B Figures 1 and 2) may vary from the 1:1 ratio and/or thorough mixing requirements to achieve the desired "unacceptable" cell structure.

5.8.2 Install no more than a 1" layer of liquid silicone foam material at a time.

EXCEPTION:	Silicone foam may be installed in greater than 1" liquid layers provided the material is installed in a single pour. In no instances shall liquid foam be installed on top of curing (rising) foam.

5.8.3 Wait at least 15 minutes between installation of layers of liquid silicone foam material.

5.8.4 Repeat steps 5.8.1 trough 5.8.3, as necessary to complete penetration seal installation.

6.0 QUALITY CHECKS

The following quality checks shall be performed and documented during test assembly construction, as required by individual penetration seal Quality Verification Sign-Off Sheets (Appendix A). In addition, all other attributes listed on the by individual penetration seal Quality Verification Sign-Off Sheets (Appendix A) shall be verified.

6.1 Prior to installation of silicone foam seal material in a penetration, the penetration opening shall be verified to be clean, dry and free of foreign objects.

6.2 Prior to use of seal materials, shelf life and expiration dates shall be verified to have not expired.

6.3 The density of silicone foam installed via dispensing equipment shall be verified to be within the range of 15-30 lbs/ft^3 using standard practices.

EXCEPTION: The density range of 15-30 lbs/ft^3 does not apply to silicone foam intentionally installed with "unacceptable" cell structure. However, the density of silicone foam installed with "unacceptable" cell structure shall be calculated and recorded.

6.4 The cell structure of the cured density sample shall be acceptable if it corresponds to any combination of Figures 3-6 of Appendix B.

EXCEPTION: The cell structure of silicone foam intentionally installed with "unacceptable" cell structure shall correspond to any combination of Figures 1 and 2 of Appendix B.

6.5 Perform and document any other quality checks deemed necessary to ensure that the penetration seals installed in test assembly were constructed in accordance with approved drawings (Reference 2.3) and this procedure. Any additional quality checks shall be noted in the Comments section of the applicable Quality Verification Sign-Off Sheets (Appendix A).

7.0 APPENDICIES

The following appendices are considered stand-alone documents. As such, individual page number identifiers and revision indicators do not exist. The first page of each appendix has been labeled with the appropriate identifier (Appendix A, Appendix B, etc.) for convenience.

Appendix A – Quality Verification Sign-Off Sheets (15 pages)

Appendix B – Dow Corning® Silicone Foam Cell Structure Comparison Chart (1 page)

Appendix C – Hilti® HDI/HDI-L Drop-In Anchor Information (4 pages)

Appendix D - Tapcon® Screw Information (2 pages)

Appendix E - Dow Corning® 3-6548 Silicone RTV Foam Information (4 pages)

Appendix F – Fiberfrax® Duraboard® Products (Type LD) Information (4 pages)

Appendix G - Fiberfrax® Ceramic Fiber Information (4 pages)

Appendix H - Fiberfrax® Durablanket® Product Information (8 pages)

Quality Verification Sign-Off Sheet
Generic Verifications

Attribute	Requirement	Initial / Date
G.1	Shelf life/expiration date of silicone foam verified per 6.2.	MDM 2/28/00
G.2	Record type (name and model no.) of dispensing equipment used to mix and install Dow Corning® 3-6548 Silicone RTV Foam in the Comments section below.	MDM 2/28/00

Comments:

GRACO PRESIDENT 12:1 PROPORTIONING PUMP W/ BINKS MODEL 18 GUN HEAD

Generic Verifications Complete:

Quality Verifier

3/2/00
Date

Quality Verification Sign-Off Sheet
For Test Penetration 1

Attribute	Requirement	Initial / Date
1.1	Drop-in anchor minimum edge distance per 5.1.1.*	MDM 2/28/00
1.2	Drop-in anchor maximum spacing per 5.1.2.Ⓐ	MDM 2/28/00
1.3	Dam installed with washers and nuts on threaded rods per 5.1.5.**	MDM 2/28/00
1.4	Tapcon® screw minimum edge distance per 5.2.1.	N/A
1.5	Tapcon® screw maximum spacing per 5.2.2.	N/A MDM (1.)
1.6	Dam installed with washers on Tapcon® screws per 5.2.4.	MDM 2/28/00
1.7	Penetration cleanliness verified per 6.1.	MDM 3/2/00
1.8	Silicone foam initial sample density per 6.3. 20.12 lbs/ft³ (Record additional sample densities below, if any were taken)	MDM 3/2/00
1.9	Silicone foam cell structure per 6.4.	MDM 3/2/00
1.10	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 3/2/00
1.11	Penetration seal completed at 10:55AM (time).	MDM 3/2/00

Comments: * ANCHOR SPACING ≥1" (EDGE DISTANCE)

Ⓐ ANCHOR SPACING 12" TO 13½"

** BOLTS USED IN LIEU OF THD. ROD

(1.) DROP-INS USED

Penetration Seal Assembly 1 Complete: _____ Quality Verifier — 3/2/00 Date

Penetration 1 Ready for Testing: LSGudeck DE&S Project Manager — 3/2/00 Date

Quality Verification Sign-Off Sheet
For Test Penetration 2

Attribute	Requirement	Initial / Date
2.1	Drop-in anchor minimum edge distance per 5.1.1. (1.)	MDM 2/28/00
2.2	Drop-in anchor maximum spacing per 5.1.2. (2.)	MDM 2/28/00
2.3	Dam installed with washers and nuts on threaded rods per 5.1.5. (3.)	MDM 2/28/00
2.4	Tapcon® screw minimum edge distance per 5.2.1.	N/A
2.5	Tapcon® screw maximum spacing per 5.2.2.	N/A
2.6	Dam installed with washers on Tapcon® screws per 5.2.4.	N/A
2.7	Penetration cleanliness verified per 6.1.	MDM 3/2/00
2.8	Silicone foam initial sample density per 6.3. _____ lbs/ft^3 (4) (Record additional sample densities below, if any were taken)	MDM 3/2/00
2.9	Silicone foam cell structure per 6.4.	MDM 3/2/00
2.10	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 3/2/00
2.11	Penetration seal completed at 6:57 AM (time).	MDM 3/2/00

Comments:

(1.) ANCHOR SPACING ≥ 1" (EDGE DISTANCE)
(2.) ANCHOR SPACING 12" TO 13½"
(3.) BOLTS USED IN LIEU OF THD. ROD
(4.) SAMPLE 4 20.60 lb/FT

Penetration Seal Assembly 2 Complete: _____ Quality Verifier — 3/2/00 Date

Penetration 2 Ready for Testing: _____ DE&S Project Manager — 3/2/00 Date

Quality Verification Sign-Off Sheet
For Test Penetration 3

Attribute	Requirement	Initial / Date
3.1	Bottom side damming installed per 5.3.1 and 5.3.2.	MDM 2/29/00
3.2	Penetration cleanliness verified per 6.1.	MDM 3/2/00
3.3	Silicone foam initial sample density per 6.3. (1.) lbs/ft^3 (Record additional sample densities below, if any were taken)	MDM 3/2/00
3.4	Silicone foam cell structure per 6.4.	MDM 3/2/00
3.5	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 3/2/00
3.6	Top side damming installed per 5.3.1 and 5.3.2.	MDM 3/2/00
3.7	Penetration seal completed at 8:56AM (time).	MDM 3/2/00

Comments:

(1.) SAMPLE 4 20.60 lb/ft

Penetration Seal Assembly 3 Complete: _____ Quality Verifier — 3/2/00 Date

Penetration 3 Ready for Testing: _____ DE&S Project Manager — 3/2/00 Date

Quality Verification Sign-Off Sheet
For Test Penetration 4

Attribute	Requirement	Initial / Date
4.1	Drop-in anchor minimum edge distance per 5.1.1. (1.)	MDM 2/28/00
4.2	Drop-in anchor maximum spacing per 5.1.2. (2.)	MDM 2/28/00
4.3	Dam installed with washers and nuts on threaded rods per 5.1.5. (3.)	MDM 2/28/00
4.4	Tapcon® screw minimum edge distance per 5.2.1.	N/A
4.5	Tapcon® screw maximum spacing per 5.2.2.	N/A
4.6	Dam installed with washers on Tapcon® screws per 5.2.4.	N/A
4.7	Penetration cleanliness verified per 6.1.	MDM 3/2/00
4.8	Silicone foam initial sample density per 6.3. _____ lbs/ft^3 (4.) (Record additional sample densities below, if any were taken)	MDM 3/2/00
4.9	Silicone foam cell structure per 6.4.	MDM 3/2/00
4.10	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 3/2/00
4.11	Penetration seal completed at 8:57AM (time).	MDM 3/2/00

Comments:

(1.) ANCHOR SPACING ≥ 1" (EDGE DIST.)
(2.) " " 12" TO 13½"
(3.) BOLT USED IN LIEU OF THD. ROD
(4.) SAMPLE 4 20.60 lb/FT

Penetration Seal Assembly 4 Complete: _____ Quality Verifier — 3/2/00 Date

Penetration 4 Ready for Testing: LSGudeck DE&S Project Manager — 3/2/00 Date

Quality Verification Sign-Off Sheet
For Test Penetration 5

Attribute	Requirement	Initial / Date
5.1	Drop-in anchor minimum edge distance per 5.1.1. (1.)	MDM 2/28/00
5.2	Drop-in anchor maximum spacing per 5.1.2. (2.)	MDM 2/28/00
5.3	Dam installed with washers and nuts on threaded rods per 5.1.5. (3.)	MDM 2/20/00
5.4	Tapcon® screw minimum edge distance per 5.2.1.	N/A
5.5	Tapcon® screw maximum spacing per 5.2.2.	N/A
5.6	Dam installed with washers on Tapcon® screws per 5.2.4.	N/A
5.7	Penetration cleanliness verified per 6.1.	MDM 2/29/00
5.8	Silicone foam initial sample density per 6.3. _____ lbs/ft^3 (4.) (Record additional sample densities below, if any were taken)	MDM 2/29/00
5.9	Silicone foam cell structure per 6.4.	MDM 2/29/00
5.10	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 3/1/00
	REPAIRED AREA OF PENETRATION 5 (5.)	
5.11	Repair area excavated full depth of silicone foam.	MDM 3/1/00
5.12	Repair area sealed per approved drawings (~4 hour cure time).	MDM 3/2/00
5.13	Top side dam restored per section 5.3.	MDM 3/2/00
5.14	Penetration seal completed at 8:59AM (time).	MDM 3/2/00

Comments:

(1.) ANCHOR SPACING ≥ 1" EDGE DIST.
(2.) " " 12" TO 13½"
(3.) BOLT USED IN LIEU OF THD. ROD
(4.) SAMPLE 1 21.43 lb/FT
SAMPLE 2 20.83 lb/FT
(5.) SIZE OF REPAIRED AREA NOMINALLY 3¼" DIA. & NOMINALLY 8" DEEP.

Penetration Seal Assembly 5 Complete: _____ Quality Verifier — 3/2/00 Date

Penetration 5 Ready for Testing: LS Gudeck DE&S Project Manager — 3/2/00 Date

Quality Verification Sign-Off Sheet
For Test Penetration 6

Attribute	Requirement	Initial / Date
6.1	Bottom side damming installed per 5.3.1 and 5.3.2.	MDM 2/29/00
6.2	Penetration cleanliness verified per 6.1.	MDM 2/29/00
6.3	Silicone foam initial sample density per 6.3. SEE NOTE lbs/ft^3 (1.) (Record additional sample densities below, if any were taken)	MDM 2/29/00
6.4	Silicone foam cell structure per 6.4.	MDM 2/29/00
6.5	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 3/2/00
6.6	Top side damming installed per 5.3.1 and 5.3.2.	MDM 3/2/00
6.7	Penetration seal completed at 3:00pm (time).	MDM 2/29/00

Comments:

(1.) SAMPLE #1 21.43 lb/FT
SAMPLE #2 20.83 lb/FT

Penetration Seal Assembly 6 Complete: _____ Quality Verifier 3/2/00 Date

Penetration 6 Ready for Testing: _____ DE&S Project Manager 3/2/00 Date

Quality Verification Sign-Off Sheet
For Test Penetration 7

Attribute	Requirement	Initial / Date
7.1	Drop-in anchor minimum edge distance per 5.1.1. (1.)	MDM 2/29/00
7.2	Drop-in anchor maximum spacing per 5.1.2. (2)	MDM 2/29/00
7.3	Dam installed with washers and nuts on threaded rods per 5.1.5. (3.)	MDM 2/29/00
7.4	Tapcon® screw minimum edge distance per 5.2.1. (6)	N/A MDM 3/1/00 3/2/00 T.S
7.5	Tapcon® screw maximum spacing per 5.2.2. (6)	N/A MDM 3/1/00 3/2/00 T.S
7.6	Dam installed with washers on Tapcon® screws per 5.2.4 (6)	MDM 3/2/00
7.7	Penetration cleanliness verified per 6.1.	MDM 2/29/00
7.8	Silicone foam initial sample density per 6.3. _____ lbs/ft³ (4.) (Record additional sample densities below, if any were taken)	MDM 2/29/00
7.9	Silicone foam cell structure per 6.4.	MDM 2/29/00
7.10	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 3/2/00
7.11	Silicone foam with "unacceptable" cell structure installed per DE&S Project Manager's direction (Note location in comments). (5.)	MDM 3/1/00
	REPAIRED AREA OF PENETRATION 7 (5.)	
7.12	Repair area excavated full depth of silicone foam.	MDM 3/1/00
7.13	Repair area sealed per approved drawings (~2 hour cure time).	MDM 3/2/00
7.14	Top side dam restored per section 5.3.	MDM 3/2/00
7.15	Penetration seal completed at 3:00 pm MDM 10:57 AM (time).	MDM 3/2/00

Comments:

(1.) ANCHOR SPACING ≥ 1" EDGE DIST.

(2.) " " 12" TO 13½"

(3.) BOLT USED IN LIEU OF THD. RD.

(4.) SAMPLE 1 21.43
SAMPLE 2 20.83

Penetration Seal Assembly 7 Complete: _____ Quality Verifier — 3/2/00 Date

Penetration 7 Ready for Testing: LSGoodrich DE&S Project Manager — 3/2/00 Date

(5.) THE REPAIRED AREA WAS FULL DEPTH x THE WIDTH OF THE BLOCKOUT x 2¾" WIDE (FROM EDGE OF BLOCKOUT TO BACK OF TRAY)

(6.) 4 TAPCONS USED PER PENESCAL PER SIDE (2")

Quality Verification Sign-Off Sheet
For Test Penetration 8

Attribute	Requirement	Initial / Date
8.1	Drop-in anchor minimum edge distance per 5.1.1.	MDM 2/29/00
8.2	Drop-in anchor maximum spacing per 5.1.2.	MDM 2/29/00
8.3	Dam installed with washers and nuts on threaded rods per 5.1.5.	MDM 2/29/00
8.4	Tapcon® screw minimum edge distance per 5.2.1.	MDM 3/1/00
8.5	Tapcon® screw maximum spacing per 5.2.2. (6.)	MDM 3/2/00
8.6	Dam installed with washers on Tapcon® screws per 5.2.4.	MDM 3/2/00
8.7	Penetration cleanliness verified per 6.1.	MDM 2/29/00
8.8	Silicone foam initial sample density per 6.3. _____ lbs/ft^3 (4.) (Record additional sample densities below, if any were taken)	MDM 2/29/00
8.9	Silicone foam cell structure per 6.4.	MDM 2/29/00
8.10	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 3/2/00
	REPAIRED AREA OF PENETRATION 8 (5.)	
8.11	Repair area excavated full depth of silicone foam.	MDM 3/1/00
8.12	Repair area sealed per approved drawings ("No" cure time).	MDM 3/2/00
8.13	Top side dam restored per section 5.3.	MDM 3/2/00
8.14	Penetration seal completed at 12:46 pm (time).	MDM 3/2/00

Comments:

(1.) ANCHOR SPACING ≥ 1" EDGE DIST

(2.) " " 12" TO 13½"

(3.) BOLT USED IN LIEU OF ANCH.

(4.) SAMPLE 1 21.43
SAMPLE 2 20.83

(5.) REPAIRED AREA RANGES IN SIZE FROM 3½" TO 2½" IN WIDTH x THE TRAY WIDTH (12") x 8" DEEP NOMINALLY

Penetration Seal Assembly 8 Complete: _____ (Quality Verifier) 3/2/00 (Date)

Penetration 8 Ready for Testing: LS Gudac (DE&S Project Manager) 3/2/00 (Date)

(6.) FOUR TAPCON USED PER PENE SEAL PER SIDE (2")

Quality Verification Sign-Off Sheet
For Test Penetration 9

Attribute	Requirement	Initial / Date
9.1	Penetration cleanliness verified per 6.1.	MDM 2/29/00
9.2	Silicone foam initial sample density per 6.3. _____ lbs/ft^3 (1.) (Record additional sample densities below, if any were taken)	MDM 2/29/00
9.3	Silicone foam cell structure per 6.4.	MDM 2/29/00
9.4	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 2/29/00
	REPAIRED AREA OF PENETRATION 9 (2.)	
9.5	Repair area excavated approximately 11" deep. SEE NOTE 2	MDM 3/1/00
9.6	Repair area sealed per approved drawings ("No" cure time).	MDM 3/2/00
9.7	Penetration seal completed at 12:44 PM (time).	MDM 3/2/00

Comments:

(1.) SAMPLE 1 21.43
SAMPLE 2 20.83

(2.) REPAIRED AREA WAS SOMEWHAT CONE SHAPED; THE TOP MEASURING ~ 6" ACROSS x ~ 3" ACROSS. AT THE BOTTOM THE AREA APPEARED TO BE ~ 2" IN DIAMETER X ~ 8" DEEP

Penetration Seal Assembly 9 Complete: _____ Quality Verifier — 3/2/00 Date

Penetration 9 Ready for Testing: _____ DE&S Project Manager — 3/2/00 Date

Quality Verification Sign-Off Sheet
For Test Penetration 10

Attribute	Requirement	Initial / Date
10.1	Bottom side damming installed per 5.3.1 and 5.3.2.	MDM 2/29/00
10.2	Penetration cleanliness verified per 6.1.	MDM 2/29/00
10.3	Silicone foam initial sample density per 6.3. SEE NOTE (1.) lbs/ft³ (Record additional sample densities below, if any were taken)	MDM 2/29/00
10.4	Silicone foam cell structure per 6.4.	MDM 2/29/00
10.5	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 3/1/00
10.6	Top side damming installed per 5.3.1 and 5.3.2 (4.)	MDM 3/2/00
	REPAIRED AREA OF PENETRATION 10 (2.)	
10.7	Repair area excavated full depth of silicone foam.	MDM 3/1/00
10.8	Repair area sealed per approved drawings (~6 hour cure time).	MDM 3/2/00
10.9	Top side dam restored per section 5.3.	MDM 3/2/00 (3.) (5.)
10.10	Penetration seal completed at ~~3:00 PM~~ MDM (3.) 6:55AM (time).	~~MDM 3/2/00~~ MDM 3/2/00

Comments:

(1.) SAMPLE 1 21.43
SAMPLE 2 20.83

(2.) THE REPAIRED AREA WAS SOMEWHAT CONE SHAPED; THE TOP MEASURED ~6" ACROSS x ~8½" ACROSS. AT THE BOTTOM THE AREA APPEARED TO BE ~2" ACROSS x ~1" ACROSS x ~10" DEEP

(3.) OVERALL SEAL

(4.) PERIMETER OF SEAL @ SLV. & @ PIPE SEALED W/ D.C. 732 CAULK ON TOP OF TOP DAMMING BOARD

Penetration Seal Assembly 10 Complete: _____ (Quality Verifier) 3/2/00 (Date)

Penetration 10 Ready for Testing: L S Goodrich (DE&S Project Manager) 3/2/00 (Date)

Quality Verification Sign-Off Sheet
For Test Penetration 11

Attribute	Requirement	Initial / Date
11.1	Bottom side damming installed per 5.3.1 and 5.3.2.	MDM 2/29/00
11.2	Penetration cleanliness verified per 6.1.	MDM 2/29/00
11.3	Silicone foam initial sample density per 6.3. SEE NOTE (1.) lbs/ft^3 (Record additional sample densities below, if any were taken)	MDM 2/29/00
11.4	Silicone foam cell structure per 6.4.	MDM 2/29/00
11.5	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 2/29/00
11.6	Top side damming installed per 5.3.1 and 5.3.2.	MDM 3/2/00
11.7	Penetration seal completed at 3:00 PM (time).	MDM 2/29/00

Comments:

(1.) SAMPLE #1 21.43
SAMPLE #2 20.83

Penetration Seal Assembly 11 Complete: _____ Quality Verifier _____ 3/2/00 Date

Penetration 11 Ready for Testing: _____ DE&S Project Manager _____ 3/2/00 Date

Quality Verification Sign-Off Sheet
For Test Penetration 12

Attribute	Requirement	Initial / Date
12.1	Penetration cleanliness verified per 6.1.	MDM 2/29/00
12.2	Silicone foam initial sample density per 6.3. 20.12 lbs/ft^3 (Record additional sample densities below, if any were taken)	MDM 3/2/00
12.3	Silicone foam cell structure per 6.4.	MDM 3/2/00
12.4	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 3/2/00
12.5	Penetration seal completed at 10:57 AM (time).	MDM 3/2/00

Comments:

Penetration Seal Assembly 12 Complete: _____ (Quality Verifier) 3/2/00 (Date)

Penetration 12 Ready for Testing: _____ (DE&S Project Manager) 3/2/00 (Date)

Quality Verification Sign-Off Sheet
For Test Penetration 13

Attribute	Requirement	Initial / Date
13.1	Bottom side damming installed per 5.3.1 and 5.3.2.	MDM 2/29/00
13.2	Penetration cleanliness verified per 6.1.	MDM 3/2/00
13.3	Silicone foam initial sample density per 6.3. _____ lbs/ft^3 (1.) (Record additional sample densities below, if any were taken)	MDM 3/2/00
13.4	Silicone foam cell structure per 6.4.	MDM 3/2/00
13.5	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 3/2/00
13.6	Top side damming installed per 5.3.1 and 5.3.2.	MDM 3/2/00
13.7	Penetration seal completed at 6:58 AM (time).	MDM 3/2/00

Comments:

(1.) SAMPLE 4 20.60 lb/ft

Penetration Seal Assembly 13 Complete: _____ Quality Verifier — 3/2/00 Date

Penetration 13 Ready for Testing: _____ DE&S Project Manager — 3/2/00 Date

Quality Verification Sign-Off Sheet
For Test Penetration 14

Attribute	Requirement	Initial / Date
14.1	Top and bottom side damming installed per 5.3.1 and 5.3.2.	MDM 2/29/00
14.2	Penetration cleanliness verified per 6.1.	MDM 2/29/00
14.3	Silicone foam initial sample density per 6.3. SEE NOTE (1.) lbs/ft^3 (Record additional sample densities below, if any were taken)	MDM 2/29/00
14.4	Silicone foam cell structure per 6.4.	MDM 2/29/00
14.5	Silicone foam minimum depth per approved drawings (Reference 2.3).	MDM 2/29/00
14.6	Top side damming installed per 5.3.1 and 5.3.2.	MDM 3/2/00
	REPAIRED AREA OF PENETRATION 14 (2.)	
14.7	Repair area excavated full depth of silicone foam.	MDM 3/1/00
14.8	Repair area sealed per approved drawings ("No" cure time).	MDM 3/2/00
14.9	Top side dam restored per section 5.3.	MDM 3/2/00
14.10	Penetration seal completed at MDM ~~3:00PM~~ 12:43PM (time). (INITIAL SEAL NOT REPAIRED AREA)	MDM 3/2/00

Comments:

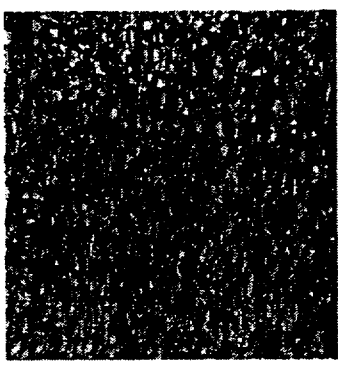
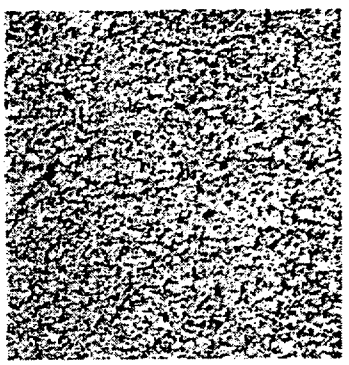
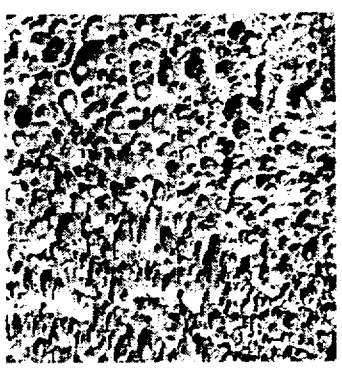
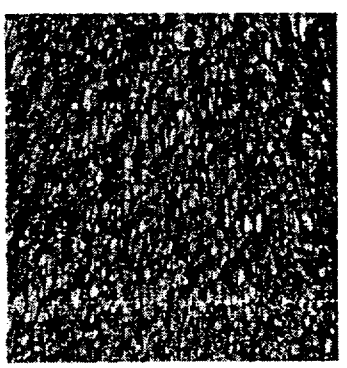
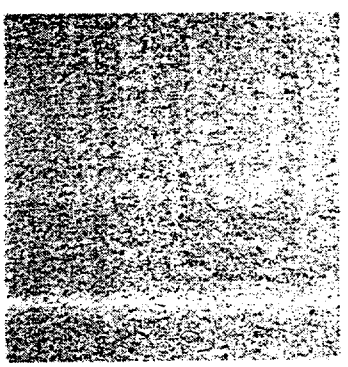
(1.) SAMPLE 1 21.43
SAMPLE 2 20.83

(2.) THE REPAIRED AREA WAS OBLONG & SOMEWHAT CONE SHAPED. AT THE TOP IT MEASURED ~5" X ~2 1/4 (NOMINALLY). AT THE BOTTOM ~2" X ~1" X 10" DEEP.

Penetration Seal Assembly 14 Complete: _____ (Quality Verifier) 3/2/00 (Date)

Penetration 14 Ready for Testing: L S Goodrich (DE&S Project Manager) 3/2/00 (Date)

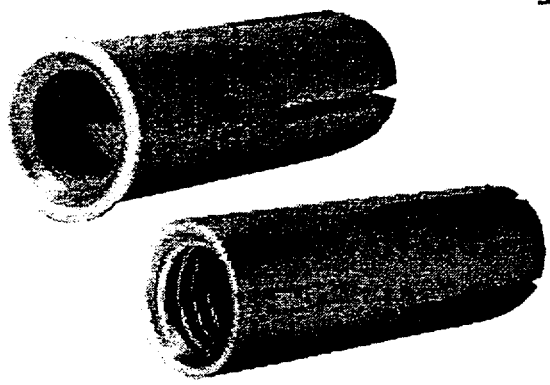
DOW CORNING®
Silicone Foams
Cell Structure Comparison Chart

Unacceptable Cell Structure Range	Acceptable Cell Structure Range	Optimum Cell Structure Range
 1.	 3.	 5.
 2.	 4.	 6.
The cured foam cell structure is too large and nonuniform in both samples 1 and 2. Check your equipment mix ratio. You should also check the temperature of the A and B liquid components before and after mixing. These temperature readings should be between 55 F and 80 F and the snap time between 1 and 2 minutes for optimum results.	The proper mix ratio, controlled temperature of components and correct snap time result in a more uniform, acceptable cell structure, as illustrated in samples 3 and 4.	DOW CORNING® Fire Stop Foam and DOW CORNING® 3-6548 silicone RTV foam have an optimum cell structure range as shown in samples 5 and 6.

4.3.4 HDI / HDI-L Drop-In Anchor

4.3.4.1 PRODUCT DESCRIPTION

The Hilti HDI/HDI-L Drop-In anchor is an internally threaded, flush mounted expansion anchor for use in concrete.



Product Features

HDI

- Anchor, setting tool & Hilti drill bit form a matched tolerance system to provide reliable fastenings
- Below surface setting for easy patchwork
- Allows for shallow embedment without sacrificing performance

HDI-L

- Lip provides flush installation, consistent anchor depth, and easy rod alignment
- Lip allows accurate flush surface setting, independent of hole depth & ideal for repetitive fastenings with threaded rods of equal length
- Intelligent expansion section adapts to the base material & reduces number of hammer blows up to 50%
- Easy to read brand & size identification (red laser print)

Guide Specifications

Expansion Anchors: Expansion anchors shall be flush or shell type which meet the description in Federal Specification FF-S-325, Group VIII, Type 1, for expansion shield anchors. Anchors to be zinc plated in accordance with ASTM B633, Sc. 1, Type III. Anchors shall be Hilti HDI/HDI-L anchors as supplied by Hilti, Inc., P.O. Box 21148, Tulsa, OK 74121.

Installation: Shell or flush type anchors to be installed in holes drilled with Hilti carbide tipped drill bits. Anchors shall be installed per manufacturer's recommendations.

Approvals/Listings

- City of Los Angeles (COLA): Research Report No. 23709 (HDI Only)
- Factory Mutual (FM): Serial No. 22765 "Sprinkler Hangar Components—Expansion Shields." (HDI and HDI-L)
- Conforms to the description in Federal Specification FF-S-325, Group VIII, Type 1 for expansion shield anchors. (HDI and HDI-L)
- Underwriters Laboratory (UL), "Pipe Hangers" (3/8"–3/4" diameter) (HDI and HDI-L)
- International Conference of Building Officials (ICBO): Evaluation Report No. 2895 (HDI Only)
- Southern Building Code Congress (SBCCI): Report No. 9930 (HDI Only)

4.3.4.2 MATERIAL SPECIFICATIONS

	MECHANICAL PROPERTIES	
	f_y ksi (MPa)	min. f_u ksi (MPa)
HDI/HDI-L Carbon Steel material meets the requirements of AISI 1010M for the 1/4", 3/8" & 1/2"	44 (303)	53 (365)
HDI Carbon Steel material meets the requirements of AISI 12L14 for the 5/8" and 3/4" sizes	60 (415)	78 (540)
HDI Stainless Steel material meets the requirements of AISI 303	60 (414)	100 (689)

Carbon Steel HDI/HDI-L plated with a dull zinc finish for corrosion protection in accordance with ASTM B633, Sc. 1, Type III

4.3.4.3 TECHNICAL DATA

HDI/HDI-L Specification Table

Details \ Anchor Size	in. (mm)	HDI/HDI-L	HDI/HDI-L	HDI/HDI-L	HDI	HDI
		1/4 (6.4)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)
d_{bit}: bit diameter	in.	3/8	1/2	5/8	27/32	1
h_{nom}: std. depth of embed.	in.	1	1 9/16	2	2 9/16	3 1/16
ℓ: anchor length h_1: hole depth	(mm)	(25)	(40)	(51)	(65)	(81)
ℓ_{th}: useable thread length	in. (mm)	7/16 (11)	5/8 (15)	11/16 (17)	7/8 (22)	1 3/8 (34)
Threads per in.		20	16	13	11	10
h: min. base material thickness	in. (mm)	3 (76)	3 1/8 (79)	4 (102)	5 1/8 (130)	6 3/8 (162)
T_{inst}: max. tightening torque	ft lb (Nm)	4 (5.4)	11 (14.9)	22 (29.8)	37 (50.2)	80 (108.5)

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}}\right)^{5/3} + \left(\frac{V_d}{V_{rec}}\right)^{5/3} \leq 1.0$$

(Ref. Section 4.1.3)

HDI / HDI-L Drop-In Anchor 4.3.4

Carbon Steel HDI Ultimate Loads in Concrete

Anchor size in. (mm)	2000 psi (13.8 MPa)				4000 psi (27.6 MPa)				6000 psi (41.4 MPa)			
	Tension	lb(kN)	Shear	lb (kN)	Tension	lb(kN)	Shear	lb (kN)	Tension	lb (kN)	Shear	lb (kN)
	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L
1/4 (6.4)	1995 (8.9)	1995 (8.9)	1800 (8.0)	1800 (8.0)	2270 (10.1)	2270 (10.1)	2500 (11.1)	2500 (11.1)	3150 (14.0)	3150 (14.0)	2800 (12.5)	2800 (12.5)
3/8 (9.5)	3555 (15.8)	3555 (15.8)	3850 (17.1)	3850 (17.1)	4460 (19.8)	4460 (19.8)	5000(22.2)	5000 (22.2)	5430 (24.2)	5430 (24.2)	6000 (26.7)	6000 (26.7)
1/2 (12.7)	4470 (19.9)	4470 (19.9)	6000 (26.7)	6000 (26.7)	7140 (31.8)	7140 (31.8)	8500 (37.8)	7750 (34.4)	9375 (41.7)	9375 (41.7)	10000 (44.5)	10000 (44.5)
5/8 (15.9	7500 (33.4)	-	10000 (44.5)	-	11685 (52.0)	-	13000 (57.8)	-	14865 (66.1)	-	15000 (66.7)	-
3/4 (19.1)	10000 (44.5)	-	15500 (69.0)	-	16260 (72.3)	-	20000 (89.0)	-	22250 (99.0)	-	22000 (97.9)	-

Carbon Steel HDI Allowable Loads in Concrete

Anchor size in. (mm)	2000 psi (13.8 MPa)				4000 psi (27.6 MPa)				6000 psi (41.4 MPa)			
	Tension	lb(kN)	Shear	lb (kN)	Tension	lb(kN)	Shear	lb (kN)	Tension	lb (kN)	Shear	lb (kN)
	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L
1/4 (6.4)	500 (2.2)	500 (2.2)	450 (8.0)	450 (8.0)	570 (2.5)	570 (2.5)	625 (2.8)	625 (2.8)	790 (3.5)	790 (3.5)	700 (3.1)	700 (3.1)
3/8 (9.5)	890 (4.0)	890 (4.0)	965 (4.3)	965 (4.3)	1115 (5.0)	1115 (5.0)	1250 (5.6)	1250 (5.6)	1360 (6.0)	1360 (6.0)	1500 (6.7)	1500 (6.7)
1/2 (12.7)	1120 (5.0)	1120 (5.0)	1500 (6.7)	1500 (6.7)	1785 (7.9)	1785 (7.9)	2125 (9.5)	1940 (8.6)	2345 (10.4)	2345 (10.4)	2500 (11.1)	2500 (11.1)
5/8 (15.9	1875 (8.3)	-	2500 (11.1)	-	2920 (13.0)	-	3250 (14.5)	-	3715 (16.5)	-	3750 (16.7)	-
3/4 (19.1)	2500 (11.1)	-	3875 (17.2)	-	4065 (18.1)	-	5000 (22.2)	-	5565 (24.8)	-	5500 (24.5)	-

Note: The ultimate shear and allowable shear values are based on the use of SAE Grade 5 bolts, (f_y = 85 ksi, F_{ult} = 120 ksi) with the exception of the 1/4" HDI/HDI-L in f'c = 6000 psi concrete which is based upon the use of a SAE Grade 8 bolt (f_y = 120 ksi, F_{ult} = 150 ksi).

Carbon Steel HDI Allowable Load in Lightweight Concrete[3, 4]

Anchor size in. (mm)	Anchor installed in 3000 psi (20.7 MPa) Lt. Wt. Concrete [1]				Anchor Installed Through Steel Decking into 3000 psi (20.7 MPa) Lt. Wt. Concrete[2]			
	Tension lb (kN)		Shear lb (kN)		Tension lb (kN)		Shear lb (kN)	
HDI – 1/4 (6.4)	465	(2.1)	340	(1.5)	530	(2.4)	335	(1.5)
HDI – 3/8 (9.5)	755	(3.4)	940	(4.2)	880	(3.9)	1010	(4.5)
HDI – 1/2 (12.7)	1135	(5.0)	1700	(7.6)	1105	(4.9)	1755	(7.8)
HDI – 5/8 (15.9)	1465	(6.5)	2835	(12.6)	—		—	
HDI – 3/4 (19.1)	2075	(9.2)	3680	(16.4)	—		—	

1. The tabulated shear and tensile values are for anchors installed in structural lightweight concrete having the designated ultimate compressive strength at the time of installlation. The concrete must comply with ASTM C 330-77.
2. The tabulated shear and tensile values are for anchors installed through 20 gauge intermediate decking into structural lightweight concrete having the designated ultimate strength at the time of installation. The concrete must comply with ASTM C 330-77. Anchors were located in the valley of the fluted deck.
3. The allowable values are based on the use of SAE Grade 2 bolts installed in the anchors.
4. Based on using a safety factor of 4

Stainless Steel HDI Ultimate Loads in Concrete

Anchor size in. (mm)	4000 psi (27.6 MPa)				6000 psi (41.4 MPa)			
	Tension lb (kN)		Shear lb (kN)		Tension lb (kN)		Shear lb (kN)	
SS HDI – 1/4 (6.4)	1930	(8.6)	2400	(10.7)	2950	(13.1)	2400	(10.7)
SS HDI – 3/8 (9.5)	4170	(18.5)	4920	(21.9)	5850	(26.0)	4920	(21.9)
SS HDI – 1/2 (12.7)	7350	(32.7)	11040	(49.1)	9630	(42.8)	11040	(49.1)
SS HDI – 5/8 (15.9)	10540	(46.9)	18040	(80.2)	15100	(67.2)	18040	(80.2)
SS HDI – 3/4 (19.1)	15340	(68.2)	22320	(99.3)	20130	(89.5)	22320	(99.3)

Stainless Steel HDI Allowable Loads in Concrete

Anchor size in. (mm)	4000 psi (27.6 MPa)				6000 psi (41.4 MPa)			
	Tension lb (kN)		Shear lb (kN)		Tension lb (kN)		Shear lb (kN)	
HDI – 1/4 (6.4)	480	(2.1)	600	(2.7)	740	(3.3)	600	(2.7)
HDI – 3/8 (9.5)	1040	(4.6)	1230	(5.5)	1460	(6.5)	1230	(5.5)
HDI – 1/2 (12.7)	1840	(8.2)	2760	(12.4)	2410	(10.7)	2760	(12.3)
HDI – 5/8 (15.9)	2630	(11.7)	4510	(20.1)	3770	(16.8)	4510	(20.1)
HDI – 3/4 (19.1)	3830	(17.0)	5580	(24.8)	5030	(22.4)	5580	(24.8)

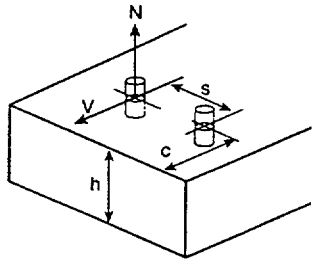
Note: The allowable shear values are based on the use of Type 18-8 bolts.

Anchor Spacing and Edge Distance Guidelines *(See Anchoring Technology Section 4.1.3)*

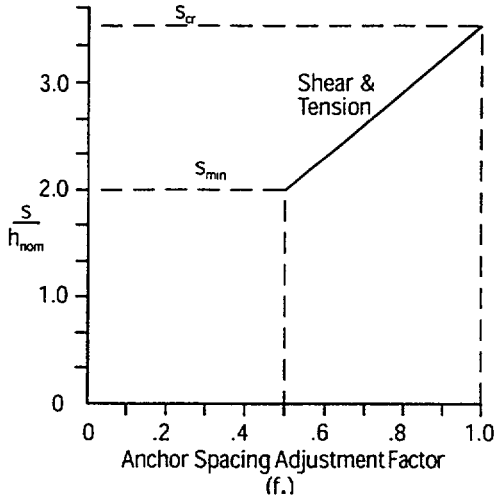
Influence of Anchor Spacing and Edge Distance f_A, f_R

Anchor Size	in.	1/4	3/8	1/2	5/8	3/4
	(mm)	(6.4)	(9.5)	(12.7)	(15.8)	(19.1)
h_{nom}	in.	1	1 9/16	2	2 9/16	3 3/16
	(mm)	(25)	(40)	(51)	(65)	(81)

h_{nom} = standard embedment depth

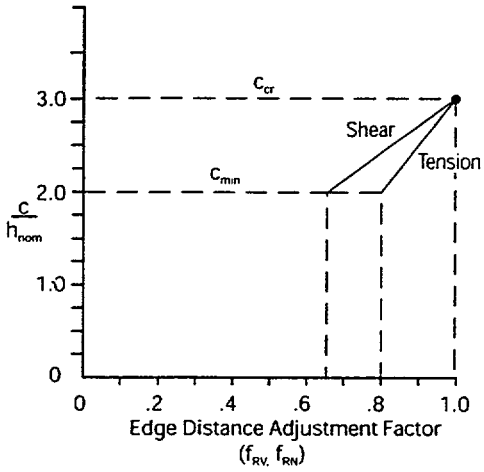


Anchor Spacing Adjustment Factors



s = Actual spacing
s_{min} = 2.0 h_{nom}
s_{cr} = 3.5 h_{nom}

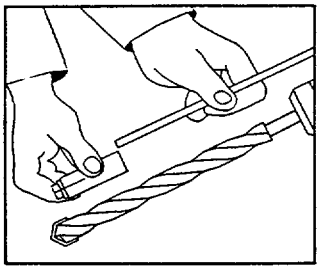
Edge Distance Adjustment Factors



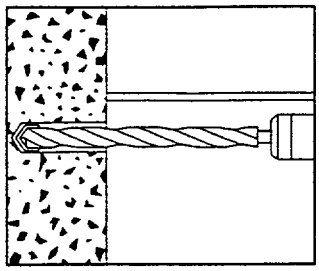
c = Actual edge distance
c_{min} = 2.0 h_{nom}
c_{cr} = 3.0 h_{nom}

Load Adjustment Factors (Anchor Spacing) f_A							Load Adjustment Factors (Edge Distance) f_R										
Tension/Shear							Tension, f_{RN}						Shear, f_{RV}				
Spacing s in. (mm)		Anchor Diameter					Edge Distance c in. (mm)		Anchor Diameter					Anchor Diameter			
		1/4	3/8	1/2	5/8	3/4			1/4	3/8	1/2	5/8	3/4	1/4	3/8	1/2	5/8	3/4
2	(51)	.50					2	(51)	.80					.65				
2 1/2	(64)	.67					2 1/2	(64)	.90					.83				
3	(76)	.83	.50				3	(76)	1.0	.80				1.0	.65			
3 1/2	(89)	1.0	.58				3 1/2	(89)		.85					.73			
4	(102)		.69	.50			4	(102)		.91	.80				.85	.65		
4 1/2	(114)		.79	.58			4 1/2	(114)		.98	.85				.96	.74		
5	(127)		.90	.67	.50		5	(127)		1.0	.90	.80			1.0	.83	.65	
5 1/2	(140)		1.0	.75	.55		5 1/2	(140)			.95	.83				.91	.70	
6	(152)			.83	.61	.50	6	(152)			1.0	.87				1.0	.77	
7	(178)			1.0	.74	.57	6 1/2	(165)				.91	.80				.84	.65
8	(203)				.87	.67	7	(178)				.95	.84				.91	.72
9	(229)				1.0	.77	8	(203)				1.0	.90				1.0	.83
10	(254)					.88	9	(229)					.96					.94
11	(279)					.98	10	(254)					1.0					1.0
12	(305)					1.0												
s_{min} = 2.0 h_{nom}, s_{cr} = 3.5 h_{nom} $f_A = 0.33 \frac{s}{h_{nom}} - 0.17$ for $s_{cr} > s > s_{min}$							c_{min} = 2.0 h_{nom}, c_{cr} = 3.0 h_{nom} $f_{RN} = 0.2 \frac{c}{h_{nom}} + 0.4$ for $c_{cr} > c > c_{min}$							c_{min} = 2.0 h_{nom}, c_{cr} = 3.0 h_{nom} $f_{RV} = 0.35 \frac{c}{h_{nom}} - 0.05$ for $c_{cr} > c > c_{min}$				

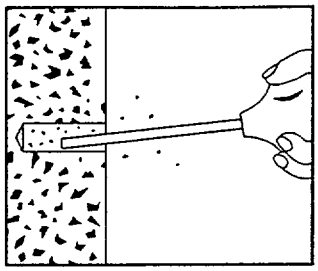
4.3.4.4 INSTALLATION INSTRUCTIONS



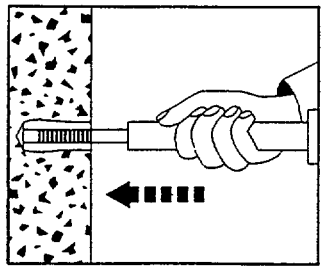
1. Adjust depth gauge so that anchor will be flush with the concrete surface when installed.



2. Hammer drill hole.



3. Clean hole.



4. Install anchor using proper setting tool. Setting tool to be driven into anchor until setting tool shoulder meets top of anchor.

4.3.4.5 ORDERING INFORMATION

HDI Products

Anchor Thread Size	Carbon Steel				Stainless Steel		Quantity per Box
	Description	Item No.	Description	Item No.	Description	Item No.	
1/4"	HDI 1/4	00045752	HDI-L 1/4	247818	HDI (SS 303) 1/4	00045787	100
3/8"	HDI 3/8	00045753	HDI-L 3/8	247817	HDI (SS 303) 3/8	00045788	50
1/2"	HDI 1/2	00045754	HDI-L 1/2	247816	HDI (SS 303) 1/2	00045789	50
5/8"	HDI 5/8	00045755	-	-	HDI (SS 303) 5/8	00045790	25
3/4"	HDI 3/4	00045756	-	-	HDI (SS 303) 3/4	00045791	25

Setting Tools for HDI / HDI-L Anchors

Anchor Thread Size	Hand Setting Tools		Automatic Setting Tools [1]	
	Description	Item No.	Description	Item No.
1/4"	HST 1/4 Setting Tool	00032978	—	—
3/8"	HST 3/8 Setting Tool	00032979	HSD-MM 3/8" (TE-C-24SD10 3/8" Setting tool)	00243751
1/2"	HST 1/2 Setting Tool	00032980	HSD-MM 1/2" (TE-C-24SD12 1/2" Setting tool)	00243752
5/8"	HST 5/8 Setting Tool	00032981	—	—
3/4"	HST 3/4 Setting Tool	00032982	—	—

1. Use automatic setting tools with TE-5, TE-5A, TE-15, TE-18, and TE-25 rotary hammer drills.

ITW Buildex

BUILDING IDEAS THAT WORK™

TAPCON®

Masonry Fastening System

The original masonry anchor that cuts threads into concrete, brick or hollow block.

Applications

- Electrical junction boxes and conduit clips to masonry.
- Wood headers and furring strips to masonry.
- HVAC strapping to masonry.
- Plywood backer boards to masonry.
- Exterior insulation systems to masonry.

Product Features

- Fast installation ... drill a hole ... drive an anchor.
- Available in 3/16" and 1/4" diameters and in lengths 1-1/4" - 6".
- Replaces small diameter expansion anchors, plugs and screws in light to medium duty applications.
- No need to pre-spot holes ... and no inserts are required.
- Reversible and removable ... can be installed close to an edge.

Installation Tools

- Condrive 1000™ - A multi-purpose tool designed for installation of Tapcon hex head and Phillips flat head anchors up to 4" long.
- Condrive 2000™ - A highly-automated, high speed,one-step tool designed specifically for repetitive installation of hex head Tapcon anchors of lengths up thru 2-3/4".
- Both Buildex Condrive Tools are designed to specifically install Tapcon Anchors and to fit standard hammer drills.

Approvals and Listings

City of Chicago; Dade County, Florida; City of New York; Palm Beach County, Florida; City of L.A.; I.C.B.O. Listed.

Product Specifications

Diameter	3/16" and 1/4"
Thread Form	Original notched Hi-Lo
Point Type	Nail
Finish	Blue Climaseal

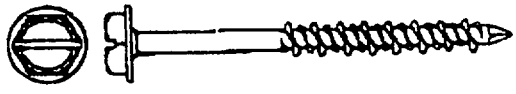
Corrosion Resistance

Kesternich Results (DIN 50018, 2.0L)
- 30 Cycles - 10% or less red rust

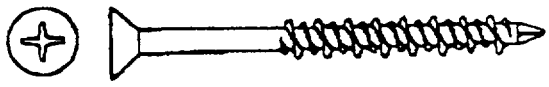
Salt Spray Results (ASTM B117)
- 720 Hours - 10% or less red rust

Head Styles

3/16" Diameter: 1/4" slotted hex washer head (HWH)
1/4" Diameter: 5/16" slotted hex washer head (HWH)



3/16" Diameter: #2 phillips flat head (PFH)
1/4" Diameter: #3 phillips flat head (PFH)



TAPCON® Masonry Fastening System

Product Report No. 40814

Selector Guide

Part Number PFH	Part Number HWH	Description	Drill Bit	Part Number	Fixture Thickness	Common Applications
3169407	3139407	3/16 x 1-1/4"	5/32 x 3-1/2"	3095910	0 - 1/4"	• Mounting brackets; control panels; cable clamps, conduit clips, junction switch and control boxes.
3183407	3153407	1/4 x 1-1/4"	3/16 x 3-1/2"	3098910	0 - 1/4"	
3171407	3141407	3/16 x 1-3/4"	5/32 x 3-1/2"	3095910	1/4 - 3/4"	• 1/2" or 3/4" plywood backer boards; mounting brackets; control panels; cable clamps; conduit clips, junction, switch and control box meters.
3185407	3155407	1/4 x 1-3/4"	3/16 x 3-1/2"	3098910	1/4 - 3/4"	
3173407	3143407	3/16 x 2-1/4"	5/32 x 4-1/2"	3096910	3/4" - 1-1/4"	• 1 x 2 wood furring; 3/4" plywood backer boards; metal safety grating.
3187407	3157407	1/4 x 2-1/4"	3/16 x 4-1/2"	3099910	3/4" - 1-1/4"	
3175407	3145407	3/16 x 2-3/4"	5/32 x 4-1/2"	3096910	1-1/4" - 1-3/4"	• 2 x 4 wood nailers
3189407	3159407	1/4 x 2-3/4"	3/16 x 4-1/2"	3099910	1-1/4" - 1-3/4"	
3177407	3147407	3/16 x 3-1/4"	5/32 x 5-1/2"	3097910	1-3/4" - 2-1/4"	• Sill plates; 2 pieces of 2 x 4 or 2 x 6 to masonry. Insulation to masonry.
3191407	3161407	1/4 x 3-1/4"	3/16 x 5-1/2"	3100910	1-3/4" - 2-1/4"	
3179407	3149407	3/16 x 3-3/4"	5/32 x 5-1/2"	3097910	2-1/4" - 2-3/4"	
3193407	3163407	1/4 x 3-3/4"	3/16 x 5-1/2"	3100910	2-1/4" - 2-3/4"	
3181407	3151407	3/16 x 4"	5/32 x 5-1/2"	3097910	2-1/2" - 3"	
3195407	3165407	1/4 x 4"	3/16 x 5-1/2"	3100910	2-1/2" - 3"	
3197407	3167407	1/4 x 5"	3/16 x 6-1/2"	3102910	3-1/4" - 4"	
3203407	3205407	1/4 x 6"	3/16 x 7-1/2"	3206910	4-1/4" - 5"	
3103910		Condrive 1000	For 3/16 and 1/4 diameter, Hex and Flat Heads, lengths up to 4"			
3119910		Condrive 2000	For 3/16 and 1/4 diameter, Hex Head, lengths up to 2-3/4"			

The minimum embedment requirement is 1" and the maximum embedment is 1-3/4".
One drill bit is provided with every box of 100 pieces.
Also available for 1/4" diameter Tapcon Anchors only: 3/16" x 7" SDS Rotary Hammer Drill Bit.

Tapcon Anchors must be installed using all Buildex system components (Tapcon Anchors, Condrive Tools and Tapcon Drill Bits) in order to qualify for ITW Buildex system support.

Performance Data

PULLOUT IN CONCRETE (3145 PSI, cured 40 days) (lbs)

Anchor Diameter	Depth of Embedment in Solid Material (Inches) 1"	1-1/4"	1-1/2"	1-3/4"
3/16"	341lbs.	581 lbs.	863 lbs.	1059 lbs.
1/4"	718 lbs.	1138 lbs.	1537 lbs.	1860 lbs.

Test Number CH3932/Pittsburgh Testing Laboratories

PULLOUT IN HOLLOW BLOCK

Anchor Diameter	Depth of Embedment in Solid Material (Inches) 1"	1-1/4"	1-1/2"	1-3/4"
3/16"	209 lbs.	357 lbs.	466 lbs.	547 lbs.
1/4"	406 lbs.	615 lbs.	851 lbs.	984 lbs.

Test Number CH3748/Pittsburgh Testing Laboratories

SHEAR STRENGTH

Anchor Diameter	Anchor Embedment	Shear Strength 3145 PSI Hard Rock Concrete	Shear Strength Lightweight Hollow Block
3/16"	1-1/4"	852 lbs.	731 lbs.
1/4"	1-1/4"	1604 lbs.	1058 lbs.

Test Number CH3932/Pittsburgh Testing Laboratories

Installation Guidelines using Condrive 1000

STEP 1: *Place correct drill bit into driver adapter and drill hole 1/4" deeper than depth of embedment.*

STEP 2: *Slide Condrive Installation Tool sleeve over drill bit. Snap hex head or Phillips Socket in place.*

STEP 3: *Insert anchor in socket, position fixture to be fastened, begin to drive Tapcon into pre-drilled hole.*

STEP 4: *The anchor is fully set when the nosepiece of the Condrive Tool automatically disengages from the socket and fixture is secured in place.*

Note: Indicated pull-out and shear failure values were obtained in tests witnessed by Pittsburgh Testing Laboratory personnel. Designated holding power depends on the quality of the masonry material, depth of embedment and proper hole size. These figures are offered only as a guide and are not guaranteed in any way by Illinois Tool Works Inc. The figures indicate average ultimate pull-out and shear failure values. A safety factor of 4:1 or 25% of ultimate pull-out value is generally accepted as a safe working load. However, reference should always be made to applicable codes for the specific safe working ratio. All values are based on close tolerance holes drilled with Buildex Tapcon® carbide drill bits. Performance of the Tapcon anchor may vary in extremely hard concrete aggregates. Consult your Buildex representative for further information.

As in the case with all applications, Buildex can only suggest typical fasteners for typical applications and that the connection design is the sole responsibility of the Building Design Engineer, Architect or otherwise responsible person charged with the design of the connection. For further product information, please contact the nearest Authorized Buildex Distributor or the Buildex Customer Service Department at 1-800-323-0720.

BUILDING IDEAS THAT WORK™
1349 West Bryn Mawr Avenue
Itasca, Illinois 60143
708/595-3500 FAX: 708/595-3549

DOW CORNING

Information About DOW CORNING® 3-6548 Silicone RTV Foam

DESCRIPTION

DOW CORNING® 3-6548 silicone RTV foam is a medium-density, two-part product supplied as A and B liquid components. The A component is black and the B component is off-white for easy identification and inspection of mix. When the A and B components are thoroughly mixed in a 1:1 ratio by either weight or volume, the product will expand and cure to a foamed elastomer at room temperature. Only a mild exotherm is exhibited during the curing reaction.

USES

DOW CORNING 3-6548 silicone RTV foam is formulated to have fire-resistance properties. As a result, it can be used for preparing fire-resistant penetration seals as evidenced by the results of fire endurance testing as defined in ASTM E 814 "Standard Method of Fire Tests for Through-Penetration Fire Stops". The material, used in specific designs, has achieved three-hour fire ratings per this test criteria. DOW CORNING 3-6548 silicone RTV foam is listed in UL's Fire Resistance Directory for use in Through-Penetration Firestop Systems.

It should be specifically noted that various silicone foams have different fire resistant properties. The use of the generic term "silicone foam" should be avoided when referencing this product or this data. This test data pertains to this product by its specific name and number designation, namely DOW CORNING 3-6548 silicone RTV foam.

DOW CORNING® 3-6548 SILICONE RTV FOAM

Type	Two-component silicone
Physical Form, as supplied	Medium-viscosity liquid
as cured	Flexible foam
Special Properties	Cures at room temperature; reversion resistant; noncorrosive; fire resistant
Primary Use	Fire resistant penetration seals

TYPICAL PROPERTIES

These values are not intended for use in preparing specifications.

As Supplied		
Part A – Physical		
* CTM 0176	Appearance	Black liquid
* CTM 0097	Specific Gravity at 25°C (77°F)	1.05-1.11
* CTM 0050	Viscosity, Brookfield Model HAF spindle No. 3 at 10 rpm, poises	40-60
† CTM 0052	Flash Point	>243°C (>470°F)
† CTM 0052	Fire Point	>344°C (>650°F)
As Supplied		
Part B – Physical		
* CTM 0176	Appearance	Off-white liquid
* CTM 0097	Specific Gravity at 25°C (77°F)	1.05-1.11
* CTM 0050	Viscosity, Brookfield Model HAF spindle No. 3 at 10 rpm, poises	50-75
† CTM 0052	Flash Point	>133°C (>277°F)
† CTM 0052	Fire Point	>199°C (>390°F)
As Cured – Physical[1]		
† CTM 0176	Appearance	Dark gray-black elastomeric foam
* CTM 092A	Snap Time[2], minutes	1-2
* CTM 0812	Density[3], gm/cm³ (lb/ft³)	.22-.32 (14-20)
† CTM 0826	Cell Structure[4], closed cell, percent	50
† ASTM D 3574	Tensile Strength, N/m² (psi)	2.28×10^5 (33.0)
† CTM 0525	Compression Deflection, N/m² (psi)	
	at 20% compression	3.59×10^4 (5.2)
	at 40% compression	6.96×10^4 (10.1)
	at 60% compression	1.46×10^5 (21.2)
† CTM 0224	Thermal Conductivity[5], cal cm/sec² cm °C	1.8×10^{-4}
† CTM 0740	K Factor[6], 0.27 gm/cm² (17 lb/ft²) foam, J cm/hr cm² °C (BTU cm/hr cm² °C)	527 (0.5)
† CTM 0585	Linear Coefficient of Thermal Expansion, -25° to 150°C (-11° to 344°F), cm/cm °C (in/in °F)	3.2×10^{-4} (1.78×10^{-4})

TYPICAL PROPERTIES – *Continued*

As Cured – Flammability[7]

† CTM 0316A Flammability, vertical burn:

	Time in Flame, seconds	*Average Time Flame-Glow Out seconds*	*Average Weight Loss, percent*
	15	7.2	1.3
	60	15.6	13.5

† CTM 0780 Limiting Oxygen Index, LOI rating 39

† ASTM E 84-79A Flame Spread Rating[8] 15

As Cured – Electrical[9]

† CTM 0114 Dielectric Strength, volts/mil 165

† CTM 0112 Dielectric Constant, 100 Hz 1.95

† CTM 0112 Dissipation Factor, 100 Hz 0.00505

† CTM 0249 Volume Resistivity, ohm-cm ..... 2.24×10^{15}

Specification Writers: Please contact Dow Corning Corporation, Midland, Michigan, before writing specifications on this product.

[1] One part A thoroughly mixed with one part B and cured at 25°C (77°F) for 24 hrs.

[2] Time to nonpour condition. Also time to begin foam rise.

[3] Power mixed for 30 seconds and cured in nonconfined condition.

[4] Breathability method.

[5] Cenco Fitch method.

[6] Cured foam sample thickness – 2.54 cm (1 in).

[7] Tests, claims, representations and descriptions regarding flammability are based on standard small scale laboratory tests. Such tests may not be reliable for determining, evaluating, predicting, or describing the flammability or burning characteristics of the product under actual fire conditions, whether the product is used alone or in combination with other products.

[8] Test report available upon request.

[9] Cured foam sample thickness – .317 cm (.125 in).

* Sales Specifications: Dow Corning performs acceptance testing on lot of material and certifies that this product will meet the above specification requirements for 12 months from date of shipment when properly stored in the original, unopened container.

Other: Testing on what we believe to be a representative lot of material. Testing is not done on a lot by lot basis. If property is critical for your application then you should test on a lot by lot basis prior to use.

Note: Some properties will vary depending on the cured density of the foam.

LIMITATIONS

Inhibition of Cure[1]

Certain materials, chemicals, curing agents and plasticizers can inhibit the cure of DOW CORNING 3-6548 silicone RTV foam. The most notable include:

- Organotin and other organometallic compounds
- Silicone rubber containing organotin catalyst
- Sulfur, polysulfides, polysulfones and other sulfur-containing materials
- Amines, urethanes and amine-containing materials
- Unsaturated hydrocarbon plasticizers

[1] If a substrate or material is questionable with respect to causing potential inhibition of cure, it is recommended that a small scale compatibility test be run to ascertain suitability in a given application. The presence of liquid or uncured product at the interface between the questionable substrate and the cured DOW CORNING 3-6548 silicone RTV foam would indicate incompatibility and inhibition of cure. Please contact Dow Corning for more information.

Preparatory Work

The penetration opening and all related surfaces must be clean of dirt, dust and loose impediments. Surfaces must also be free of water, oil or other free liquids.

Painting or Coating

Most coatings/paints do not adhere to this product. Contact Dow Corning prior to painting or coating.

HOW TO USE

Delivery and Storage

The Part A and Part B components of DOW CORNING 3-6548 silicone RTV foam are delivered in separate containers. They should be stored out of the weather in their unopened containers at or below 32°C (90°F). When stored in the original unopened containers at this temperature, the shelf life is 12 months from date of shipment from Dow Corning. Partially used containers should be sealed tightly and stored in a similar manner.

The liquid Part B components of DOW CORNING 3-6548 silicone RTV foam in contact with bases or catalytic oxidizing materials, could generate hydrogen gas. A bulged Part B component container may indicate hydrogen gas pressurization, and appropriate caution should be exercised. If this occurs, contact Dow Corning at (517) 496-5900.

Preparatory Work

The penetration opening and all related surfaces must be clean of dirt, dust and loose impediments. Surfaces must also be freed of water, oil or other free liquids.

Damming the Penetration

Damming the penetration is required to prevent the liquid foam mixture from running out before it foams. Damming materials may also contribute to the fire resistant properties of particular system configurations. Check system design to make sure that proper damming materials and techniques are used.

CAUTION: When components A and B of DOW CORNING 3-6548 silicone RTV foam are mixed, the foam generates hydrogen gas during cure. Forced air ventilation is necessary if the work area has less than two cubic feet of free air space for each pound of liquid mixture being foamed. Additional information is provided in the sections entitled "SAFE HANDLING INFORMATION" and "Gas Evolution".

Mixing the Components

Prior to use, Part A and Part B components must be thoroughly stirred in their original containers to uniformly redisperse any fillers or pigments that may have settled. When mixing Part A and Part B, use clean containers and mixing equipment. If stirred containers stand for more than four hours, re-stir.

At time of installation, material temperature should be between 18°C (65°F) and 27°C (80°F). This can be done by bringing the containers into a room between 18°C (65°F) and 27°C (80°F) and allowing them to sit for 12 hours. Please check material temperature prior to use if there is a possibility it is outside this range.

To properly catalyze DOW CORNING 3-6548 silicone RTV foam, an equal quantity of Part A is added to an equal quantity of Part B by either weight or volume. For batch mixing by hand or power mix, vigorous and thorough

mixing should be maintained for 30 to 60 seconds. The mixed product begins to foam shortly after mixing; therefore, it should be dispensed in the penetration as soon as mixing is completed. For large-volume applications, the use of suitable automatic mixing, metering and dispensing equipment is recommended. A list of equipment manufacturers is available from Dow Corning upon request.

The type and degree of mixing can significantly affect the cell structure and density of the final foam product. Mixing with a 198-g (7-oz) Semco[2] cartridge will generally result in a slightly higher density than mixing by hand. Hand mixing, in turn, will result in a higher density than power mixing by automatic mixing, metering and dispensing equipment.

Likewise, the expansion ratios of foam volume to liquid volume can vary from 2:1 to 4:1, depending on the type and degree of mixing and degree of confinement. If foam rise is restricted or confined during cure, foam densities as high as 0.48 gm/cm³ (30 lbs/ft³) can result.

Working Time

As supplied and properly mixed, DOW CORNING 3-6548 silicone RTV foam has a snap time, or working time, of one to two minutes at 25°C (77°F). The snap time is dependent upon the temperature of the A and B components just before and after they are mixed.

Installation

DOW CORNING 3-6548 silicone RTV foam typically expands from two to four times its liquid volume during cure. DOW CORNING 3-6548 silicone RTV foam should not be dispensed in liquid layers thicker than 2.54 cm (1 in) at any given spot. Allow at least 15 minutes between application of each foam layer. If the opening is not filled to the desirable level when the cured foam has completed its expansion, repeat the injection and cure procedure until the desired fill rate is attained.

To permit a clear view when filling a wall cavity, damming materials are built up gradually. The top of the opening is dammed for the final shot of foam.

After the foam is installed, damming materials are left in place for 24 hours to allow the penetration seal to cure fully.

[2] "Semco" is a registered trademark of Courtaulds Aerospace, Inc.

TABLE 1: FOUR-STEP QUALITY CONTROL REQUIREMENTS FOR CHECKING DOW CORNING 3-6548 SILICONE RTV FOAM AND DISPENSING EQUIPMENT

1. Snap Time, minutes[1]	1-2
2. Free Foam Density[1], gm/cm³ (lb/ft³)	.22-.32 (14-20)
3. Color Chart Comparison (Dow Corning Form No. 61-880)	Pass
4. Cell Structure Chart Comparison (Dow Corning Form No. 61-880)	Pass

[1] Standard procedures for measuring snap time and free foam density are available from Dow Corning upon request. Totally unconfined, density values as low as .22 gm/cm³ (14 lb/ft³) may be obtained. Values shown are typical for field installation.

Inspection

After 24 hours, the penetration seal must be completely inspected by removing the damming materials. Curing foam should completely fill the penetration, providing a tight, compressive fit. Any remaining gaps are filled with freshly mixed foam or DOW CORNING® 96-081 RTV adhesive/sealant. The seal should then be reinspected after an additional 24 hours. Damming materials that are part of a specific system design must be replaced to their proper positions.

Quality Control

Dow Corning has developed a four-step quality control check that can be performed on the site quickly and easily. It should be performed at least once daily and upon changing to a new lot of material to ensure the performance of both dispensing equipment and foam product prior to installing penetration seals. (The quality control check is shown in Table 1.)

Follow the equipment manufacturers instructions for maintaining product component ratios.

Clean-Up

Excess cured foam around the penetration seal can be removed with a sharp knife or blade. Spills of Part A and Part B liquid components can be removed with high-flash-point mineral spirit solvent.

CAUTION: Consult solvent material data sheet for safe handling information. Follow state, federal and local environmental regulations.

Repairability

Once cured in place, DOW CORNING 3-6548 silicone RTV foam can be removed, repaired or changed, and the repaired area reformed in place with additional product. Since this product develops good adhesion to itself, the repaired region will become an integral part of the original foam.

Adhesion

Maximum adhesion is obtained when foaming against a freshly exposed foam surface, free of dust, dirt, moisture and other contaminants.

DOW CORNING 3-6548 silicone RTV foam does obtain good adhesion to a wide variety of substrates, however, it does not adhere to some substrates such as Teflon[3], polyethylene, polypropylene and related materials.

SAFE HANDLING INFORMATION

Immediately upon mixing the A and B components of DOW CORNING 3-6548 silicone RTV foam, a chemical reaction takes place that results in the generation of hydrogen gas. Appropriate caution should be exercised. Keep away from sparks and open flame.

When using DOW CORNING 3-6548 silicone RTV foam to seal large penetration openings, care should be exercised to avoid gas entrapment. Adequate ventilation should be provided to prevent build-up of hydrogen gas. Forced air ventilation is necessary if the work area has less than two cubic feet of free air space for each pound of liquid mixture being foamed. Adequate ventilation must be provided to prevent build-up of hydrogen at explosive levels. Additional information on release rate is provided in the section titled "Gas Evolution".

Waste materials must be considered with regard to these precautionary measures during disposal and storage. Waste materials should not be sealed in such things as plastic bags and similar containers that could trap hydrogen gas.

The liquid Part B components of DOW CORNING 3-6548 silicone RTV foam in contact with bases or catalytic oxidizing materials could generate hydrogen gas. A bulged Part B

[3] "Teflon" is a registered trademark of E.I. duPont de Nemours & Company.

component container may indicate hydrogen gas pressurization, and appropriate caution should be exercised. If this occurs, contact Dow Corning at (517) 496-5900. Consult MSDS prior to handling product.

MSDS INFORMATION

PRODUCT SAFETY INFORMATION REQUIRED FOR SAFE USE OTHER THAN PHYSICAL HAZARDS STATED ABOVE IS NOT INCLUDED. BEFORE HANDLING, READ PRODUCT AND MATERIAL SAFETY DATA SHEETS AND CONTAINER LABELS FOR SAFE USE, PHYSICAL AND HEALTH HAZARD INFORMATION. THE MATERIAL SAFETY DATA SHEET IS AVAILABLE FROM YOUR DOW CORNING REPRESENTATIVE, OR DISTRIBUTOR, OR BY WRITING TO DOW CORNING CUSTOMER SERVICE, OR BY CALLING (517) 496-6000.

Gas Evolution

Immediately upon mixing the A and B components of DOW CORNING 3-6548 silicone RTV foam, a cure reaction takes place that results in the evolution of hydrogen gas. The product then cures to an elastomer in the presence of the evolved gas, resulting in a flexible, elastomeric foam.

While the gas generation is essentially completed during the first three minutes after the A and B components are mixed, hydrogen gas will continue to be released from the foam for at least 24 hours. Most of the evolved gas is initially retained in each foam cell and is not immediately released to the surrounding atmosphere, because the foam is greater than 50 percent closed cell. The gas is released over a period of time by diffusion. The rate of release is dependent upon penetration sizes, sealing designs and ambient temperatures. The amount of gas generated is dependent upon the amount of foam used.

PACKAGING

DOW CORNING 3-6548 silicone RTV foam is packaged in 198-g, 0.9-, 7.25-, 36.3-, and 409-kg (7-oz, 2-, 16-, 80-, and 900-lb) kits, net weight.

SHIPPING LIMITATIONS

DOW CORNING 3-6548 silicone RTV foam Part B cannot be shipped by air.

DISPOSAL INFORMATION

Please review and analyze the appropriate disposal requirements (local, state and federal) for waste streams, used product, etc. Should you have specific questions about the waste characteristics of this Dow Corning product, contact Dow Corning product information at (517) 496-6000.

LIMITED WARRANTY – PLEASE READ CAREFULLY

Some of the information and data contained herein are based upon testing of specific designs at independent test laboratories per ASTM E 814/UL 1479 "Method of Fire Tests of Through-Penetration Fire Stops" at independent test laboratories and some are based upon testing at Dow Corning per Dow Corning Corporate test methods. Test conditions may not be representative of actual fire conditions. Variation from tested designs can also alter system performance. For these reasons, it is the user's responsibility to determine that the designs used are suitable for the application intended and will provide the level of protection required. Since application of the product(s), conditions of their use, and the intensity and duration of actual fires are beyond any manufacturers control, Dow Corning shall not be held liable for damages, direct or consequential, resulting from the use of its product(s) or tested design(s). Suggestions of uses should not be taken as inducements to infringe any particular patent.

Unless Dow Corning provides you with a specific written warranty of fitness for a particular use, Dow Corning's sole warranty is that the product or products will meet Dow Corning's then current sales specifications. DOW CORNING SPECIFICALLY DISCLAIMS ANY OTHER EXPRESS OR IMPLIED WARRANTY, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR USE. Your exclusive remedy and Dow Corning's sole liability for breach of warranty is limited to refund of the purchase price or replacement of any product shown to be other than as warranted, and Dow Corning expressly disclaims any liability for incidental or consequential damages.

CLASSIFIED UL

FILL, VOID OR CAVITY MATERIALS CLASSIFIED BY UNDERWRITERS LABORATORIES INC.® FOR USE IN THROUGH-PENETRATION FIRESTOP SYSTEMS.

SEE UL FIRE RESISTANCE DIRECTORY

DOW CORNING CORPORATION
MIDLAND, MICHIGAN 48686-0994

Printed in U.S.A. Form No. 61-320F-93

DOW CORNING

Appendix F

Fiberfrax® Duraboard® Products

Introduction

Fiberfrax® Duraboard® products are a family of rigid, high temperature ceramic fiber boards manufactured in a wet forming process using Fiberfrax alumina-silica fibers and binders. All Duraboard products offer low thermal conductivity, high temperature stability, uniform density, and excellent resistance to thermal shock and chemical attack.

They are also well-suited for applications experiencing vibration, mechanical stress and strong erosive forces. The excellent rigidity and modulus of rupture possessed by these boards makes them strong and self-supporting, yet relatively lightweight and easy to cut or machine.

These product features allow for quick, efficient handling and high installation rates, thereby enabling fast turnaround times in a variety of industrial insulation applications. Once installed, they can help reduce energy costs and cycling times due to their high insulating capability, as well as serving to protect refractory surfaces from thermal shock.

Product Range

Temperature	Density	Board		Description
2300°F	5-18#	RG	—	A rolled, rigidized surface finish and high MOR give a tough, economic refractory grade product.
	15-18#	LD	—	A higher quality surface finish and tighter dimensional tolerances make this board suitable for use in situations where aesthetic quality as well as performance is important.
	24-28#	HD	—	The addition of clay gives a higher density, MOR, and strength.
	35#	GH	—	A board manufactured with inorganic binding agents and post-soaked to give an inorganic, high density product.
2600°F	12-14#	2600	—	Formed from a special blend of regular Fiberfrax alumina silica fibers and Fibermax® Mullite fibers. These boards give high stability at elevated temperatures.
3000°F	10-12#	3000	—	Formed from a special blend of regular Fiberfrax alumina silica fibers and Fibermax Mullite fibers. These boards give high stability at elevated temperatures.

Duraboard® Products

Duraboard RG

Duraboard RG (Refractory Grade) insulation is a cost-effective insulating board manufactured with the specific requirements of the refractory industry in mind. It has a rolled, rigidized surface which gives it a high modulus of rupture and compressive strength as well as high abrasion and hot gas erosion resistance.

These properties make Duraboard RG insulation ideally suited for use both as a backup to dense refractories, such as those used in the glass industry, and as a hot face protective layer over blanket linings where the rigidized surface aids in dust suppression during both installation and operation.

Duraboard LD

This product possesses the same density and temperature rating as Duraboard RG insulation, but is manufactured to tighter dimensional tolerances and has an excellent finished surface. These characteristics make it ideally suited for use as a sandwich or core material or for use in the manufacture of components where aesthetic quality, as well as uniformity and performance is important.

It is available in a variety of standard thicknesses ranging from ⅛" to 2".

Duraboard HD

Duraboard HD insulation is a high density board product that offers the same high level of dimensional and surface uniformity as Duraboard LD insulation, but provides enhanced compressive strength and a higher modulus of rupture. This higher density is achieved through the inclusion of clay additives during the manufacturing process.

Its higher strength makes Duraboard HD insulation particularly well-suited to weight load support applications such as refractory brick backup or for covering larger unsupported spans.

GH Board

GH Board insulation possesses the highest density and modulus of rupture of the board product family. This rigid board is manufactured using inorganic binding agents and is post-soaked to impart its high density.

Due to its high modulus of rupture, it is ideal for use in areas experiencing vibration, mechanical stress and strong erosive forces.

Duraboard 2600

Duraboard 2600 insulation is a high temperature insulating board designed to promote high stability at elevated temperatures. This capability is achieved by manufacturing a board formulated with a blend of Fiberfrax® alumina-silica fibers and Fibermax®, Unifrax Corporation's patented polycrystalline mullite fibers.

This unique formulation controls shrinkage to a level of only 1.5% after 168 hours at 2600°F/1427°C.

Duraboard 3000

Duraboard 3000 insulation, the highest temperature rated board manufactured by Unifrax Corporation, provides maximum high temperature stability and shrinkage resistance. Also formulated from a blend of Fiberfrax alumina-silica fibers and Fibermax, Unifrax Corporation's patented polycrystalline mullite fibers, Duraboard 3000 insulation derives its exceptional high temperature capability from an increased Fibermax fiber concentration in the blend.

This unique formulation controls shrinkage to a level of only 1.2% after 168 hours at 2700°F/1482°C.

Typical Chemical Properties

The Fiberfrax Duraboard family exhibits excellent chemical stability, resisting attack by most corrosive agents. Exceptions are hydrofluoric, phosphoric, hydrochloric and sulfuric acids as well as concentrated alkalies. Fiberfrax Duraboard products also resist oxidation and reduction. If wet by water, steam or oil, thermal and physical properties are completely restored upon drying.

In order to provide handling strength during the manufacturing process, small quantities of organic and inorganic binders are typically added to the board formulation. Where present, the organic binding agents burn out at temperatures between 450°F/ 232°C to 600°F/316°C during initial heat up by the end user. Following burnout of the organic binder, the boards are white in color.

Inorganic Boards

Duraboard products are manufactured using a combination of both organic and inorganic binding agents. In certain applications, the presence of organic binders and the low temperature burnout that is associated with them may be unacceptable. These products may be ordered with the organic binding agents already removed by heat treating following the manufacturing process. Heat treated boards display a reduced modulus of rupture and an increase in dustiness.

Applications

Board

RG	LD*	HD	GH	2600	3000	Application
●		●		●	●	Full thickness refractory lining
●	●	●		●	●	Insulating backup to dense refractories
●				●	●	Insulating backup to brick & castable
●				●	●	Furnace hot face lining in ceramic kiln, box furnace & petrochemical furnace
●	●	●		●	●	Board over blanket hot face lining
●						Alternative to lower temperature mineral wool block
●	●					Use in industrial heat processing equipment
●	●	●				Rigid high temperature gaskets & seals
●	●	●	●	●		High temperature baffles & muffles
	●	●	●	●	●	Flue & chimney linings in furnaces & kilns
	●	●		●	●	Infra red element supports
			●			Heating element support brackets
●	●	●		●	●	Glass tank side & end wall & port neck insulation
●	●	●		●	●	Trough & insulation linings for conveying molten metals
			●			Molten metal trough covers
●	●	●		●	●	Thermal insulation where high velocities are encountered
	●	●		●	●	Heat shields for personnel protection
●	●	●		●	●	Hot gas duct linings
	●	●		●	●	Low & high temperature dryers
	●	●				Pouring forms for castable
	●	●				Expansion joint material
			●			Wind tunnel insulation
	●		●			Industrial heat shields & thermal barriers
	●			●	●	Industrial combustion chamber construction
	●					Domestic appliance & light duty industrial combustion chamber construction
	●		●			Wood burning stove backup insulation

*Duraboard LD has been recognized under certain categories at Underwriters Laboratories Inc.

Availability

Sheet Size	Thickness ⅛" 3 mm	¼" 6 mm	½" 13 mm	1" 25 mm	1½" 38 mm	2" 51 mm
12 x 36 305 x 914 mm		GH*		HD	HD	HD
18 x 18 457 x 457 mm				2600 3000	2600 3000	2600 3000
24 x 24 610 x 610 mm				2600 3000	2600 3000	2600 3000
24 x 36 610 x 914 mm		LD	LD	LD HD	LD HD	LD HD
24 x 48 610 x 1120 mm		LD	LD	RG LD HD 2600 3000	 LD HD 2600 3000	RG LD HD 2600 3000
42 x 48	LD	LD	LD			

Duraboard® HD & Duraboard LD are available 3" & 4" thick by special order. *Other sizes by special request.

Product Properties

Properties		Board RG		LD		HD		GH		2600		3000	
Nominal Density	lb/ft³ kg/m³	16	258	16	258	26	419	35	560	14	224	12	192
Continuous Use Limit	°F/°C	2300	1260	2300	1260	2300	1260	2300	1260	2600	1427	3000	1649
Product Melting Point	°F/°C	3200	1760	3200	1760	3200	1760	3200	1760	3300	1816	3400	1871
MOR PSI	Green (typ.) Fired (24 hrs @ cont. use)	250 110		200 80		300 125		300 125		150 65		150 55	
LOI (% by Wt)		5-7%		6-7%		6-7%		0		4-6%		4-6%	
Dielectric Strength		—		27 volts/mil		27 volts/mil		27 volts/mil		—		—	
Color		Cream to tan		Cream/white		Cream		White		Cream		Cream	
Shrinkage	(%)												
24 Hrs @ Cont. Use Limit		5%		4.5%		4.5%		5%		1.5 (168 hrs 1.5)		—	
24 Hrs @ 1600°F/817°C		—		—		—		0%		—		—	
24 Hrs @ 1800°F/920°C		—		1.8%		1.7%		—		—		—	
24 Hrs @ 2540°F/1343°C		—		—		—		—		1.4%		1.0%	
24 Hrs @ 2600°F/1427°C		—		—		—		—		—		1.0%	
24 Hrs @ 2700°F/1482°C		—		—		—		—		—		1.2%	
168 Hrs @ 2450°F/1343°C		—		—		—		—		1.4%		1.2%	
Compressive Strength	lb/in²	Green	Fired	Green	Fired	Green	Fired	Green	Fired	Green	Fired	Green	Fired
Deformation @	5%	48	25	42	23	59	35	—	—	22	19	42	14
	10%	61	25	50	22	70	33	—	—	25	18	44	14
	15%	71	25	57	23	81	32	—	—	27	18	47	14
Fiber Content													
Fiberfrax®**		100%		100%		100%		100%		75%		50%	
Fibermax®***										25%		50%	
Thermal Conductivity****	Temperature					Btu-in/hr ft² °F							
	600°F/316°C	0.62		0.62		0.62		0.74		0.50		0.47	
	1000°F/538°C	0.85		0.85		0.85		1.07		0.71		0.73	
	1400°F/760°C	1.14		1.14		1.44		1.44		1.02		1.16	
	1800°F/982°C	1.53		1.53		1.55		1.83		1.36		1.70	
	2200°F/1093°C	—		—		—		—		1.85		2.40	

**Fiberfrax is Unifrax's patented 2300°F/1260°C amorphous alumina-silica fiber.
***Fibermax is Unifrax's patented 3000°F/1649°C polycrystalline mullite fiber.
****As per ASTM C-177.

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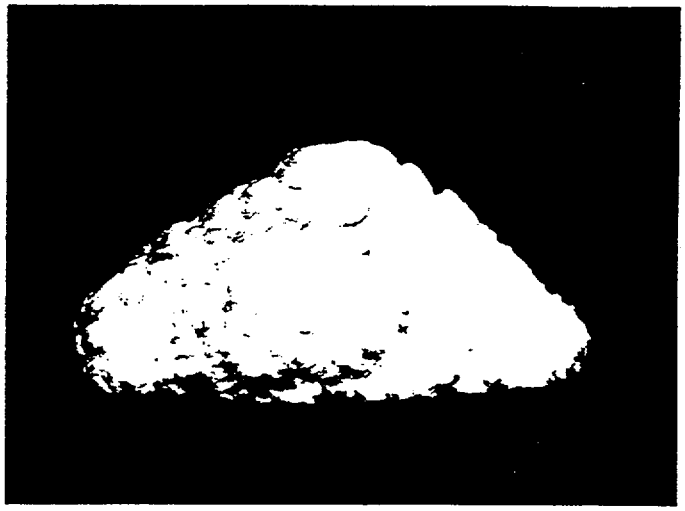
APPENDIX G

Fiberfrax® Ceramic Fiber



Introduction

Fiberfrax® ceramic fibers are the basis for the Fiberfrax family of product forms. Manufactured from alumina-silica materials, Fiberfrax fibers are chemically inert. Some of the outstanding and unique properties these fibers offer are high temperature stability, low thermal conductivity, low heat storage, excellent thermal shock resistance, light weight, superior corrosion resistance and excellent sound absorption. Fiberfrax fibers are available in a variety of lengths, diameters, surface areas and chemistries. These fibers can be further modified by removal of the unfiberized particles (called shot).

Fiberfrax fibers exhibit excellent chemical stability and resistance to attack from most corrosive agents. Exceptions include hydrofluoric acid, phosphoric acid and strong alkalies. Fiberfrax fibers also effectively resist oxidation and reduction. If wet by water or steam, thermal and physical properties are restored upon drying. Fiberfrax fibers contain no water of hydration.

Fiberfrax Regular Fiber

Fiberfrax Regular fibers are made from high purity alumina-silica materials. These fibers have a use limit of 2300°F (1260°C) and a melting point of 3260°F (1790°C). Fiberfrax Regular fiber is used as a high temperature fill or packing material in a variety of applications such as expansion joints, furnace base seals, tube seals, packing around burner tiles and as glass feeder bowl insulation. This fiber can also be used in the manufacture of other ceramic fiber product forms such as felts, boards, papers, vacuum cast shapes as well as in cements, castables and moldables.

Fiberfrax Regular fiber conforms to the U.S. Coast Guard requirements for "Incombustible Materials," subpart 164.009. Additional information on conformations, specifications and approvals is available on request.

Fiberfrax SEF Fibers

Fiberfrax 6000 fibers are made from kaolin materials and Fiberfrax 7000 fibers are made from high purity alumina-silica materials. The temperature limit on these fibers extends from the cryogenic levels through the melting point of the material at 3260°F (1790°C) dependent on the specific application. In addition to being usable in the applications described for Fiberfrax Regular fiber, these fibers can be used as an additive in products such as friction materials, cements, castables, moldables and textiles.

Fiberfrax 6000 and 7000 fibers conform to the U.S. Coast Guard requirements for "Incombustible Materials" subpart 164.009 and the fire performance requirements of MIL-STD-1623.

Fiberfrax Spun Fiber

Fiberfrax Spun fiber is composed of extra-long lubricated alumina-silica fibers made from kaolin materials. These fibers, which are formed by a unique spinning operation, combine the superior insulating properties of other Fiberfrax fibers with an excellent resistance to breakdown from mechanical stress and vibration. With a melting point of over 3260°F (1790°C), these fibers can in certain applications be used in excess of 2300°F (1260°C), the continuous use limit of the material. Fiberfrax Spun fiber can be used as a catalyst recovery filter medium, a diffusion medium for fluidized beds, high temperature acoustical insulation, filter/catalyst carrier for radioactive particles/hot exhaust gases and as a raw material in the manufacture of textiles, ropes and braids.

Fiberfrax Spun fiber conforms to the U.S. Coast Guard requirements for "Incombustible Materials," subpart 164.009 and fire performance requirements of MIL-STD-1623.

Typical Physical Properties

Fiber Type	Chemistry	Color	Use Limit	Fiber Index	Fiber Length
Regular	High purity	White	2300°F	50%	Up to 4 inch
6000/6001	Kaolin	White to lt. gray	2300°F	50%	Up to 4 inch
7000/7001	High purity	White	2300°F	50%	Up to 4 inch
Spun	Kaolin	White to lt. gray	2300°F	50%	Up to 10 inch
Long Staple Fine Coarse	High purity	White	2300°F	50%	Up to 10 inch
Washed	High purity	White	2300°F	70%	Up to 4 inch
Milled	High purity	White	2300° F	50%	20 microns (mean)
Fibermax®	Mullite	White	2800°F	95+%	Up to 4 inch

Typical Physical Properties (Con't)

Fiber Type	Fiber Diameter	Specific Gravity	Standard Packaging	Applications
Regular	2-3 microns (mean)	2.73 g/cc	25 lbs bag	• Packing material Expansion joints Burner tiles Tube seals • Basis material for Vacuum cast shapes Felts Boards Paper
6000/6001	2-3 microns (mean)	2.67 g/cc		• Packing material • Basis material for ceramic fiber products • Additive Friction materials Cements Textiles
7000/7001	2-3 microns (mean)	2.73 g/cc		• Packing material • Basis material for ceramic fiber products • Additive
Spun	2-3 microns (mean)	2.62 g/cc		• Packing material • Filtration medium • Acoustical insulation • Basis material for Textiles Ropes Braids
Long Staple Fine Coarse	 5 microns (mean) 13 microns (mean)	 2.62 g/cc	 25 lbs carton	 • Filtration medium • Acoustical insulation
Washed	2-3 microns (mean)	2.73 g/cc	50 lbs container	• Packing material • Basis material for ceramic fiber paper • Insulation of aircraft/ aerospace • Additive
Milled	2-3 microns (mean)	2.73 g/cc	200 lbs drum	• Additive Resin Refractory cement • Compact filler insulation
Fibermax®	2-3.5 microns (mean)	3 g/cc	25 lbs carton	• High temperature packing material • Basis material for higher temperature ceramic fiber materials

Fiberfrax® Long Staple Fiber

Fiberfrax Long Staple fiber is composed of extra-long alumina-silica fibers formed by a unique spinning operation from high purity materials. Two types of Long Staple fibers are available – fine and coarse – differing in mean fiber diameter. These fibers combine insulating properties with excellent resistance to mechanical stress and vibration. Long Staple fibers work well in filtration type applications such as a catalyst recovery filter medium, filter/catalyst carrier for radioactive particles/hot exhaust gases and as a diffusion medium for fluidized beds.

Fiberfrax Washed Fiber

Fiberfrax Washed fiber is produced by a unique process which removes the unfiberized particles (shot), resulting in the cleanest and most thermally efficient high purity ceramic fiber. This fiber is used in applications where reduction in unfiberized particles and improved thermal efficiency are important, such as in the manufacture of ceramic fiber papers, filler/reinforcement in ablative materials and insulation in aircraft/aerospace vehicles and components.

Fiberfrax Washed fiber conforms to the U.S. Coast Guard requirements for "Incombustible Materials," subpart 164.009 and to the fire performance requirements of MIL-STD-1623.

Fiberfrax Milled Fiber

Fiberfrax Milled fiber is ball milled from Regular fiber to reduce fiber length, thus increasing the flowability of the fiber and facilitating its dispersion in a matrix, such as resins or refractory cement compositions. Fiberfrax Milled fiber can also be used as a compact filler insulation.

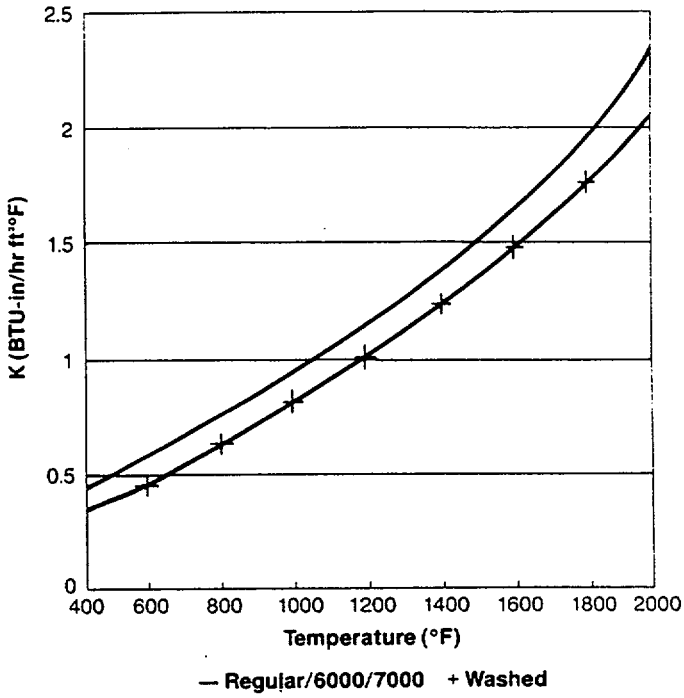
Fibermax® Fiber

Fibermax fiber is a polycrystalline mullite fiber, manufactured by a patented process. With a use limit of 2800°F (1538°C) and a melting point of 3400°F (1870°C) it is the basis for higher temperature boards, modules and coatings.

Typical Chemical Analysis (%)

	Kaolin	High Purity	Fibermax
Al_2O_3	45.0-51.0	47.0-53.0	72.0
SiO_2	46.0-52.0	48.0-53.0	27.0
Fe_2O_3	0.8-1.1	0.1	0.06
TiO_2	1.0-1.8	0.1	0.02
Na_2O	0.1-0.2	0.1-1.3	0.20
Traces	1.0	0.5	0.20

Typical Thermal Conductivity



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Appendix H

Fiberfrax® Blanket and Mat Products

Introduction

The Fiberfrax® blanket and mat product family consists of a group of lightweight, thermally efficient ceramic fiber insulating materials that combine the advantages of both low heat storage and complete resistance to thermal shock. Offering a broad range of thermal capabilities and physical characteristics, this product family provides proven and effective solutions to a variety of heat processing applications.

Durablanket® ceramic fiber products are comprised of high strength, needled insulating blankets that are made from spun Fiberfrax ceramic fibers. The extra long spun fibers, cross-locked through a unique forming process, produce a blanket with unexcelled handling strength. The Durablanket product family is completely inorganic and available in a variety of combinations of physical characteristics, temperature capabilities and sizes.

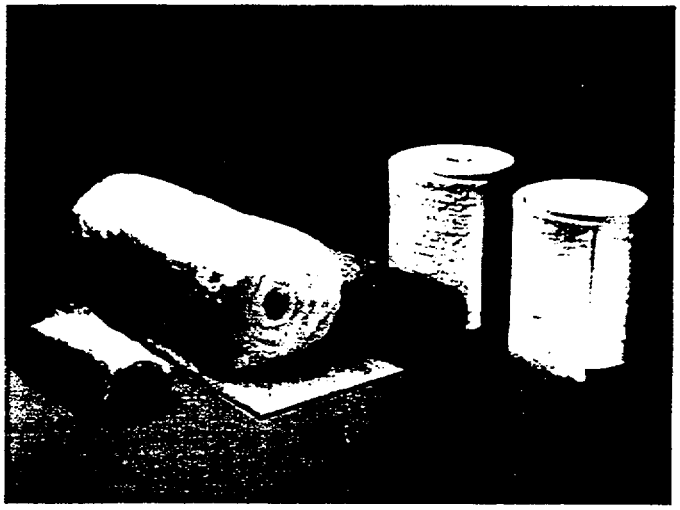
Fibermat® mat, PH blanket and Moist Pak-D® insulation provide additional options for specific application needs ranging from cost-effectiveness to high hot gas velocity resistance.

Fibermax® mat is a high temperature, flexible mat product entirely composed of Fibermax polycrystalline mullite fibers, making it an extremely lightweight, highly resilient insulator that is virtually free of unfiberized ("shot") particles.

Having excellent chemical stability, Fiberfrax blanket and mat products are unaffected by most chemicals except hydrofluoric and phosphoric acids and concentrated alkalies. If wet by water or steam, thermal and physical properties remain unaffected after drying.

Durablanket S

Fiberfrax Durablanket S insulation, the flagship of the Durablanket product family, is a strong, lightweight, flexible needled blanket that is made from spun ceramic fibers. Available in a wide variety of thicknesses, widths and densities, Durablanket S insulation provides an array of proven solutions for the broadest spectrum of applications.



Durablanket HP-S

Fiberfrax Durablanket HP-S insulation is made from spun, high purity Fiberfrax ceramic fibers. Coupled with all of the physical characteristics offered by Durablanket S insulation, the high purity level of Durablanket HP-S insulation makes it especially suitable for those applications requiring high purity fiber chemistry.

Durablanket 2600

Fiberfrax Durablanket 2600 insulation is a high temperature version of the Durablanket product line. It is made from high purity alumina, zirconia and silica spun Fiberfrax ceramic fibers. This composition, in combination with a unique manufacturing process, imparts Durablanket 2600 insulation with extremely low shrinkage characteristics at elevated temperatures.

Duraback®
Fiberfrax® Duraback blanket is a strong, lightweight, flexible needled blanket intended for use as a cost-effective back-up insulation for Fiberwall® furnace linings. It is recommended for use up to 982°C (1800°F).

Duraback blanket can be installed up to four times faster than common block-type back-up insulation and is priced competitively with mineral wool block.

Fibermat® Mat
Fiberfrax Fibermat is a lightweight, high strength needled insulating blanket. The blanket fibers are spun from a ceramic composition having a normal use limit of 760°C (1400°F). Fibermat is completely inorganic and derives its exceptional strength from the needling of long ceramic fibers.

It has excellent thermal and acoustical insulating properties.

PH Blanket
Fiberfrax PH blanket is a unique product that has been specifically designed to provide excellent filtration capabilities in addition to the high chemical stability and low thermal conductivity that is possessed by all Fiberfrax products.

PH blanket is made from Fiberfrax bulk ceramic fibers in a unique wet felting process which removes unfiberized particles. In addition to the strength and resiliency afforded by the interlocking of fibers during the manufacturing process, handling strength is further enhanced by the addition of a small amount of organic binder.

A typical filtration application would involve utilizing PH blanket as a platinum catalyst recovery filter in nitric acid production. In this application, PH blanket offers numerous advantages over glass wool products including longer life, 50-60% improved filter efficiency, reduced chance of blowouts and better temperature resistance. Other typical non-filtration applications include high temperature and acoustical insulation.

Moist Pak-D®
Fiberfrax Moist Pak-D insulation is made from high strength ceramic fiber blanket and inorganic bonding agents resulting in a flexible insulation that air dries to a hard, rigid structure. Moist Pak-D is ideal for insulation of complex shapes and for service under conditions of high hot gas velocities.

The material is packaged in a clear polyethylene bag to retain the wet binder during shipment and storage. Care should be taken to prevent freezing the product since damage will occur.

Curing of product can be accomplished by air drying for several days or by immediate temperature exposure in the application. Curing is merely a function of removal of the water in the inorganic binder.

Fibermax® Mat
Fibermax mat is a high temperature, flexible mat product that is lightweight (1.5 lb/ft^3 density) and highly resilient. It is composed entirely of Fibermax polycrystalline mullite fibers, thereby rendering a product that is high temperature (1650°C/3000°F) resistant and virtually shot-free.

Fibermax mat contains no organic binders or other additives which cause outgassing fumes or associated problems. In addition to exhibiting excellent resistance to attack from most corrosive agents (exceptions include hydrofluoric acid, phosphoric acid and strong alkalies), Fibermax fiber also resists oxidation and reduction.

Product Family Characteristics

- Excellent handling strength
- Excellent hot strength
- Low thermal conductivity
- Low heat storage
- Light weight
- Resiliency
- Thermal shock resistance
- High heat reflectance
- Excellent corrosion resistance
- Excellent thermal stability
- Excellent sound absorption

Specific Product Characteristics

- Very low shrinkage: Durablanket® 2600 insulation
- Extremely low shrinkage: Fibermax mat
- Exceptional handling strength: Durablanket 2600 insulation, Durablanket S insulation, Durablanket HP-S insulation, Fibermat mat
- Exceptional hot strength: Durablanket 2600 insulation
- Exceptional velocity resistance: Moist Pak-D insulation
- Excellent conformance to complex shapes: Moist Pak-D insulation
- Low shot content (95% fiber index): Fibermax mat
- Exceptional sound absorption: Fibermax mat, PH blanket
- High resiliency: Fibermax mat
- Excellent compression recovery: Fibermat mat
- Excellent filtration capabilities: PH blanket

Typical Applications

Durablanket® S and Durablanket HP-S
- Furnace, kiln, reformer and boiler linings
- Investment casting mold wrappings
- Removable insulating blankets for field stress relieving welds
- Reusable insulation for steam and gas turbines
- Flexible high temperature pipe insulation
- Pressure and cryogenic vessel fire protection
- High temperature kiln and furnace insulation
- Furnace door linings and seals
- Soaking pit seals
- Furnace repairs
- Thermal reactor insulation
- Expansion joint seals
- Primary reformer header insulation
- High temperature gasketing
- Glass furnace crown insulation
- Incineration equipment and stack linings
- Annealing cover seals
- High temperature filtration
- Nuclear insulation applications
- Atmosphere furnace lining
- Field steam generator lining

Durablanket 2600
- Ceramic kilns (abrasives, sanitary ware, electrical insulators, etc.)
- Billet/slab reheat furnaces
- Forge furnaces
- Refractory kilns
- BOF door/shields
- Soaking pit seals
- High temperature kilns and furnaces
- Boiler linings
- Furnace door linings and seals
- Glass furnace crown insulation
- Incineration equipment

Duraback®
- Backup for Fiberwall™ lining systems
- Filler for insulating pads
- Expansion joint material

Fibermat™
- Acoustical insulation
- Thermal insulation for external applications
- Insulating pads

PH Blanket
- Catalyst recovery filter in nitric acid production
- Diffusion medium for fluidized beds
- High temperature acoustical insulation
- Filtration and catalyst carrier medium for radioactive particles and hot exhaust gases
- Insulation for gas turbines and jet engines

Moist Pak-D®
- Hot face layer of Fiberfrax® heater, furnace and kiln linings where hot gas velocities exceed 12.2 m/sec (40 ft/sec)
- Hot gas duct, flue and stack linings
- Recuperator linings
- Blow pipe linings
- External and internal pipe insulation
- Reformer header insulation
- Process furnace tube weld protection
- Thermal and corrosion protection of process heater tube supports

Fibermax® Mat
- Expansion joint packing
- Burner wraps
- Batten strips with fiber modules
- High temperature filters
- High vibration areas, i.e. nuclear reactors

Typical Chemical Analysis

	Duraback®	Durablanket® S	Durablanket HP-S	Durablanket 2600
Al_2O_3	31-35%	40%	48.0%	30.5%
SiO_2	50-54%	52%	51.8%	53.5%
ZrO_2	5%	5%	—	16.0%
Fe_2O_3	1.3%	0.6%	0.04%	—
TiO_2	1.7%	1.5%	0.002%	—
MgO	*0.5%	—	0.01%	—
CaO	≤7.5%	—	0.02%	—
Na_2O_3	—	—	0.01%	—
Alkali	—	0.05%	—	—
Leachable Chlorides	—	<10 ppm	<10 ppm	<10 ppm
Other Inorganics	—	0.85%	—	—

*MgO and other trace inorganics

Typical Physical Properties

	Duraback®	Durablanket® S	Durablanket HP-S	Durablanket 2600
Color	White	White	White	White
Continuous Use Limit*	982°C (1800°F)	1260°C (2300°F)	1260°C (2300°F)	1430°C (2600°F)
Melting Point	1648°C (3000°F)	1760°C (3200°F)	1760°C (3200°F)	1760°C (3200°F)
Fiber Diameter	2-4 microns (mean)	2.5-3.5 microns (mean)	2.5-3.5 microns (mean)	3.5 microns (average)
Specific Heat @ 1093°C (2000°F)	1130 J/kg °C (0.27 Btu/lb °F)	1130 J/kg °C (0.27 Btu/lb °F)	1130 J/kg °C (0.27 Btu/lb °F)	1130 J/kg °C (0.27 Btu/lb °F)
Specific Gravity	2.73 g/cm³	2.73 g/cm³	2.73 g/cm³	2.73 g/cm³
Average Tensile Strength (ASTM 686-76)	—	5.5 lb/in² @ 4 PCF 9.9 lb/in² @ 6 PCF 12.5 lb/in² @ 8 PCF	—	—
Available Density				
kg/m³	64	64, 96, 128	64, 96, 128	96, 128
(lb/ft³)	(4)	(4, 6, 8)	(4, 6, 8)	(6, 8)

Typical Chemical Analysis

	PH Blanket	Moist Pak-D®	Fibermat™ Blanket	Fibermax® Mat
Al_2O_3	44%	34.5%	31-35%	72%
SiO_2	51%	62.8%	50-54%	27%
ZrO_2	5%	—	5%	—
Fe_2O_3	—	0.64-0.80%	1.3%	0.02%
TiO_2	—	0.54-1.37%	1.7%	0.001%
MgO	—	—	**0.5%	0.05%
CaO	—	—	≤7.5%	0.05%
Na_2O_3	—	—	—	0.10%
Alkali	—	0.23%	—	—
Leachable Chlorides	<10 ppm	—	<10 ppm	11 ppm
Other Inorganics	—	—	—	—

Typical Physical Properties
PH Blanket

Color:	Tan
Continuous Use Limit*:	1260°C (2300°F)
Melting Point:	1790°C (3260°F)
Fiber Diameter:	
PH Fine:	5 microns (mean)
PH Coarse:	13 microns (mean)
Fiber Length:	Up to approximately 254 mm (10")
Density:	96 kg/m³ (6 lb/ft³)
Binder Content:	3-5%

Typical Physical Properties
Moist Pak-D®

Color:	White
Basic Composition:	Alumina-silica
Recommended Use Limit*:	1093°C (2000°F)
Melting Point:	1790°C (3260°F)
Typical Dry Density:	190-290 kg/m³ (12-18 lb/ft³)
Specific Heat Capacity at 1093°C (2000°F):	1130 J/kg °C (0.27 Btu/lb °F)
Tensile Strength – 6.4 mm (¼"):	Wet = 1.2 x 10⁵ N/m² (17 psi) Dry = 3.5 x 10⁵ N/m² (50 psi)
Hot Gas Erosion Resistance:	Test procedure based on British Gas Council Research Comm. GC173 = over 30.5 m/sec (100 ft/sec)

Normal shelf life one year in unopened containers.

*The continuous use limit of Fiberfrax® insulation is determined by irreversible linear change criteria, not product melting point.
**MgO and other trace inorganics.

Form C-1421
Effective 9/96

Typical Physical Properties
Fibermat™ Blanket

Color:	White
Continuous Use Limit*:	760°C (1400°F)
Fiber Diameter:	2.5-3.5 microns (mean)
Specific Gravity:	2.73 g/cm³
Nominal Weight:	½" thickness = 3.7 oz/ft²
	1" thickness = 7.3 oz/ft²
	2" thickness = 14.7 oz/ft²
Tensile Strength (ASTM 686-76):	7-10 psi (typical)

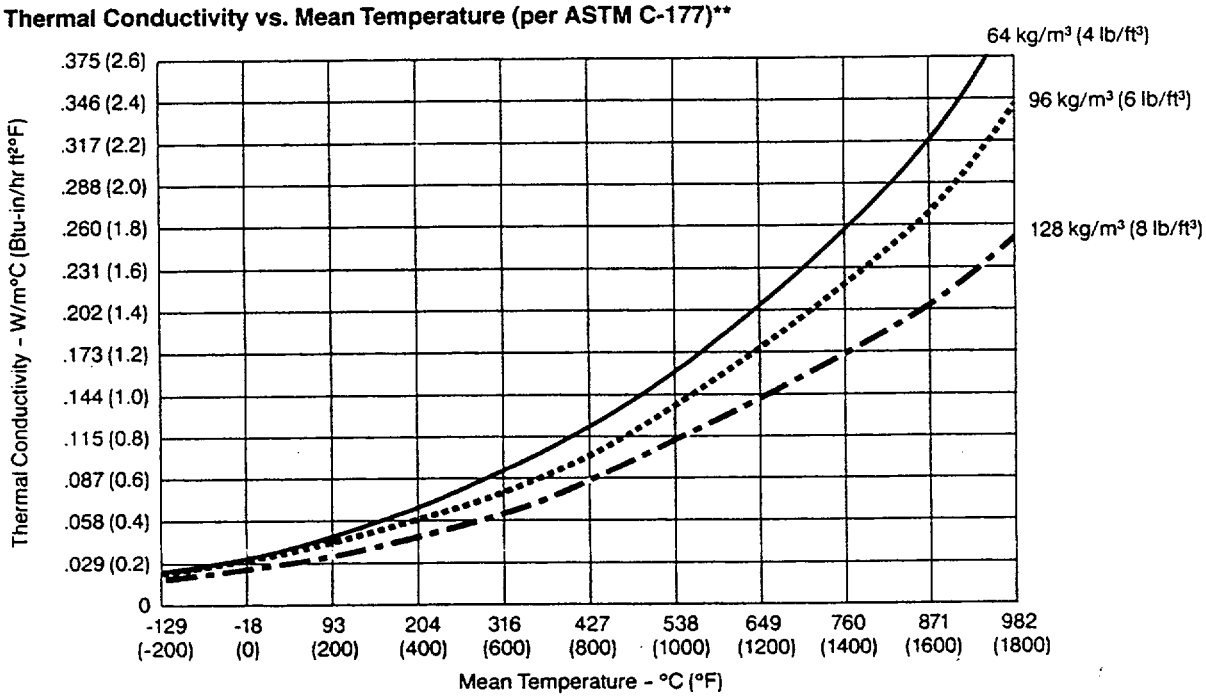
Typical Physical Properties
Fibermax® Mat

Color:	White
Continuous Use Limit*:	1650°C (3000°F)
Melting Point:	1870°C (3400°F)
Fiber Diameter:	2-3.5 microns (mean)
Specific Gravity:	3 g/cm³
Specific Heat Capacity	1246 J/kg °C
at 1093°C (2000°F):	(0.297 Btu/lb °F)
Fiber Surface Area:	7.65 m²/g

Typical Mechanical Properties
Compression Recovery

Percent Compression	Percent Recovery
10	93
30	82
50	71

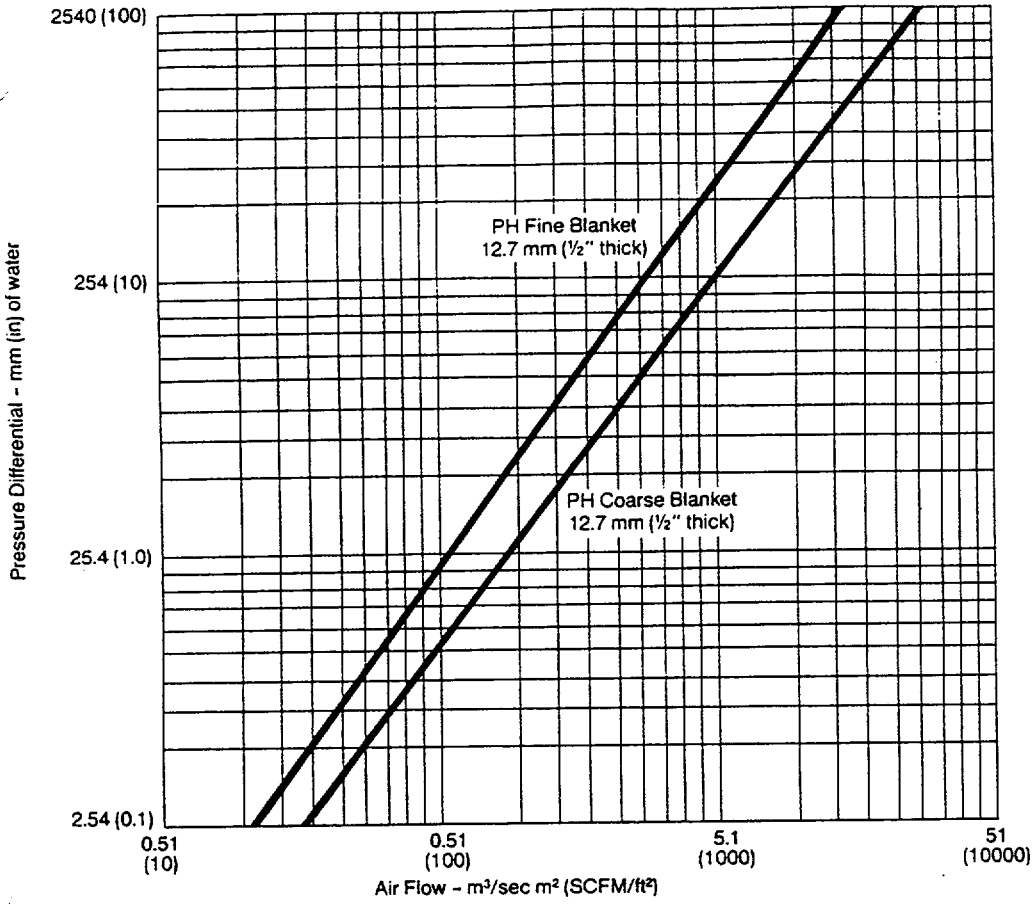
Duraback®
Durablanket® S
Durablanket HP-S
Durablanket 2600
Thermal Conductivity vs. Mean Temperature (per ASTM C-177)**



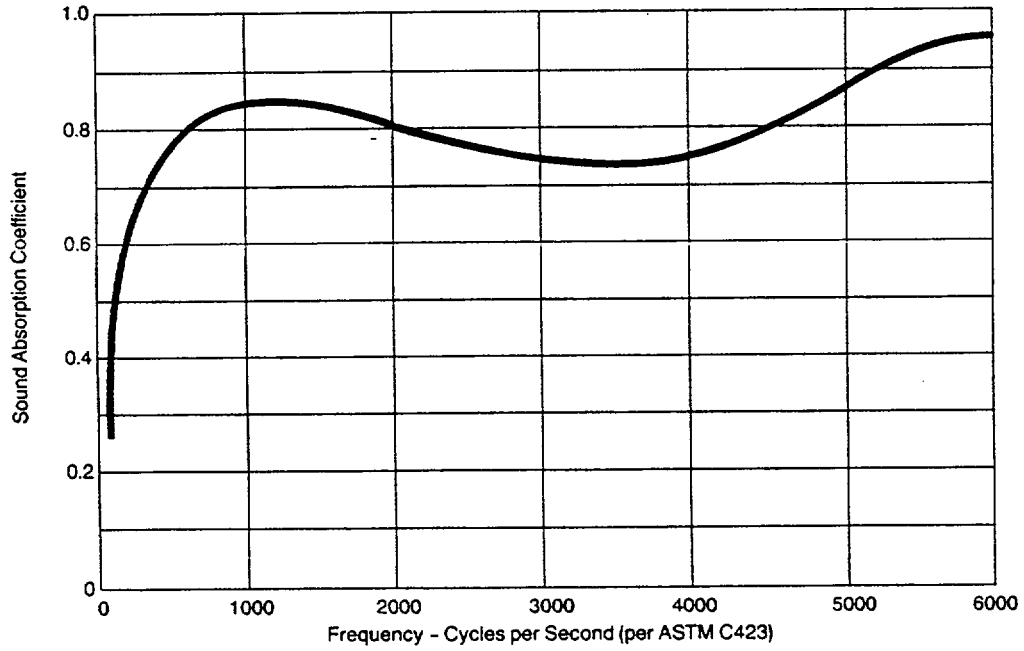
**All heat flow calculations are based on a surface emissivity factor of 0.90, an ambient temperature of 27°C (80°F), and zero wind velocity, unless otherwise stated. All thermal conductivity values for Fiberfrax materials have been measured in accordance with ASTM Test Procedure C-177. When comparing similar data, it is advisable to check the validity of all thermal conductivity values and ensure the resulting heat flow calculations are based on the same condition factors. Variations in any of these factors will result in significant differences in the calculated data.

*The continuous use limit of Fiberfrax® insulation is determined by irreversible linear change criteria, not product melting point.

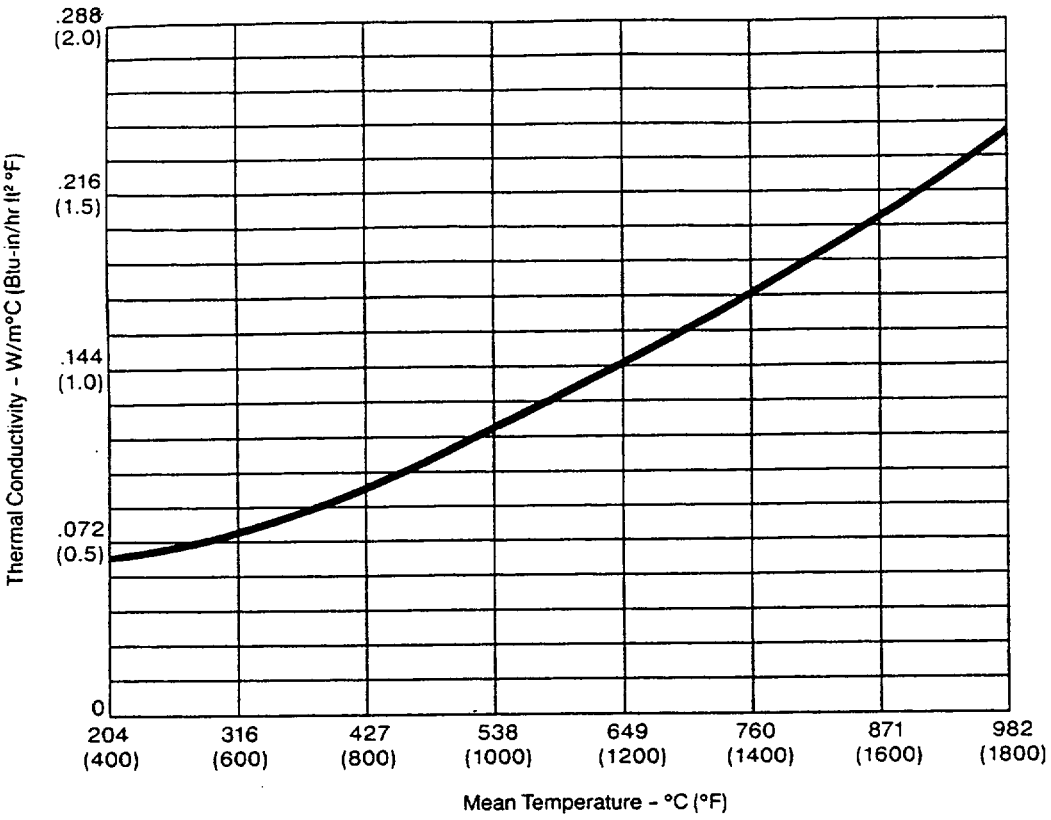
PH Blanket – Air Permeability – 96 kg/m³ (6 lb/ft³) density



PH Fine Blanket – 25 mm (1"), 96 kg/m³ (6 lb/ft³)



Moist Pak-D®
Thermal Conductivity vs. Mean Temperature (per ASTM C-177)*



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Quality Assurance Statement

Omega Point Laboratories, Inc. is an independent, wholly owned company incorporated in the state of Texas, devoted to engineering, inspection, quality assurance and testing of building materials, products and assemblies. The company has developed and implemented a Quality Assurance Program designed to provide its clients with a planned procedure of order and document processing for inspection and testing services it provides to assure conformity to requirements, codes, standards and specifications. The Program is designed to meet the intent of ANSI 45.2 Quality Assurance Program Requirements for Nuclear Power Plants, and complies with the requirements of the ASME Code, SPPE, Military Standards and other less stringent programs. It is the Laboratory's intention to adhere strictly to this Program, to assure that the services offered to its clients remains of the highest quality and accuracy possible.

The overall responsibility of the supervision, operation and coordination of this Quality Assurance Program is that of the Quality Assurance Manager, a person not involved with the performance of the inspection or testing services, and who is under the full time employ of the Laboratory. This individual is responsible for implementing and enforcing all procedures presented in the Quality Assurance Manual and the Procedures Manual. All personnel involved with activities which fall under the scope of this Program are required to cooperate with the letter and intent of this Program.

All QA Surveillance documents remain on file at the Laboratory, and are available for inspection by authorized personnel in the performance of an on-site QA Audit. All materials, services and supplies utilized herein were obtained with appropriate QA Certifications of Compliance, and the inclusion of these in this report would not be practical nor useful to the reader.

OMEGA POINT LABORATORIES

ACCEPTABILITY DOCUMENTATION

PROJECT NO. 14980-106206
Duke Eng. / Duke Power Test Program

The following signatures attest to the review and acceptance of each attribute listed regarding the above-noted project:

I. TEST ITEM ASSEMBLY

C Humphrey — Omega Point Laboratories, Inc. — Date 2/28/00

LS Gosbeck — Duke Engineering Services, Inc. — Date 3/2/00

II. ELECTRICAL CABLE INSTALLATION

C Humphrey — Omega Point Laboratories, Inc. — Date 2/29/00

LS Gosbeck — Duke Engineering Services, Inc. — Date 3/2/00

Omega Point Laboratories, Inc.
16015 Shady Falls Road
Elmendorf, Texas 78112-9784
210-635-8100 / FAX: 210-635-8101 / 800-966-5253
www.opl.com / e-mail: moreinfo@opl.com

III. THERMOCOUPLE INSTALLATION

C Humphrey — 3/2/00
Omega Point Laboratories, Inc. — Date

CS Goodrich — 3/2/00
Duke Engineering Services, Inc. — Date

IV. FIRE PROTECTION BARRIER

[signature] — 3/2/00
Omega Point Laboratories, Inc. — Date

CS Goodrich — 3/2/00
Duke Engineering Services, Inc. — Date

V. FINAL PRE-BURN INSPECTION

[signature] — 3/2/00
Omega Point Laboratories, Inc. — Date

CS Goodrich — 3/2/00
Duke Engineering Services, Inc. — Date

OMEGA POINT LABORATORIES

EVENT LOG

EXPERIMENTAL THREE HOUR FIRE RESISTANCE TEST OF SILICONE FOAM PENETRATION SEAL DESIGNS

PROJECT NUMBERS:

14980-106206

DUKE ENG. / DUKE POWER

Omega Point Laboratories, Inc.
16015 Shady Falls Road
Elmendorf, Texas 78112-9784
210-635-8100 / FAX: 210-635-8101 / 800-966-5253
www.opl.com / e-mail: moreinfo@opl.com

EVENT LOG

DUKE ENG. / DUKE POWER
Client # 14980

NOTE:
This Log is used to document the date and note significant events during the completion of test projects #106206, "Experimental Three Hour Fire Resistance Test of Silicone Foam Penetration Seal Designs". The following is a brief description of this project:

Proj. No. 106206: Three Hour Fire Endurance Test of a concrete slab containing (12) 12" diameter penetrations with either 2" Conduits or Electrical Cabling and (2) 12" X 24" Blockouts with 6" X 12" Cable Trays with Electrical Cables. Penetrations are insulated with various depths of Silicone Foam, with and without Ceramic Damming.

ITEM	DATE	INIT'L
Deg Priest, President of Omega Point Labs, issues Proposal No. P000114-01 to T. Scott Groesbeck of Duke Engineering & Services, Inc.	1/14/00	CH
Drawings for Slab Layout and Rebar Layout are issued by OPL.	1/14	CH
OPL Technicians begin construction on the test assembly frame.	1/24	CH
Duke Eng. approved slab drawings.	1/26	CH
Deg Priest issues Test Plan, Rev. 0A for Project 106206.	1/27	CH
Test frame is verified by OPL QA/QC personnel after completion by OPL Technicians.	1/27	CH
OPL Technicians pour the concrete for the test slab.	1/28	CH
Duke Engineering issues the purchase order for project 106206.	1/31	CH
OPL QA/QC manager verifies project requirements.	1/31	CH
OPL QA/QC personnel order and receive the 2" conduit from supplier.	2/1	CH
The test slab is installed on the furnace to accelerate the	2/3 2/3/00	CH CH

EVENT LOG

DUKE ENG. / DUKE POWER
Client # 14980

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ITEM	DATE	INIT'L
cure time.	2/3/00	CH
Project test slab is removed from the furnace after curing.	2/10	CH
OPC technicians build test article supports.	2/15	CH
Positions of the steel pipes were verified by QA/QC personnel.	2/17	CH
Promatec Technologies personnel arrive at OPC. The following arrived on site:	2/23	CH
Michael Jordan. Foreman		
Frank Haese. Installer		
Promatec technicians cut damming board an install anchor bolts.	2/23	CH
Promatec crew continues cutting damming board. Rev. 0 Test plan issued.	2/24	CH
Cable trays and cables came in from McGuire Nuclear Station, Huntersville, NC.	2/25	CH
Mike Murphy arrives from Promatec to handle QC Documentation	2/28	CH
Scott Goesbeck, Duke Eng arrives at OPC as Client project Mana-	2/28	CH
Electrical cables are cut and installed into the cable trays	2/28 & 2/28	CH CH

EVENT LOG

DUKE ENG. / DUKE POWER
Client # 14980

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ITEM	DATE	INIT'L
by OPC technicians. Overall length of the cable trays and the electrical cables installed in the trays is changed to four feet. Other electrical cable bundles are all in four foot lengths.	2/28/00	CH
Cable trays and cable bundles are installed into the penetrations by OPC technicians and verified by OPC QA/QC.	2/29	CH
Promatec installers cut damming boards and blanket in preparation of foam seal installation.	2/29	CH
Foam seal installation is started in penetrations 5, 6, 7, 8, 9, 10, 11 and 14.	2/29	CH
Penetrations were trimmed level with the slab on penetrations 5, 7 and 8.	3/1	CH
Penetration pipe foam seal is trimmed to be level with the penetration pipe. Penetrations 6, 10, 11 and 14 are trimmed to 1" below top of the penetration pipe. Penetrations 5, 8, 9, 10 and 14 have repair holes that are	3/1/00	CH

EVENT LOG

DUKE ENG. / DUKE POWER
Client # 14980

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ITEM	DATE	INIT'L
cut away to refill with the foam seal material in order to simulate field repairs. Penetration 7 Cable tray has been filled on the back side of the tray with "inacceptable" foam with a ratio of 3 parts of B to 1 part of A foam.	3/1/00	CH
Penetrations 2, 13 and the repair on Penetration 10 were poured beginning at 5:30am.	3/2	CH
Steven and poured the four hour cure penetrations on 3, 4 and 5 CH and the repair on penetration #5	3/2	CH
The pour on the two hour penetrations were begun at 9:12am on penetrations 2, 13 and the repair on #7 by Promatec technicians. OPL QA/QC personnel and Promatec QC witnessed photographed and documented.	3/2	CH
The no cure pour began at 11:30am on items 8, 9 and 14 repairs.	3/2	CH
OPL QA/QC verified thermocouple location after installing the test article on the test furnace.	3/2	CH
Mike Dey OPL Fire Technologist performs the preburn checklist and OPL technicians	3/2 3/2/00	CH CH

EVENT LOG

DUKE ENG. / DUKE POWER
Client # 14980

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ITEM	DATE	INIT'L
attach the test thermocouples to the data acquisition equipment. OPL GA/QC verifies.	3/2/00	CH
On site to witness this three hour fire test of Project #106206 are:	3/2	CH
Peg Priest, Omega Point Labs		
Cookie Humphrey " " "		
Mike Dey " " "		
Jim Motley " " "		
Aleda Patton " " "		
Troy Bronstad " " "		
Ludevico Castañon " " "		
Richard Beasley " " "		
Oscar Estrada " " "		
Cal Banning Duke Engineering		
Scott Groesbeck " "		
Chris Gibson " "		
Brian Murphy " "		
Jeff Suter " "		
Wayne Gregood " "		
Ralph Black Prosmatic Tech		
Charlie Spriggs " "		
Michael Murphy " "		
Mike Jordan " "		
Frank Haase " "		
Denis Spunaker PSE&G		
Ron Erdman OPPD		
Ed Alston Kewaunee Nuclear	3/2/00	CH

EVENT LOG

DUKE ENG. / DUKE POWER
Client # 14980

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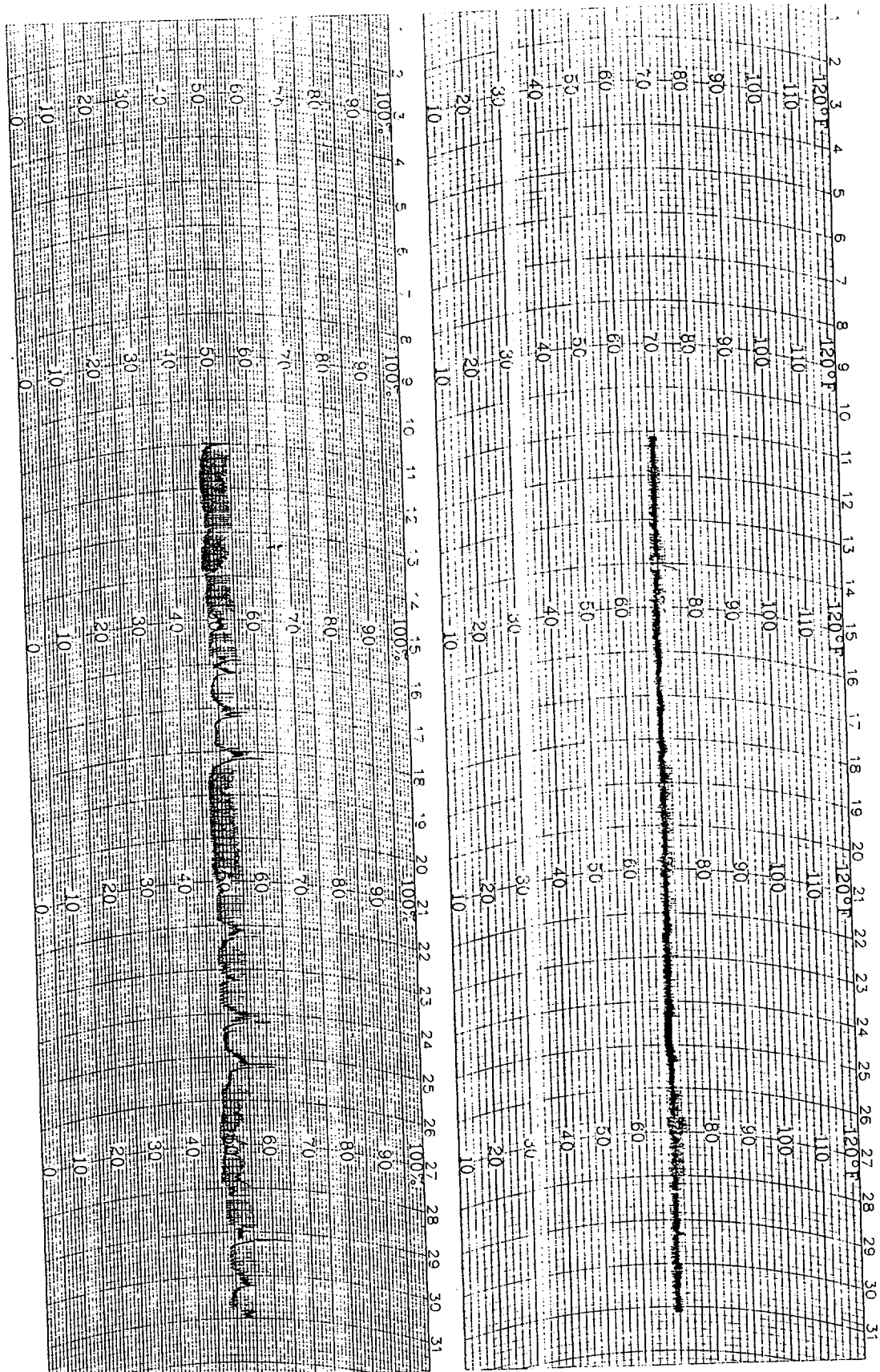
ITEM	DATE	INIT'L
Matt Hogan, Duke Power	3/2/00	CH
Harold Lefkowitz, " "		
Doug Brandes, " "		
James Oldham " "		
This three hour test was followed by a hose stream test using the 30° fog nozzle with a 75 psig from a distance of five feet for five minutes. OPL pressure Gage # 99LE002 was used with cal due date 4/27/00.	3/2	CH
A tear down and inspection of this test article was done by Mike Dey and OPL test technicians.	3/2	CH
- end -		



WeatherMeasure
WEATHERtronics
Division of QUALIMETRICS, Inc.

P.O. BOX 41039
SACRAMENTO, CA. 95841
PHONE: (916) 923-0055

HYGROTHERMOGRAPH
31 DAY

CHART NO. 50208
ECN 2717
3-15-88

STATION "Bldg C" Conditioning Room START ON 2-11-00 DATE OFF 3-11-2000

Q/A RECEIVING REPORT

CLIENT/PROJECT NAME DE+S
CLIENT/PROJECT NUMBER 14980-106206
RECEIVED FROM Pronatec
PROJECT LOCATION Omega Point Labs

REPORT NUMBER 1965A.14980
DATE RECEIVED 2-28-00
DATE INSPECTED 2-28-00
INSPECTED BY: CBatton

ITEM DESCRIPTION	P.O. NO.	QUANTITY Order	Rec'd	B.O.	I.D. NO.	COND MATL Y/N	COND PKG Y/N	CONTAINER INTEGRITY	EXCEPTION	ACCEPTANCE Accept	Hold	Reject	REMARKS
Blanket - Fiber-frax	NA	Q	1 box	Q	28235-7645 210 Ctn#1050	Y	N	Good	None	X			Verification Only
Fiberfrax Duraboard	NA	Q	4 boxes	Q	9355-9361 (739641100)	Y	N	Good	None	X			
New Corning 3645B Silicone RTV FOAM	NA	Q	3	Q	Part A 0000375478A	Y	N	Good	None	X			
"	NA	Q	3	Q	Part B 0000366320B	Y	N	Good	None	X			
"	NA	Q	1	Q	Part A 0000375477A	Y	N	Good	None	X			
"	NA	Q	1	Q	Part B 0000390038B	Y	N	Good	None	X			

FORM
1/29/93

MEGA POINT LABORATORIES

Client Name: DES

Client #: 14980 Project #: 106206

Description: Material shipped from Promatec

Date: 2-18-00

Name: [illegible]

Fiberfrax Blanket - Lot# 28235-7645210 Ctn# 1050 1 box
6 pound weight

Fiberfrax Duraboard 1"x24"x36" 4 boxes
9355-9361 (73964100)

Dow Corning - 3-645B Silicone RTV Foam

Part A - 0000375478A
Part B - 0000366320B
Exp date for both 2-28-2001

Part A - 0000375477A Exp date 2-28-2001

Part B - 0000390038B Exp date 2-28-2001

Q/A RECEIVING REPORT

CLIENT/PROJECT NAME DE+S
CLIENT/PROJECT NUMBER 14980-106206
RECEIVED FROM McGuire Nuclear Station
PROJECT LOCATION Omega Point Labs

REPORT NUMBER 1964 . 14980
DATE RECEIVED 2-25-00
DATE INSPECTED 2-25-00
INSPECTED BY: [illegible]

ITEM DESCRIPTION	P.O. NO.	QUANTITY Order	QUANTITY Rec'd	QUANTITY B.O.	I.D. NO.	COND MATL Y/N	CERT. REQ'D Y/N	CONTAINER INTEGRITY	EXCEPTION	ACCEPTANCE Accept	ACCEPTANCE Hold	ACCEPTANCE Reject	REMARKS
Cable - Control	NA	Q	50'	Q	01051042N	Y	N	Good	None	X			Receiving Verification Only
Cable - Control			50'		01051029N								
Cable - Control			50'		01051022N								
Cable - Control			50'		01051025N								
Cable - Dust			50'		01091065N								
Cable - Dust			50'		1091086								
Cable - Control			50'		01051030N								
Cable - Control			50'		01091085N								
Cable - Dust			50'		01091096N								
Cable - Dust	↓	↓	50'	↓	01050005N	↓	↓	↓	↓	↓			

FORM
1/29/93

OMEGA POINT LABORATORIES

Client Name: DES

Client #: 14980 Project #: 106206

Description: Cables from McGuire

Page: _____ of 170

Date: 2-28-00

Name: Patton

le Cable - Description

- 01051029N - 8 copper
- 01051022N - 12 copper white jacket
- 01051025N - 19 copper
- 01051042N - 3 large 3 small white jackets
- 1091086 - 1 black, 1 white, several small
- 01091085N - galv jacket - 12/8 copper
- 01050005N - galv jacket - 3 copper - 1 red - 1 wht - several small
- 01091065N - 4 white, 4 black, 3 sets of several small
- 01051030N - galv jacket - 8 white
- 01091096N - 1 wht - 1 black - several small copper · galv

54

200

RECIPIENT: PEEL HERE

FedEx FedEx Tracking Number 815925091270

SNA22

Form I.D. No. 0215 Recipient's Copy

1 From This portion can be removed for Recipient's records.

Date 2/23/00 FedEx Tracking Number 815925091270

Sender's Name Toni Woodward Phone 704 875-4794

Company MCGUIRE NUCLEAR STATION

Address 13225 HAGERS FERRY RD

Dept./Floor/Suite/Room

City HUNTERSVILLE State NC ZIP 28078

2 Your Internal Billing Reference 7376 GOAG R&D 1075N0228 1075N0238

3 To

Recipient's Name Phone 800 966-5253

Company Omega Point Laboratories, Inc

Address 16015 Shady Falls Road

We cannot deliver to P.O. boxes or P.O. ZIP codes. Dept./Floor/Suite/Room

To "HOLD" at FedEx location, print FedEx address here.

City Elmendorf State TX ZIP 78112-9784

8159 2509 1270

0115417315

4a Express Package Service — Packages up to 150 lbs. Delivery commitment may be later in some areas.

- ☐ FedEx Priority Overnight — Next business morning
- ☐ FedEx Standard Overnight — Next business afternoon
- ☐ FedEx First Overnight — Earliest next business morning delivery to select locations
- ☐ FedEx 2Day* — Second business day
- ☐ FedEx Express Saver* — Third business day

* FedEx Letter Rate not available. Minimum charge: One-pound rate

4b Express Freight Service — Packages over 150 lbs. Delivery commitment may be later in some areas.

- ☐ FedEx 1Day Freight* — Next business day
- ☑ FedEx 2Day Freight — Second business day
- ☐ FedEx 3Day Freight — Third business day

* Call for Confirmation: _____

5 Packaging — * Declared value limit $500

- ☐ FedEx Letter*
- ☐ FedEx Pak*
- ☑ Your Pkg. — Includes FedEx Box, FedEx Tube, and customer pkg.

6 Special Handling

- ☐ Saturday Delivery — Available for FedEx Priority Overnight and FedEx 2Day to select ZIP codes
- ☐ Sunday Delivery — Available for FedEx Priority Overnight to select ZIP codes
- ☐ HOLD Weekday at FedEx Location — Not available with FedEx First Overnight
- ☐ HOLD Saturday at FedEx Location — Available for FedEx Priority Overnight and FedEx 2Day to select locations

Does this shipment contain dangerous goods? One box must be checked.

- ☑ No
- ☐ Yes — As per attached Shipper's Declaration
- ☐ Yes — Shipper's Declaration not required
- ☐ Dry Ice — Dry Ice, 9, UN 1845 _____ kg
- ☐ Cargo Aircraft Only

Dangerous Goods cannot be shipped in FedEx packaging.

7 Payment Bill to: Enter FedEx Acct. No. or Credit Card No. below.

- ☑ Sender — Acct. No. in Section 1 will be billed.
- ☐ Recipient
- ☐ Third Party
- ☐ Credit Card
- ☐ Cash/Check

Total Packages: 2 Total Weight: 1500 Total Charges

Credit Card Auth.

†Our liability is limited to $100 unless you declare a higher value. See the *FedEx Service Guide* for details.

8 Release Signature — *Sign to authorize delivery without obtaining signature.*

By signing you authorize us to deliver this shipment without obtaining a signature and agree to indemnify and hold us harmless from any resulting claims.

Questions? Call 1-800-Go-FedEx® (800-463-3339)

Visit our Web site at www.fedex.com

Rev. Date 11/98 Part #154813G© 1994-98 FedEx PRINTED IN U.S.A. GBFE 9/99

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Q/A RECEIVING REPORT

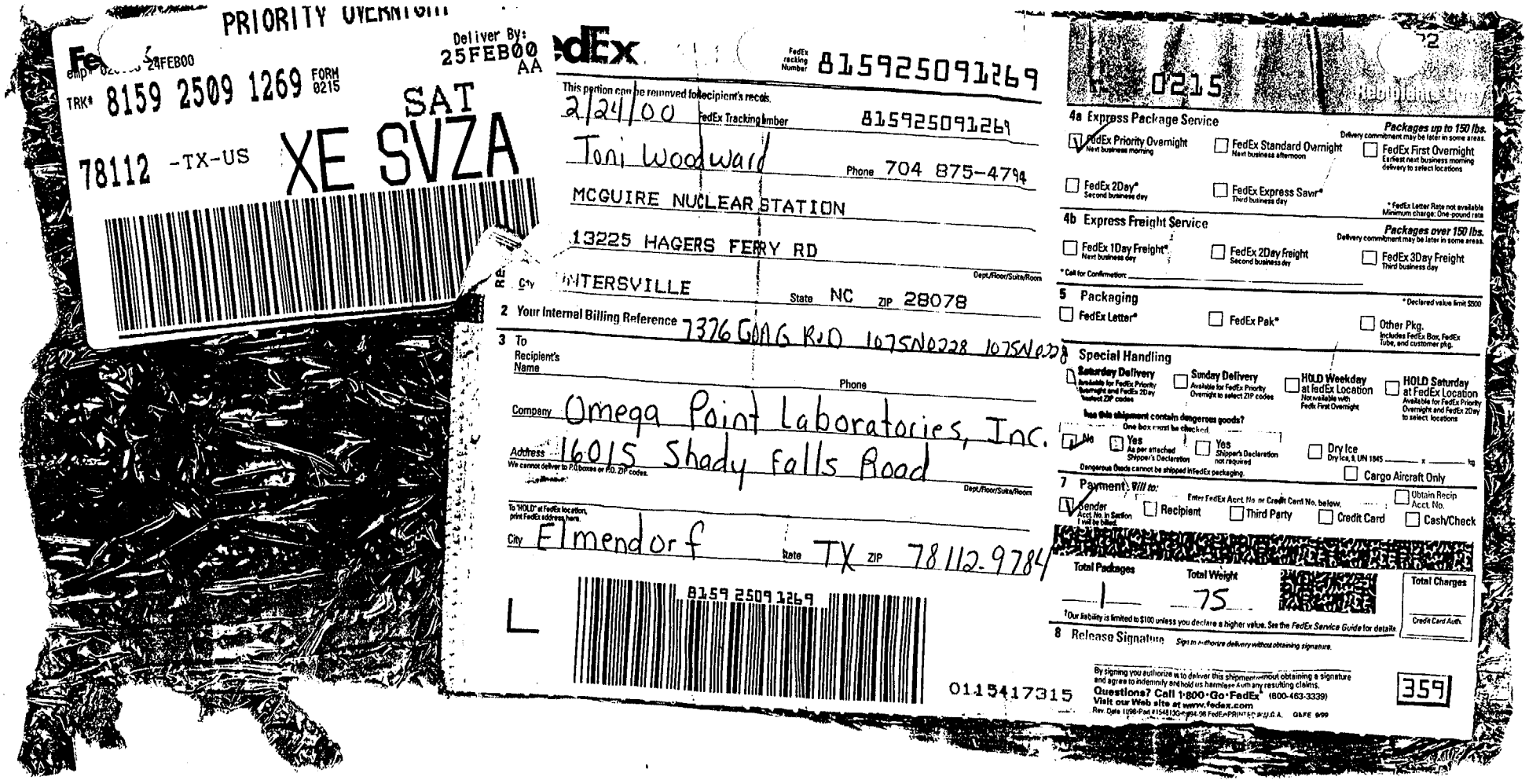
CLIENT/PROJECT NAME DE&S
CLIENT/PROJECT NUMBER 14980-106206
RECEIVED FROM McGuire Nuclear Station
PROJECT LOCATION Omega Point Labs

REPORT NUMBER 1963 - 14980
DATE RECEIVED 2-25-00
DATE INSPECTED 2-25-00
INSPECTED BY: [illegible]

ITEM DESCRIPTION	P.O. NO.	QUANTITY			I.D. NO.	COMM MAIL Y/N	CERT. REQ'D Y/N	CONTAINER INTEGRITY	EXCEPTION!	ACCEPTANCE			REMARKS
		Order	Rec'd	B.O.						Accept	Hold	Reject	
Cable trays 4'X12"	NA	0	3	0		Y	N	Good	None	X			Receiving only

FORM
1/29/93

172



PRIORITY OVERNIGHT

Deliver By:
25FEB00
AA

24FEB00

TRK# 8159 2509 1269 FORM 0215

SAT

78112 -TX-US

XE SVZA

FedEx tracking Number 815925091269

This portion can be removed for recipient's records.

2/24/00 FedEx Tracking Number 815925091269

Toni Woodward Phone 704 875-4794

MCGUIRE NUCLEAR STATION

13225 HAGERS FERRY RD

Dept/Floor/Suite/Room

City HUNTERSVILLE State NC ZIP 28078

2 Your Internal Billing Reference 7376 GONG RD 1075N0228 1075N0228

3 To
Recipient's Name

Phone

Company Omega Point Laboratories, Inc.

Address 16015 Shady Falls Road

We cannot deliver to P.O. boxes or P.O. ZIP codes.

Dept/Floor/Suite/Room

To "HOLD" at FedEx location, print FedEx address here.

City Elmendorf State TX ZIP 78112-9784

8159 2509 1269

0115417315

4a Express Package Service

Packages up to 150 lbs.
Delivery commitment may be later in some areas.

- [x] FedEx Priority Overnight — Next business morning
- [ ] FedEx Standard Overnight — Next business afternoon
- [ ] FedEx First Overnight — Earliest next business morning delivery to select locations
- [ ] FedEx 2Day* — Second business day
- [ ] FedEx Express Saver* — Third business day

* FedEx Letter Rate not available. Minimum charge: One-pound rate

4b Express Freight Service

Packages over 150 lbs.
Delivery commitment may be later in some areas.

- [ ] FedEx 1Day Freight* — Next business day
- [ ] FedEx 2Day Freight — Second business day
- [ ] FedEx 3Day Freight — Third business day

* Call for Confirmation:

5 Packaging

* Declared value limit $500

- [ ] FedEx Letter*
- [ ] FedEx Pak*
- [ ] Other Pkg. — Includes FedEx Box, FedEx Tube, and customer pkg.

6 Special Handling

- [ ] Saturday Delivery — Available for FedEx Priority Overnight and FedEx 2Day to select ZIP codes
- [ ] Sunday Delivery — Available for FedEx Priority Overnight to select ZIP codes
- [ ] HOLD Weekday at FedEx Location — Not available with FedEx First Overnight
- [ ] HOLD Saturday at FedEx Location — Available for FedEx Priority Overnight and FedEx 2Day to select locations

Does this shipment contain dangerous goods?
One box must be checked.

- [x] No
- [ ] Yes — As per attached Shipper's Declaration
- [ ] Yes — Shipper's Declaration not required
- [ ] Dry Ice — Dry Ice, 9, UN 1845 ____ x ____ kg

Dangerous Goods cannot be shipped in FedEx packaging.

- [ ] Cargo Aircraft Only

7 Payment Bill to:

Enter FedEx Acct. No. or Credit Card No. below.

- [x] Sender — Acct. No. in Section 1 will be billed
- [ ] Recipient
- [ ] Third Party
- [ ] Credit Card
- [ ] Cash/Check
- [ ] Obtain Recip Acct. No.

Total Packages	Total Weight	Total Charges
1	75	

Credit Card Auth.

†Our liability is limited to $100 unless you declare a higher value. See the FedEx Service Guide for details.

8 Release Signature — Sign to authorize delivery without obtaining signature.

By signing you authorize us to deliver this shipment without obtaining a signature and agree to indemnify and hold us harmless from any resulting claims.

Questions? Call 1-800-Go-FedEx® (800-463-3339)
Visit our Web site at www.fedex.com

Rev. Date 10/98 Part #154130 ©1994-98 FedEx PRINTED IN U.S.A. GBFE 9/99

359

Q/A RECEIVING REPORT

CLIENT/PROJECT NAME DE&S
CLIENT/PROJECT NUMBER 14980-106206
RECEIVED FROM Toltec
PROJECT LOCATION Omega Point Labs

REPORT NUMBER 1956.14980
DATE RECEIVED 2-1-00
DATE INSPECTED 2-1-00
INSPECTED BY: D Dalton

ITEM DESCRIPTION	P.O. NO.	QUANTITY			I.D. NO.	COND MATL Y/N	CERT. REQ'D Y/N	CONTAINER INTEGRITY	EXCEPTION	ACCEPTANCE			REMARKS
		Order	Rec'd	B.O.						Accept	Hold	Reject	
2" Pipe	123430	42'	42'	0	2"BPSCH40X21'	Y	Y	Good	None	X			

FORM
1/29/93

OMEGA POINT LABORATORIES
16015 SHADY FALLS RD.
ELMENDORF, TEXAS 78112
PH. (210) 635-8100
FAX (210) 635-8101

PURCHASE ORDER
12343 Q

Date: 2/1/00
Page: 1 of 1

Order From: Toltec Steel
5390 Dietrich Rd.
San Antonio
TX 78219
(210) 661-4672

Deliver to: Omega Point Laboratories, Inc
16015 Shady Falls Road
Elmendorf
TX 78112
(210) 635-8100

Vendor No: 0162

Your Item Number / Item Description	Our Reference	Qty Ordered	Units	Unit Cost	Extension
2" BP SCH 40x21'	001	42.0	Feet	$37.485	$74.97

"See Special Instructions Regarding Purchasing Specifications for Quality Assurance Requirements."
QA Approval C Patton
Date 2-1-00

Please Quote Purchase Order Number on all correspondence.

Special Instructions: **Please include Certificate of Compliance to applicable standards and Mill Test.**

Subtotal:	$74.97
Freight:	0.00
Tax Amount:	5.81
Total Value:	$80.78

* * * * * * * * * * * * * * * * *
* S A L E S O R D E R 55507 *
* * * * * * * * * * * * * * * * *

TOLTEC STEEL PRODUCTS, INC.
5390 DIETRICH
SAN ANTONIO, TX 78219

DELIVER PICKING TICKET

BILL TO: 000177
OMEGA POINT LABORATORIES

16015 SHADY FALLS
ELMENDORF, TEXAS 78112

SHIP TO:
OMEGA POINT LABORATORIES

16015 SHADY FALLS
ELMENDORF, TEXAS 781120000

PURCHASE ORDER: 12343Q
PLACED BY: CLETA
TELEPHONE #: (210) 635-8100
SHIP VIA:
COMMENTS:

ORDER DATE: 2/01/00
REQUEST DATE: 2/01/00
SALESMAN: KEITH CUNNINGHAM

LINE	ORDER QTY	SHIP QTY	COD PART NUMBER	DESCRIPTION	WEIGHT	UNIT COST	EXTEND COST
1	2	2	PIP 28PEX21	2 BPS SCH-10 X 21'	153	140.40	58.97
2	0	0		CUT 4PCS 58"	0	8.00	8.00
3	0	0		CUT 4PCS 60"	0	8.00	8.00
4	0	0		MILL CERTS.	0	.00	.00

TOTAL WEIGHT: 153 LBS

RECEIVED BY: Richard Bailey

NET BEFORE TAX	74.97
TAX.....	5.81
GRAND TOTAL...	80.78

TUBERIA NACIONAL

Villacero

CERTIFICATE OF QUALITY

2" STD.
API 5L-A
BLACK PLAIN END PIPE

CUSTOMER/CLIENTE [redacted]. DATE/ FECHA 08/12/99

INVOICE/FACTURA: 8487

MANUFACTURER / PLANTA : TUBERIA NACIONAL, S.A. DE C.V.
DIEGO DIAZ DE BERLANGA, NO. 1002 SUR
SAN NICOLAS DE LOS GARZA, NUEVO LEON, MEXICO

I HEREBY CERTIFY THAT THE PRODUCT ACCOMPILSHED WITH THE SPECIFICATION TO THE INVOICE AND/OR REMISSION (DATABASE OF SYSTEM SUPERCEP) .
ESTE PRODUCTO FUE FABRICADO BAJO LA NORMA QUE SE DESCRIBE HACIENDO CUMPLIR LOS REQUERIMIENTOS DE LA ESPECIFICACION (BASE DE DATOS DEL SISTEMA).

MEASUREMENT DIMENSIONAL OF PRODUCT
DIMENSION REAL VERIFICADA EN EL PRODUCTO

Fecha de Elaborac	Turno	Oper	Order #OP	Diam. (in)	Cara1 (in)	Cara2 (in)	Thickness Esp. (in)	Length Largo
29/11/99	1	RRV	201	2.375			0.154	42.000

Number Ident.	%C	%Mn	%P	%S	%Si	YS (Psi)	TS (Psi)	%Elong	HYD TEST (Psi)
298273	0.0910	0.3750	0.0120	0.0090	0.0090	55.793	58.782	25.00	2300

I HAVE PERSONAL KNOWLEDGE AS TO ACCURANCY OF THE ABOVE INFORMATION, AND HAVE AUTHORITY TO SIGN ON BEHALF OF THE COMPAÑY.
TENGO EL CONOCIMIENTO Y AUTORIZACION EN NOMBRE DE LA COMPAÑIA PARA AVALAR ESTA INFORMACION.

S I N C E R E L Y
A T E N T A M E N T E

ASEGURAMIENTO DE CALIDAD
QUALITY ASSURANCE

TUBERIA NACIONAL, S.A. DE C.V.
DIEGO DIAZ DE BERLANGA No. 1002 SUR, SAN NICOLAS DE LOS GARZA, N.L. C.P. 66480
TELS. (8) 351-08-07 / 351-82-82, Y 351-06-07 FAX (8) 351-60-50 / 351-34-01 Y 351-73-52

5L0284 E156557 FM36854 ISO-9002

ATTN: Cleta

TUBERIA NACIONAL

Villacero

CERTIFICATE OF QUALITY

2" STD.
API 5L-A
BLACK PLAIN END PIPE

CUSTOMER/CLIENTE [redacted]. DATE/ FECHA 08/12/99

INVOICE/FACTURA: 8487

MANUFACTURER / PLANTA : TUBERIA NACIONAL, S.A. DE C.V.
DIEGO DIAZ DE BERLANGA, NO. 1002 SUR
SAN NICOLAS DE LOS GARZA, NUEVO LEON, MEXICO

I HEREBY CERTIFY THAT THE PRODUCT ACCOMPILSHED WITH THE SPECIFICATION TO THE INVOICE AND/OR REMISSION (DATABASE OF SYSTEM SUPERCEP) .
ESTE PRODUCTO FUE FABRICADO BAJO LA NORMA QUE SE DESCRIBE HACIENDO CUMPLIR LOS REQUERIMIENTOS DE LA ESPECIFICACION (BASE DE DATOS DEL SISTEMA).

MEASUREMENT DIMENSIONAL OF PRODUCT
DIMENSION REAL VERIFICADA EN EL PRODUCTO

Fecha de Elaborac	Turno	Oper	Order #OP	Diam. (in)	Cara1 (in)	Cara2 (in)	Thickness Esp. (in)	Length Largo
29/11/99	1	RRV	201	2.375			0.154	42.000

Number Ident.	%C	%Mn	%P	%S	%Si	YS (Psi)	TS (Psi)	%Elong	NO TEST (Psi)
298273	0.0910	0.3750	0.0120	0.0090	0.0090	55.793	58.782	25.00	2300

I HAVE PERSONAL KNOWLEDGE AS TO ACCURANCY OF THE ABOVE INFORMATION, AND HAVE AUTHORITY TO SIGN ON BEHALF OF THE COMPAÑY.
TENGO EL CONOCIMIENTO Y AUTORIZACION EN NOMBRE DE LA COMPAÑIA PARA AVALAR ESTA INFORMACION.

S I N C E R E L Y
A T E N T A M E N T E

ASEGURAMIENTO DE CALIDAD
QUALITY ASSURANCE

TUBERIA NACIONAL, S.A. DE C.V.
DIEGO DIAZ DE BERLANGA No. 1002 SUR, SAN NICOLAS DE LOS GARZA, N.L. C.P. 66450
TELS. (8) 351-06-07 / 351-82-82, Y 351-06-07 FAX (8) 351-60-50 / 351-34-01 Y 351-73-62

API 5L0284 UL E156567 [redacted] ISO-9002

Q/A REC /ING REPORT

CLIENT/PROJECT NAME Omega Point Labs
CLIENT/PROJECT NUMBER OPL Equipment
RECEIVED FROM Rothe
PROJECT LOCATION Omega Point Labs

REPORT NUMBER 1895 - OPL
DATE RECEIVED 5-14-99
DATE INSPECTED 5-14-99
INSPECTED BY: D Bottino

ITEM DESCRIPTION	P.O. NO.	QUANTITY Order	Rec'd	B.O.	I.D. NO.	COND MATL Y/N	CERT. RECD Y/N	CONTAINER INTEGRITY	EXCEPTIONS	ACCEPTANCE Accept	Hold	Reject	REMARKS
0-100psi Pressure Gage	118640	1	1	0	SN: 99LE001	Y	Y	Good	None	X			Calibration Service
0-100psi Pressure Gage	118640	1	1	0	SN: 99LE002	Y	Y	Good	None	X			
0-100psi Pressure Gage	118640	1	1	0	SN: 98LE001	Y	Y	Good	None	X			

FORM
1/29/93

OMEGA POINT LABORATORIES
16015 SHADY FALLS RD.
ELMENDORF, TEXAS 78112
PH. (210) 635-8100
FAX (210) 635-8101

PURCHASE ORDER
11864Q

180

Date: 4/15/99
Page: 1 of 1

Order From: Rothe Develoment Inc.
4614 Sinclair Road
San Antonio
TX 78222
210-648-3131

Deliver to: Omega Point Laboratories, Inc
16015 Shady Falls Road
Elmendorf
TX 78112
(210) 635-8100

Vendor No: 0161

Your Item Number / Item Description	Our Reference	Qty Ordered	Units	Unit Cost	Extension
0-100 psi Pressure Gage SN: 99LE001	001	1.00	Each	$44.00	$44.00
0-100 psi Pressure Gage SN: 99LE002	002	1.00	Each	$44.00	$44.00
'00 psi Pressure Gage 98LE001	003	1.00	Each	$44.00	$44.00

"See Special Instructions Regarding Purchasing Specifications for Quality Assurance Requirements."
QA Approval [signature]
Date 4-15-99

CALIBRATION CERT. REQUIREMENTS1.
Statement of NIST traceability
2. NIST test or I.D. number
3. As Found
4. As Left Values
5. Uncertainties of calibration measurements
6. Calibration data

ase Quote Purchase Order Number on all correspondence.

Special Instructions:
Please provide calibration services per attached Vendor Purchasing Specification and QA Requirements

Subtotal:	$132.00
Freight:	0.00
Tax Amount:	0.00
Total Value:	$132.00

080625

VENDOR PURCHASING SPECIFICATION AND QUALITY ASSURANCE REQUIREMENTS

Vendor Rutile

Purchase Order No. 118640

Any or all of the following Quality Assurance requirements shall be incorporated as conditions to this procurement when corresponding box is marked. Failure to comply with any requirement specified herein may result in rejection and/or return of shipment at seller's expense.

1.0 QUALITY PROGRAM

☒ Seller shall furnish all items on this Purchase Order in accordance with Quality Program approved by Buyer.

2.0 QUALITY VERIFICATION

When additional quality verification activities are required as a condition to this procurement, invoices will not be paid until satisfactory completion of such activities. Excessive rejection rates may result in removal from buyer's Approved Vendors List.

☒ Receiving Inspection - Buyer shall inspect items upon receipt to verify compliance with purchase order requirements. Rejected items shall be returned at seller's expense.

☐ Independent Laboratory Tests - Samples of materials furnished shall be tested independently for conformance to specification requirements prior to final acceptance. Rejected materials shall be returned at seller's expense.

☒ Document Review - Final acceptance shall be based on satisfactory review of required certifications and other supporting documents.

3.0 CERTIFICATIONS

When certifications are required as a condition to this procurement, the seller shall furnish one reproducible copy either with or prior to each shipment. Shipments will not be accepted and invoices will not be paid until certifications are in buyer's possession.

PURCHASING SPECIFICATIONS
PAGE 2 OF 3

VENDOR Rothe
PURCHASE ORDER NO. 118640

☐ Certificate of Compliance/Conformance Required - Certification that materials and/or services comply with purchase order requirements. Certification shall reference purchase order number and traceability numbers (when applicable).

☐ Certified Test Report Required - Certification that material complies with applicable material specification(s) and the purchase order. Include actual results of required tests.

☒ Certificate of Calibration Required - Certification shall be traceable to National Bureau of Standards. (Renamed NIST, Nat. Institute of Science & Technology)

4.0 AUDITS/RIGHT OF ACCESS

☒ The buyer reserves the right to audit your facility to verify compliance with purchase order, code and specification requirements with minimum of ten (10) days notice.

☒ Shipments shall only originate from facilities approved by the buyer.

☐ Buyer reserves the right to inspect any or all work included in this order at seller's facility with as early notice as practicable.

5.0 IDENTIFICATION

☐ Seller shall identify each item with a unique traceability number by physical marking or tagging. Traceability numbers shall be traceable to certifications and packing lists.

☒ Seller shall identify each container with a unique identification number. The identification number shall be traceable to certifications and packing lists.

6.0 10 CFR, PART 21

☐ The material, equipment and/or services to be furnished under the provisions of this purchase order are involved in the testing of basic components of a Nuclear Regulatory Commission (NCR) licensed facility. Accordingly, the seller is subject to the provisions of 10 CFR, Part 21 (Reporting of Defects and Non-compliance)

PURCHASING SPECIFICATIONS
PAGE 3 OF 3

VENDOR Rothe
PURCHASE ORDER NO. 118640

7.0 PACKING/SHIPPING

☒ All materials shall be packaged in air tight, moisture free containers and shall be free from all foreign substances such as dirt, oil, grease or other deleterious material.

☐ All materials and equipment shall be suitably crated, boxed or otherwise prepared for shipment to prevent damage during handling and shipping. Wherever practical, equipment shall be palletized for ease of unloading and storage at destination. each container shall be clearly marked with buyer's purchase order number.

QUALITY ASSURANCE APPROVAL D Fuller DATE 4-15-99

Rothe Development, Inc. 4614 Sinclair Road San Antonio, Texas 78222
METROLOGY SERVICES DIVISION TRACEABLE TO NIST (210)648-3131 Fax (210)648-4091

184

CHARGE # 107 CONTROL # 556 - 26672 WORK ORDER # 71579

RECEIVED FROM: Omega Point Laboratories
ADDRESS: 10013 Shady Falls Road
Elmendorf, TX 78112-9794
DATE: 04/20/1999
PHONE #: 635-2100
FAX #: 635-2101

CONTACT NAME: Ms. Cleda Patton
PURCHASE ORDER #: 119643

ITEM
MFG: McDaniel
MODEL: 0-100 PSI
NOMEN: Gauge
S/N: 95LE001
CUST ID: 95LE001
ACCESS
RCVD:

Need Manual

CUSTOMER COMMENTS/REQUIREMENTS:

OUR PO:

DATA: BEFORE & AFTER DATA REQUIRED

RECEIVED:
( ) IN TOLERANCE
( ) OUT OF TOLERANCE
( ) INOPERATIVE

RETURNED:
(X) IN TOLERANCE
( ) LIMITED CALIBRATION
( ) REPAIR ONLY
( ) NO ACTION DATA

CALIBRATION INTERVAL: 12mos.
CAL DATE: 4/27/99
DUE DATE: 4/27/00

CAL'D AT:
(X) RDMSD
( ) ON-SITE
( ) SUB

ENVIRONMENTAL CONDITIONS:
78 °F
47 %RH

SPECIFICATIONS:
( ) MFG
( ) RDMSD:
(X) OTHER: ± mesa +/- 3PSI

PROCEDURE:
( ) MFG
( ) RDMSD:
(X) OTHER: NAVAIR 17-20MP-41

RDMSD TECH: SAR

SERVICE CODE: 5

RESULT/SYMPTOM:

WORK PERFORMED: calibrated

P#'S: 261

LIMITED CALIBRATION:

COMMENTS:

QTY	PART #	DESCRIPTION	COST	REPAIR LABOR HOURS:		
				PARTS TOTAL		
				REPAIR LABOR		
				SHIPPING		
				TEAR DOWN CHARGE		
				CALIBRATION	11	00
				TAX 7.750%	3	41
				TOTAL	47	41

INITIA: DATE:

RDMSD 2002

RCVD BY
(SIGNED): (PRINTED):

CERT. NUMBER: 58175 185

ROTHE DEVELOPMENT, INC.

METROLOGY SERVICES DIVISION

4614 SINCLAIR RD., SAN ANTONIO, TEXAS 78222 PH:210-648-3131

CERTIFICATE OF CALIBRATION

ISSUED TO: Omega Point Laboratories
16015 Shady Falls Road
Elmendorf, TX 78112-9784
635-8100

MFG: McDaniel
MODEL: 0-100 PSI
NOMEN: Gauge
S/N: 98LE001
CUST. ID: 98LE001

CAL DATE: 04/27/1999
DUE DATE: 04/27/2000

CONTROL NO.: 556 - 26672
TECHNICIAN: 2
SPECIFICATIONS: OMEGA +/-3PSI
PROCEDURE: NAVAIR 17-20MP-41
WORK ORDER: 71670
CUSTOMER P.O.: 118640
RECEIVED CONDITION: IN TOLERANCE
RETURNED CONDITION: IN TOLERANCE

CALIBRATION PERFORMED AT: RDMSD
CALIBRATION INTERVAL: 12mos.
TEMPERATURE: 68 °F
RELATIVE HUMIDITY: 47 %

DATE RECEIVED: 04/20/1999

COMMENTS:

ATTACHMENTS: CALIBRATION DATA

Calibrations performed at Rothe Development, Inc. Metrology Services Division meet the requirements of ANSI/NCSL Z540-1-1994, ISO/IEC GUIDE 25, and ISO 10012-1, and are traceable to the National Institute of Standards and Technology. The collective uncertainty of the measurement(s) does not exceed 25% (TUR≥4:1) of the instrument specification(s) unless noted in the COMMENTS section.

TR#	MFG	MODEL	SERIAL NO.	DUE DATE
261	HEISE	ATS2000	ATS-10521	04/28/1999

Calibration Certificate Acceptance

Item 0-100psi Pressure Gage
SN 98-LE001

	Q/A	Eng.
NIST Traceability Adequate		ES
As Found/As Left Values		ES
Calibration Data Sufficient		ES
Tolerance Range Adequate		ES
Date of Review:	5/14/99	5/14/99

OPL QA/QC Dept. Eng./ Dept. Mgr.

APPROVED BY: _____ ☒ CMS ☐ QCO DATE: 05/13/1999

ROTHE DEVELOPMENT METROLOGY SERVICES

CALIBRATION DATA: PRESSURE GAUGE

CUSTOMER: Omega Point Lab
WO NUMBER: 71670
SERIAL:
CUST ID: 98LE001

DATE: 4/27/99
TECH: Sam
INST NO: 26672

CALIBRATION DATA TAKEN
INCOMING X
OUTGOING X

CONDITION OF EQUIPMENT
IN TOLERANCE X
OUT OF TOLERANCE

MANUFACTURER McDaniel

RANGE 0-100 PSI

ACCURACY +/- 3 PSI

GAUGE PRESSURE	STANDARD READING
10	9.89
30	30.09
50	50.30
70	70.63
95	95.86

Rothe Development, Inc. 4614 Sinclair Road San Antonio, Texas 78222
METROLOGY SERVICES DIVISION TRACEABLE TO NIST (210)648-3131 Fax (210)648-4091

187

CHARGE # 107 CONTROL # 556 - 28820 WORK ORDER # 71668

RECEIVED FROM: Omega Point Laboratories
DATE: 04/20/1999
PHONE #: 635-8100
FAX #: 635-8101
ADDRESS: 16015 Shady Falls Road
Elmendorf, TX 78112-9794

CONTACT NAME: Ms. Cleda Patton
PURCHASE ORDER #: 119610

ITEM
MFG: McDaniel
MODEL: 0-100 PSI
NOMEN: Gauge
S/N: 99LE001
CUST ID: 99LE001
ACCESS
RCVD:
***** Need Manual *****

TOMER COMMENTS/REQUIREMENTS:
A: BEFORE & AFTER DATA REQUIRED

OUR PO:

EIVED:
IN TOLERANCE
OUT OF TOLERANCE
INOPERATIVE

RETURNED:
(X) IN TOLERANCE
( ) LIMITED CALIBRATION
( ) REPAIR ONLY
( ) NO ACTION Data

CALIBRATION INTERVAL: 12 mos.
CAL DATE: 4/27/99
DUE DATE: 4/27/00

CAL'D AT:
(X) RDMSD
( ) ON-SITE
( ) SUB

IRONMENTAL DITIONS: 78 °F, 17 %RH

SPECIFICATIONS:
(X) MFG
( ) RDMSD:
(X) OTHER: +/- 3PSI

PROCEDURE:
( ) MFG
( ) RDMSD:
(X) OTHER: NAVAIR 17-20MP-41

RDMSD TECH: JAM
SERVICE CODE: J

LT/SYMPTOM: Omega

RK PERFORMED: Calibrated

THIS IS NOT ...

'S:
261

ITED CALIBRATION:

MMENTS:

QTY	PART #	DESCRIPTION	COST	REPAIR LABOR HOURS:

PARTS TOTAL	
REPAIR LABOR	
SHIPPING	
TEAR DOWN CHARGE	
CALIBRATION	44.00
TAX 7.7500	3.41
TOTAL	47.41

II A: DATE:

SD 2002 RCVD BY
(SIGNED): (PRINTED):

CERT. NUMBER: 58173 188

ROTHE DEVELOPMENT, INC.

METROLOGY SERVICES DIVISION

4614 SINCLAIR RD., SAN ANTONIO, TEXAS 78222 PH:210-648-3131

CERTIFICATE OF CALIBRATION

ISSUED TO: Omega Point Laboratories
16015 Shady Falls Road
Elmendorf, TX 78112-9784
635-8100

MFG: McDaniel
MODEL: 0-100 PSI
NOMEN: Gauge
S/N: 99LE001
CUST. ID: 99LE001

CAL DATE: 04/27/1999
DUE DATE: 04/27/2000

CONTROL NO.: 556 - 26820
TECHNICIAN: 2
SPECIFICATIONS: OMEGA +/-3PSI
PROCEDURE: NAVAIR 17-20MP-41
WORK ORDER: 71668
CUSTOMER P.O.: 118640
RECEIVED CONDITION: IN TOLERANCE
RETURNED CONDITION: IN TOLERANCE

CALIBRATION PERFORMED AT: RDMSD
CALIBRATION INTERVAL: 12mos.
TEMPERATURE: 68 °F
RELATIVE HUMIDITY: 47 %

DATE RECEIVED: 04/20/1999

COMMENTS:

ATTACHMENTS: CALIBRATION DATA

alibrations performed at Rothe Development, Inc. Metrology Services Division meet the requirements of ANSI/NCSL Z540-1-1, ISO/IEC GUIDE 25, and ISO 10012-1, and are traceable to the National Institute of Standards and Technology. The collective uncertainty of the measurement(s) does not exceed 25% (TUR≥4:1) of the instrument specification(s) unless noted in the COMMENTS section.

TR#	MFG	MODEL	SERIAL NO.	DUE DATE
261	HEISE	AT52000	ATS-10521	04/28/1999

Calibration Certificate Acceptance

Item 0-100 Pressure Gage
SN 99LE001

	Q/A	Eng.
NIST Traceability Adequate	✓	✓
As Found/As Left Values	✓	✓
Calibration Data Sufficient	✓	✓
Tolerance Range Adequate	✓	✓
Date of Review:	5-11-99	5/11/99

OPL QA/QC Dept. Eng./ Dept. Mgr.

APPROVED BY: Peter J. Stemmer ☒ CMS ☐ QCO DATE: 05/13/1999

ROTHE DEVELOPMENT METROLOGY SERVICES

CALIBRATION DATA: PRESSURE GAUGE

CUSTOMER: Omega Point Lab
WO NUMBER: 71668
SERIAL:
CUST ID: 99LE001

DATE: 4/27/99
TECH: JAM
INST NO: 28820

CALIBRATION DATA TAKEN

INCOMING X
OUTGOING X

CONDITION OF EQUIPMENT

IN TOLERANCE X
OUT OF TOLERANCE

MANUFACTURER McDaniel

RANGE 0-100 PSI

ACCURACY +/-3 PSI

GAUGE PRESSURE	STANDARD READING
10	9.65
30	29.91
50	50.17
70	70.55
95	95.50

Kothe Development, Inc. 4614 Sinclair Road San Antonio, Texas 78222
METROLOGY SERVICES DIVISION TRACEABLE TO NIST (210)648-3131 Fax (210)648-4091

190

CHARGE # 107 CONTROL # 556 - 29821 WORK ORDER # 71669

RECEIVED FROM: Omega Point Laboratories
DATE: 04/20/1999
PHONE #: 635-8100
FAX #: 635-8101
ADDRESS: 16015 Shady Falls Road
Elmendorf, TX 78112-9784
CONTACT NAME: Ms. Cleda Patton
PURCHASE ORDER #: 118640

ITEM
MFG: McDaniel
MODEL: 0-100 PSI
NOMEN: Gauge
S/N: 99LE002
CUST ID: 99LE002
ACCESS
RCVD:
***** Need Manual *****

TOMER COMMENTS/REQUIREMENTS:
A: BEFORE & AFTER DATA REQUIRED

OUR PO:

EIVED:
IN TOLERANCE
OUT OF TOLERANCE
INOPERATIVE

RETURNED:
(X) IN TOLERANCE
( ) LIMITED CALIBRATION
( ) REPAIR ONLY
( ) NO ACTION DATA

CALIBRATION INTERVAL: 12 MOS.
CAL DATE: 4/22/99
DUE DATE: 4/22/00

CAL'D AT:
(X) RDMSD
( ) ON-SITE
( ) SUB

IRONMENTAL IDITIONS:
,8 °F
17 %RH

SPECIFICATIONS:
( ) MFG
( ) RDMSD:
(X) OTHER: OMega +/- 3 PSI

PROCEDURE:
( ) MFG
( ) RDMSD:
(X) OTHER: NAVAIR 17-20MP-41

RDMSD TECH: SAM

SERVICE CODE: 3

LT/SYMPTOM:

THIS IS NOT IN

RK PERFORMED:

Calibrated

PS:
261

ITED CALIBRATION:

MMENTS:

QTY	PART #	DESCRIPTION	COST	REPAIR LABOR HOURS: _____		
				PARTS TOTAL		
				REPAIR LABOR		
				SHIPPING		
				TEAR DOWN CHARGE		
				CALIBRATION	11	00
				TAX 7.750%	3	41
				TOTAL	47	41

IP A: DATE:

ISD 2002

RCVD BY
(SIGNED): _____ (PRINTED): _____

CERT. NUMBER: 58174 191

ROTHE DEVELOPMENT, INC.

METROLOGY SERVICES DIVISION

4614 SINCLAIR RD., SAN ANTONIO, TEXAS 78222 PH:210-648-3131

CERTIFICATE OF CALIBRATION

ISSUED TO: Omega Point Laboratories
16015 Shady Falls Road
Elmendorf, TX 78112-9784
635-8100

MFG: McDaniel
MODEL: 0-100 PSI
NOMEN: Gauge
S/N: 99LE002
CUST. ID: 99LE002

CAL DATE: 04/27/1999
DUE DATE: 04/27/2000

CONTROL NO.: 556 - 28821
TECHNICIAN: 2
SPECIFICATIONS: OMEGA +/-3PSI
PROCEDURE: NAVAIR 17-20MP-41
WORK ORDER: 71669
CUSTOMER P.O.: 118640
RECEIVED CONDITION: IN TOLERANCE
RETURNED CONDITION: IN TOLERANCE

CALIBRATION PERFORMED AT: RDMSD
CALIBRATION INTERVAL: 12mos.
TEMPERATURE: 68 °F
RELATIVE HUMIDITY: 47 %

DATE RECEIVED: 04/20/1999

COMMENTS:

ATTACHMENTS: CALIBRATION DATA

/ alibrations performed at Rothe Development, Inc. Metrology Services Division meet the requirements of ANSI/NCSL Z540-1-ISO/IEC GUIDE 25, and ISO 10012-1, and are traceable to the National Institute of Standards and Technology. The collective uncertainty of the measurement(s) does not exceed 25% (TUR≥4:1) of the instrument specification(s) unless noted in the COMMENTS section.

TR#	MFG	MODEL	SERIAL NO.	DUE DATE
261	HEISE	ATS2000	ATS-10521	04/28/1999

Calibration Certificate Acceptance

Item Pressure Gage 0-100psi
SN 99LE002

	Q/A	Eng.
NIST Traceability Adequate	ES	
As Found/As Left Values	ES	
Calibration Data Sufficient	ES	
Tolerance Range Adequate	ES	
Date of Review:	5-14-99	5/14/99

OPL QA/QC Dept. — Eng./ Dept. Mgr.

ROVED BY: Peter J. Stemmer ☒ CMS ☐ QCO DATE: 05/13/1999

ROTHE DEVELOPMENT METROLOGY SERVICES

CALIBRATION DATA: PRESSURE GAUGE

CUSTOMER: Omega Point Lab
WO NUMBER: 71669
SERIAL:
CUST ID: 99LE002

DATE: 4/27/99
TECH: SAM
INST NO: 28821

CALIBRATION DATA TAKEN
INCOMING X
OUTGOING X

CONDITION OF EQUIPMENT
IN TOLERANCE X
OUT OF TOLERANCE

MANUFACTURER McDaniel

RANGE 0-100 PSI

ACCURACY +/- 3PSI

GAUGE PRESSURE	STANDARD READING
10	10.40
30	30.25
50	50.04
70	70.29
95	95.35

Channel Verification for Fluke Hydras 40 Channel

Serial No.: 98LE003

Calibrator Used: Tegam T-207318

Temperature Setting (°F): 0

Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-
1	0	0	11	0	0	21	0	0	31	1	1
2	0	0	12	0	0	22	0	0	32	1	1
3	0	0	13	0	0	23	0	0	33	1	1
4	0	0	14	0	0	24	0	0	34	0	0
5	0	0	15	0	0	25	0	0	35	0	0
6	-1	-1	16	0	0	26	0	0	36	0	0
7	0	0	17	0	0	27	0	0	37	0	0
8	0	0	18	0	0	28	1	1	38	-1	-1
9	0	0	19	0	0	29	0	0	39	1	1
10	0	0	20	-1	-1	30	0	0	40	1	1

Temperature Setting (°F): 1000

Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-
1	1000	0	11	1000	0	21	1000	0	31	1000	0
2	1000	0	12	1000	0	22	1000	0	32	1000	0
3	1000	0	13	1000	0	23	1000	0	33	1000	0
4	1000	0	14	1000	0	24	1000	0	34	1000	0
5	1000	0	15	1000	-1	25	1000	0	35	1000	0
6	1000	0	16	999	-1	26	1000	0	36	1000	0
7	1000	0	17	999	-1	27	1000	0	37	1000	0
8	1000	0	18	999	-1	28	1000	0	38	1000	0
9	1000	-1	19	1001	1	29	1000	0	39	999	-1
10	1000	0	20	1001	1	30	1000	0	40	1000	0

Overall Tolerance (°F): +1/-1

Performed by:

James Bundick Systems Eng. 10/8/99
Title Date

Approved by:

James R Bundick Systems Eng 10/08/99
Title Date

Omega Point Laboratories, Inc.
16015 Shady Falls Road
Elmendorf, Texas 78112
800-966-5253 FAX 210-635-8101

Certificate of Calibration

Certification No.:	92061
Calibration Date:	3/23/2000
Re-calibration Date:	9/23/2000
Manufacturer:	Yokogawa
Model No.:	300 Channel DAU
Serial No.:	48JF0082
Equipment Description:	300 Channel Data Acquisition System with YOKOGAWA Darwin Series
Calibration Sources:	Tegam Calibrator/Themometer, Model 840A, Serial # T-207318

PERFORMANCE:

Temperature: (250°F)+1.2/-0.4	Temperature: (500°F) +1.3/-0.4	Temperature: (1000°F) +1.7/-0.3	Temperature: (1750°F) +2.6/-0.8

Overall Tolerance for all Temperatures: +2.6/-0.8

Calibration Performed by:

Mike Dey
Fire Technologist

OMEGA POINT LABORATORIES

Channel Verification for Yokogawa 300 Channel

Serial No.: 48JF0082

Calibrator Used: Tegam T-207318

Temperature Setting (°F): 250.0

Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-
1	250.3	0.3	101	249.6	-0.4	201	249.8	-0.2
2	250.3	0.3	102	249.6	-0.4	202	249.8	-0.2
3	250.2	0.2	103	249.6	-0.4	203	249.8	-0.2
4	250.2	0.2	104	249.8	-0.2	204	250.0	0.0
5	250.3	0.3	105	249.8	-0.2	205	250.0	0.0
6	250.3	0.3	106	250.0	0.0	206	250.2	0.2
7	250.5	0.5	107	250.0	0.0	207	250.2	0.2
8	250.7	0.7	108	250.2	0.2	208	250.2	0.2
9	250.7	0.7	109	250.2	0.2	209	250.3	0.3
10	250.9	0.9	110	250.3	0.3	210	250.7	0.7
11	250.3	0.3	111	250.3	0.3	211	250.7	0.7
12	250.2	0.2	112	250.3	0.3	212	250.7	0.7
13	250.2	0.2	113	249.8	-0.2	213	249.8	-0.2
14	250.2	0.2	114	249.8	-0.2	214	250.0	0.0
15	250.2	0.2	115	250.0	0.0	215	250.0	0.0
16	250.2	0.2	116	250.0	0.0	216	250.2	0.2
17	250.2	0.2	117	250.0	0.0	217	250.2	0.2
18	250.2	0.2	118	250.0	0.0	218	250.2	0.2
19	250.5	0.5	119	250.2	0.2	219	250.2	0.2
20	250.7	0.7	120	250.5	0.5	220	250.5	0.5
21	250.3	0.3	121	250.7	0.7	221	249.6	-0.4
22	250.2	0.2	122	250.5	0.5	222	249.6	-0.4
23	250.2	0.2	123	250.5	0.5	223	249.6	-0.4
24	250.2	0.2	124	250.5	0.5	224	249.6	-0.4
25	250.2	0.2	125	250.5	0.5	225	250.0	0.0
26	250.3	0.3	126	250.7	0.7	226	250.0	0.0
27	250.2	0.2	127	250.7	0.7	227	250.0	0.0
28	250.3	0.3	128	250.7	0.7	228	250.0	0.0
29	250.3	0.3	129	250.9	0.9	229	250.2	0.2
30	250.7	0.7	130	251.2	1.2	230	250.5	0.5
31	250.2	0.2	131	250.2	0.2	231	249.6	-0.4
32	250.2	0.2	132	250.0	0.0	232	249.8	-0.2
33	250.2	0.2	133	250.0	0.0	233	250.0	0.0
34	250.2	0.2	134	250.0	0.0	234	250.2	0.2
35	250.2	0.2	135	250.0	0.0	235	250.2	0.2
36	250.2	0.2	136	250.0	0.0	236	250.2	0.2
37	250.2	0.2	137	250.2	0.2	237	250.3	0.3
38	250.3	0.3	138	250.2	0.2	238	250.3	0.3
39	250.5	0.5	139	250.3	0.3	239	250.5	0.5
40	250.7	0.7	140	250.7	0.7	240	250.7	0.7
41	250.2	0.2	141	250.2	0.2	241	250.5	0.5
42	250.2	0.2	142	250.2	0.2	242	250.2	0.2
43	250.2	0.2	143	250.2	0.2	243	250.2	0.2
44	250.2	0.2	144	250.2	0.2	244	250.3	0.3
45	250.2	0.2	145	250.3	0.3	245	250.3	0.3
46	250.2	0.2	146	250.3	0.3	246	250.5	0.5
47	250.2	0.2	147	250.3	0.3	247	250.5	0.5
48	250.2	0.2	148	250.3	0.3	248	250.5	0.5
49	250.5	0.5	149	250.3	0.3	249	250.5	0.5
50	250.5	0.5	150	250.3	0.3	250	250.5	0.5
51	250.2	0.2	151	250.3	0.3	251	249.8	-0.2
52	250.2	0.2	152	250.2	0.2	252	250.0	0.0
53	250.2	0.2	153	250.2	0.2	253	250.0	0.0

OMEGA POINT LABORATORIES

Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-
54	250.2	0.2	154	250.2	0.2	254	250.0	0.0
55	250.3	0.3	155	250.3	0.3	255	250.2	0.2
56	250.5	0.5	156	250.3	0.3	256	250.2	0.2
57	250.5	0.5	157	250.3	0.3	257	250.2	0.2
58	250.7	0.7	158	250.5	0.5	258	250.3	0.3
59	250.7	0.7	159	250.7	0.7	259	250.5	0.5
60	250.7	0.7	160	250.7	0.7	260	250.9	0.9
61	250.7	0.7	161	251.1	1.1	261	250.9	0.9
62	250.7	0.7	162	250.3	0.3	262	250.9	0.9
63	250.3	0.3	163	250.2	0.2	263	250.2	0.2
64	250.2	0.2	164	250.2	0.2	264	250.2	0.2
65	250.3	0.3	165	250.2	0.2	265	250.2	0.2
66	250.3	0.3	166	250.3	0.3	266	250.2	0.2
67	250.3	0.3	167	250.3	0.3	267	250.2	0.2
68	250.5	0.5	168	250.5	0.5	268	250.3	0.3
69	250.5	0.5	169	250.5	0.5	269	250.5	0.5
70	250.7	0.7	170	250.7	0.7	270	250.7	0.7
71	250.2	0.2	171	249.8	-0.2	271	250.3	0.3
72	250.0	0.0	172	249.8	-0.2	272	250.3	0.3
73	250.0	0.0	173	249.8	-0.2	273	250.3	0.3
74	250.0	0.0	174	249.8	-0.2	274	250.3	0.3
75	250.2	0.2	175	250.2	0.2	275	250.5	0.5
76	250.2	0.2	176	250.2	0.2	276	250.5	0.5
77	250.2	0.2	177	250.3	0.3	277	250.7	0.7
78	250.2	0.2	178	250.5	0.5	278	250.5	0.5
79	250.5	0.5	179	250.7	0.7	279	250.7	0.7
80	250.7	0.7	180	251.1	1.1	280	251.1	1.1
81	250.3	0.3	181	250.2	0.2	281	249.6	-0.4
82	250.2	0.2	182	250.2	0.2	282	249.6	-0.4
83	250.2	0.2	183	250.0	0.0	283	249.8	-0.2
84	250.2	0.2	184	250.2	0.2	284	250.0	0.0
85	250.2	0.2	185	250.2	0.2	285	250.0	0.0
86	250.2	0.2	186	250.2	0.2	286	250.0	0.0
87	250.2	0.2	187	250.3	0.3	287	250.2	0.2
88	250.3	0.3	188	250.5	0.5	288	250.3	0.3
89	250.5	0.5	189	250.7	0.7	289	250.5	0.5
90	250.7	0.7	190	250.9	0.9	290	250.7	0.7
91	250.0	0.0	191	250.0	0.0	291	249.6	-0.4
92	250.0	0.0	192	249.8	-0.2	292	249.6	-0.4
93	250.2	0.2	193	250.0	0.0	293	250.0	0.0
94	250.2	0.2	194	250.0	0.0	294	250.0	0.0
95	250.2	0.2	195	250.2	0.2	295	250.2	0.2
96	250.2	0.2	196	250.2	0.2	296	250.2	0.2
97	250.2	0.2	197	250.2	0.2	297	250.2	0.2
98	250.2	0.2	198	250.2	0.2	298	249.6	-0.4
99	250.2	0.2	199	250.0	0.0	299	249.6	-0.4
100	250.2	0.2	200	250.0	0.0	300	250.2	0.2

Tolerance for 250°F Signal: **+1.2/-0.4**

	Lower	Upper
Allowable limits	248.1	251.9

Within specification for this temperature? YES

Performed by: Mike Day

TECHNOLOGIST 3-23-00
Title Date

Approved by:

MGR. FLAMMABILITY TESTING 3/29/01
Title Date

OMEGA POINT LABORATORIES

Channel Verification for Yokogawa 300 Channel

Serial No.: 48JF0082

Calibrator Used: Tegam T-207318

Temperature Setting (°F): 500.0

Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-
1	500.2	0.2	101	499.8	-0.2	201	499.8	-0.2
2	500.0	0.0	102	499.8	-0.2	202	499.8	-0.2
3	500.0	0.0	103	500.0	0.0	203	500.0	0.0
4	500.0	0.0	104	500.0	0.0	204	500.2	0.2
5	500.2	0.2	105	500.0	0.0	205	500.2	0.2
6	500.2	0.2	106	500.2	0.2	206	500.4	0.4
7	500.4	0.4	107	500.4	0.4	207	500.4	0.4
8	500.4	0.4	108	500.4	0.4	208	500.4	0.4
9	500.5	0.5	109	500.4	0.4	209	500.7	0.7
10	500.7	0.7	110	500.5	0.5	210	500.9	0.9
11	499.8	-0.2	111	499.8	-0.2	211	499.8	-0.2
12	499.8	-0.2	112	499.8	-0.2	212	499.8	-0.2
13	499.8	-0.2	113	499.8	-0.2	213	499.8	-0.2
14	499.8	-0.2	114	500.0	0.0	214	499.8	-0.2
15	499.8	-0.2	115	500.2	0.2	215	500.0	0.0
16	500.0	0.0	116	500.2	0.2	216	500.2	0.2
17	500.0	0.0	117	500.4	0.4	217	500.2	0.2
18	500.2	0.2	118	500.4	0.4	218	500.4	0.4
19	500.4	0.4	119	500.5	0.5	219	500.5	0.5
20	500.5	0.5	120	500.7	0.7	220	500.7	0.7
21	500.0	0.0	121	500.5	0.5	221	499.8	-0.2
22	500.0	0.0	122	500.5	0.5	222	500.0	0.0
23	499.8	-0.2	123	500.5	0.5	223	500.0	0.0
24	499.8	-0.2	124	500.5	0.5	224	500.0	0.0
25	500.4	0.4	125	500.5	0.5	225	500.0	0.0
26	500.4	0.4	126	500.5	0.5	226	500.2	0.2
27	500.4	0.4	127	500.7	0.7	227	500.4	0.4
28	500.4	0.4	128	500.7	0.7	228	500.4	0.4
29	500.7	0.7	129	501.1	1.1	229	500.5	0.5
30	500.7	0.7	130	501.3	1.3	230	500.7	0.7
31	500.7	0.7	131	500.0	0.0	231	499.6	-0.4
32	500.4	0.4	132	500.0	0.0	232	499.8	-0.2
33	500.4	0.4	133	500.0	0.0	233	499.8	-0.2
34	500.4	0.4	134	500.0	0.0	234	500.0	0.0
35	500.5	0.5	135	500.0	0.0	235	500.2	0.2
36	500.4	0.4	136	500.4	0.4	236	500.4	0.4
37	500.5	0.5	137	500.4	0.4	237	500.4	0.4
38	500.7	0.7	138	500.4	0.4	238	500.5	0.5
39	500.7	0.7	139	500.5	0.5	239	500.5	0.5
40	500.9	0.9	140	500.9	0.9	240	500.7	0.7
41	500.0	0.0	141	500.4	0.4	241	500.5	0.5
42	500.0	0.0	142	500.4	0.4	242	500.4	0.4
43	500.2	0.2	143	500.4	0.4	243	500.5	0.5
44	500.0	0.0	144	500.4	0.4	244	500.5	0.5
45	500.2	0.2	145	500.4	0.4	245	500.7	0.7
46	500.2	0.2	146	500.4	0.4	246	500.7	0.7
47	500.2	0.2	147	500.4	0.4	247	500.7	0.7
48	500.2	0.2	148	500.4	0.4	248	500.7	0.7
49	500.4	0.4	149	500.4	0.4	249	500.7	0.7
50	500.5	0.5	150	500.4	0.4	250	500.7	0.7
51	499.8	-0.2	151	500.2	0.2	251	499.8	-0.2
52	500.0	0.0	152	500.2	0.2	252	500.0	0.0
53	500.0	0.0	153	500.2	0.2	253	500.0	0.0
54	500.0	0.0	154	500.2	0.2	254	500.0	0.0
55	500.2	0.2	155	500.4	0.4	255	500.4	0.4

OMEGA POINT LABORATORIES

Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-
56	500.2	0.2	156	500.4	0.4	256	500.4	0.4
57	500.4	0.4	157	500.5	0.5	257	500.4	0.4
58	500.4	0.4	158	500.7	0.7	258	500.5	0.5
59	500.4	0.4	159	500.7	0.7	259	500.5	0.5
60	500.7	0.7	160	500.9	0.9	260	500.9	0.9
61	500.4	0.4	161	500.2	0.2	261	500.2	0.2
62	500.2	0.2	162	500.2	0.2	262	500.4	0.4
63	500.2	0.2	163	500.2	0.2	263	500.4	0.4
64	500.2	0.2	164	500.4	0.4	264	500.4	0.4
65	500.4	0.4	165	500.4	0.4	265	500.4	0.4
66	500.4	0.4	166	500.4	0.4	266	500.4	0.4
67	500.4	0.4	167	500.4	0.4	267	500.4	0.4
68	500.4	0.4	168	500.5	0.5	268	500.7	0.7
69	500.5	0.5	169	500.7	0.7	269	500.9	0.9
70	500.7	0.7	170	501.1	1.1	270	501.1	1.1
71	500.2	0.2	171	499.8	-0.2	271	500.0	0.0
72	500.0	0.0	172	499.8	-0.2	272	500.2	0.2
73	500.0	0.0	173	500.0	0.0	273	500.2	0.2
74	500.0	0.0	174	500.0	0.0	274	500.2	0.2
75	500.4	0.4	175	500.2	0.2	275	500.4	0.4
76	500.4	0.4	176	500.4	0.4	276	500.4	0.4
77	500.4	0.4	177	500.4	0.4	277	500.5	0.5
78	500.4	0.4	178	500.4	0.4	278	500.7	0.7
79	500.5	0.5	179	500.7	0.7	279	500.7	0.7
80	500.5	0.5	180	500.7	0.7	280	501.1	1.1
81	500.2	0.2	181	500.4	0.4	281	499.8	-0.2
82	500.2	0.2	182	500.4	0.4	282	499.8	-0.2
83	500.2	0.2	183	500.4	0.4	283	499.8	-0.2
84	500.2	0.2	184	500.4	0.4	284	499.8	-0.2
85	500.2	0.2	185	500.4	0.4	285	500.2	0.2
86	500.2	0.2	186	500.4	0.4	286	500.2	0.2
87	500.4	0.4	187	500.5	0.5	287	500.2	0.2
88	500.4	0.4	188	500.7	0.7	288	500.4	0.4
89	500.5	0.5	189	500.7	0.7	289	500.4	0.4
90	500.7	0.7	190	501.1	1.1	290	500.7	0.7
91	500.2	0.2	191	500.0	0.0	291	499.8	-0.2
92	500.0	0.0	192	500.0	0.0	292	500.0	0.0
93	500.2	0.2	193	500.4	0.4	293	500.0	0.0
94	500.2	0.2	194	500.4	0.4	294	500.2	0.2
95	500.2	0.2	195	500.4	0.4	295	500.2	0.2
96	500.2	0.2	196	500.5	0.5	296	500.2	0.2
97	500.2	0.2	197	500.5	0.5	297	500.5	0.5
98	500.2	0.2	198	500.5	0.5	298	500.5	0.5
99	500.2	0.2	199	500.5	0.5	299	500.5	0.5
100	500.2	0.2	200	500.5	0.5	300	500.5	0.5

Tolerance for 500°F Signal: **+1.3/-0.4**

	Lower	Upper
Allowable limits	498.0	502.0

Within specification for this temperature? yes

Performed by:

Title: TECHNOLOGIST Date: 3-23-00

Approved by:

Title: MGR, FLAMMABILITY TESTING Date: 3/29/00

OMEGA POINT LABORATORIES

Channel Verification for Yokogawa 300 Channel

Serial No.: 48JF0082

Calibrator Used: Tegam T-207318

Temperature Setting (°F): 1000.0

Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-
1	1000.4	0.4	101	1000.2	0.2	201	1000.4	0.4
2	1000.2	0.2	102	1000.2	0.2	202	1000.6	0.6
3	1000.2	0.2	103	1000.2	0.2	203	1000.6	0.6
4	1000.2	0.2	104	1000.2	0.2	204	1000.6	0.6
5	1000.2	0.2	105	1000.4	0.4	205	1000.6	0.6
6	1000.4	0.4	106	1000.6	0.6	206	1000.8	0.8
7	1000.4	0.4	107	1000.6	0.6	207	1000.9	0.9
8	1000.4	0.4	108	1000.6	0.6	208	1000.9	0.9
9	1000.6	0.6	109	1000.8	0.8	209	1001.1	1.1
10	1000.8	0.8	110	1000.9	0.9	210	1001.5	1.5
11	1000.0	0.0	111	1000.2	0.2	211	1000.0	0.0
12	1000.0	0.0	112	1000.0	0.0	212	1000.0	0.0
13	1000.0	0.0	113	1000.2	0.2	213	1000.0	0.0
14	1000.0	0.0	114	1000.4	0.4	214	1000.2	0.2
15	1000.2	0.2	115	1000.4	0.4	215	1000.2	0.2
16	1000.2	0.2	116	1000.4	0.4	216	1000.2	0.2
17	1000.2	0.2	117	1000.4	0.4	217	1000.4	0.4
18	1000.2	0.2	118	1000.6	0.6	218	1000.6	0.6
19	1000.4	0.4	119	1000.6	0.6	219	1000.6	0.6
20	1000.6	0.6	120	1000.9	0.9	220	1000.9	0.9
21	1000.0	0.0	121	1000.6	0.6	221	999.9	-0.1
22	1000.0	0.0	122	1000.6	0.6	222	1000.0	0.0
23	1000.0	0.0	123	1000.6	0.6	223	1000.0	0.0
24	1000.0	0.0	124	1000.6	0.6	224	1000.0	0.0
25	1000.0	0.0	125	1000.6	0.6	225	1000.2	0.2
26	1000.0	0.0	126	1000.6	0.6	226	1000.4	0.4
27	1000.2	0.2	127	1000.8	0.8	227	1000.6	0.6
28	1000.4	0.4	128	1000.9	0.9	228	1000.6	0.6
29	1000.6	0.6	129	1000.9	0.9	229	1000.8	0.8
30	1000.6	0.6	130	1001.3	1.3	230	1000.9	0.9
31	1000.6	0.6	131	1000.0	0.0	231	1000.0	0.0
32	1000.6	0.6	132	1000.0	0.0	232	1000.0	0.0
33	1000.6	0.6	133	1000.0	0.0	233	1000.0	0.0
34	1000.6	0.6	134	1000.0	0.0	234	1000.2	0.2
35	1000.6	0.6	135	1000.2	0.2	235	1000.2	0.2
36	1000.6	0.6	136	1000.2	0.2	236	1000.4	0.4
37	1000.6	0.6	137	1000.2	0.2	237	1000.6	0.6
38	1000.6	0.6	138	1000.4	0.4	238	1000.6	0.6
39	1000.6	0.6	139	1000.6	0.6	239	1000.9	0.9
40	1000.9	0.9	140	1000.9	0.9	240	1001.1	1.1
41	1000.0	0.0	141	1000.0	0.0	241	1000.6	0.6
42	1000.0	0.0	142	1000.2	0.2	242	1000.6	0.6
43	1000.2	0.2	143	1000.4	0.4	243	1000.8	0.8
44	1000.2	0.2	144	1000.4	0.4	244	1000.8	0.8
45	1000.2	0.2	145	1000.6	0.6	245	1000.9	0.9
46	1000.2	0.2	146	1000.6	0.6	246	1000.9	0.9
47	1000.4	0.4	147	1000.6	0.6	247	1000.9	0.9
48	1000.4	0.4	148	1000.6	0.6	248	1000.9	0.9
49	1000.4	0.4	149	1000.6	0.6	249	1000.9	0.9
50	1000.4	0.4	150	1000.6	0.6	250	1000.9	0.9
51	1000.0	0.0	151	1000.0	0.0	251	1000.0	0.0
52	1000.0	0.0	152	1000.0	0.0	252	1000.0	0.0
53	1000.0	0.0	153	1000.0	0.0	253	1000.0	0.0
54	1000.0	0.0	154	1000.0	0.0	254	1000.2	0.2
55	1000.0	0.0	155	1000.0	0.0	255	1000.4	0.4

OMEGA POINT LABORATORIES

Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-
56	1000.2	0.2	156	1000.2	0.2	256	1000.6	0.6
57	1000.2	0.2	157	1000.2	0.2	257	1000.6	0.6
58	1000.4	0.4	158	1000.2	0.2	258	1000.8	0.8
59	1000.6	0.6	159	1000.6	0.6	259	1000.9	0.9
60	1000.6	0.6	160	1000.8	0.8	260	1001.1	1.1
61	1000.2	0.2	161	999.9	-0.1	261	1000.4	0.4
62	1000.0	0.0	162	999.9	-0.1	262	1000.6	0.6
63	1000.0	0.0	163	999.9	-0.1	263	1000.6	0.6
64	1000.0	0.0	164	1000.0	0.0	264	1000.6	0.6
65	1000.0	0.0	165	1000.2	0.2	265	1000.6	0.6
66	1000.2	0.2	166	1000.2	0.2	266	1000.6	0.6
67	1000.2	0.2	167	1000.2	0.2	267	1000.6	0.6
68	1000.4	0.4	168	1000.4	0.4	268	1000.8	0.8
69	1000.6	0.6	169	1000.4	0.4	269	1000.9	0.9
70	1000.6	0.6	170	1000.6	0.6	270	1001.3	1.3
71	1000.0	0.0	171	999.7	-0.3	271	1000.0	0.0
72	1000.0	0.0	172	999.7	-0.3	272	1000.2	0.2
73	1000.0	0.0	173	999.7	-0.3	273	1000.4	0.4
74	1000.0	0.0	174	999.7	-0.3	274	1000.4	0.4
75	1000.0	0.0	175	999.9	-0.1	275	1000.4	0.4
76	1000.0	0.0	176	1000.0	0.0	276	1000.6	0.6
77	1000.2	0.2	177	1000.0	0.0	277	1000.6	0.6
78	1000.2	0.2	178	1000.2	0.2	278	1000.8	0.8
79	1000.6	0.6	179	1000.4	0.4	279	1000.9	0.9
80	1000.8	0.8	180	1000.6	0.6	280	1001.3	1.3
81	1000.0	0.0	181	1000.9	0.9	281	999.7	-0.3
82	1000.0	0.0	182	1000.9	0.9	282	999.9	-0.1
83	1000.0	0.0	183	1000.9	0.9	283	999.9	-0.1
84	1000.0	0.0	184	1000.9	0.9	284	1000.0	0.0
85	1000.0	0.0	185	1000.9	0.9	285	1000.0	0.0
86	1000.0	0.0	186	1000.9	0.9	286	1000.0	0.0
87	1000.0	0.0	187	1000.9	0.9	287	1000.2	0.2
88	1000.2	0.2	188	1000.9	0.9	288	1000.4	0.4
89	1000.2	0.2	189	1001.5	1.5	289	1000.6	0.6
90	1000.6	0.6	190	1001.7	1.7	290	1000.8	0.8
91	1000.4	0.4	191	1000.6	0.6	291	999.9	-0.1
92	1000.2	0.2	192	1000.6	0.6	292	1000.0	0.0
93	1000.4	0.4	193	1000.6	0.6	293	1000.0	0.0
94	1000.4	0.4	194	1000.8	0.8	294	1000.0	0.0
95	1000.6	0.6	195	1000.9	0.9	295	1000.2	0.2
96	1000.6	0.6	196	1000.9	0.9	296	1000.4	0.4
97	1000.6	0.6	197	1000.9	0.9	297	1000.4	0.4
98	1000.6	0.6	198	1000.9	0.9	298	1000.4	0.4
99	1000.6	0.6	199	1000.9	0.9	299	1000.4	0.4
100	1000.6	0.6	200	1000.9	0.9	300	1000.4	0.4

Tolerance for 1000°F Signal: **+1.7/-0.3**

	Lower	Upper
Allowable limits	997.7	1002.3

Within specification for this temperature? yes

Performed by:

Matthew Dery — TECHNOLOGIST (Title) — 3-23-00 (Date)

Approved by:

[signature] — MGR. FLAMMABILITY TESTING (Title) — 3/29/00 (Date)

OMEGA POINT LABORATORIES

Channel Verification for Yokogawa 300 Channel

Serial No.: 48JF0082

Calibrator Used: Tegam T-207318

Temperature Setting (°F): 1750.0

Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-
1	1750.5	0.5	101	1750.6	0.6	201	1751.2	1.2
2	1750.3	0.3	102	1750.6	0.6	202	1751.2	1.2
3	1750.3	0.3	103	1750.6	0.6	203	1751.4	1.4
4	1750.3	0.3	104	1750.6	0.6	204	1751.5	1.5
5	1750.3	0.3	105	1750.6	0.6	205	1751.7	1.7
6	1750.3	0.3	106	1750.6	0.6	206	1751.7	1.7
7	1750.5	0.5	107	1750.6	0.6	207	1751.9	1.9
8	1750.5	0.5	108	1750.8	0.8	208	1751.9	1.9
9	1750.6	0.6	109	1750.8	0.8	209	1751.9	1.9
10	1751.0	1.0	110	1751.4	1.4	210	1752.3	2.3
11	1750.1	0.1	111	1750.5	0.5	211	1750.1	0.1
12	1750.1	0.1	112	1750.6	0.6	212	1750.3	0.3
13	1749.9	-0.1	113	1750.6	0.6	213	1750.3	0.3
14	1750.1	0.1	114	1750.6	0.6	214	1750.3	0.3
15	1750.1	0.1	115	1750.8	0.8	215	1750.5	0.5
16	1750.1	0.1	116	1750.8	0.8	216	1750.5	0.5
17	1750.1	0.1	117	1751.0	1.0	217	1750.6	0.6
18	1750.1	0.1	118	1751.0	1.0	218	1750.6	0.6
19	1750.1	0.1	119	1751.2	1.2	219	1750.8	0.8
20	1750.5	0.5	120	1751.4	1.4	220	1751.2	1.2
21	1749.9	-0.1	121	1750.6	0.6	221	1750.1	0.1
22	1750.1	0.1	122	1750.6	0.6	222	1750.3	0.3
23	1750.1	0.1	123	1750.5	0.5	223	1750.3	0.3
24	1750.1	0.1	124	1750.5	0.5	224	1750.3	0.3
25	1750.1	0.1	125	1750.6	0.6	225	1750.5	0.5
26	1750.3	0.3	126	1750.8	0.8	226	1750.5	0.5
27	1750.3	0.3	127	1750.8	0.8	227	1750.6	0.6
28	1750.3	0.3	128	1750.8	0.8	228	1750.6	0.6
29	1750.5	0.5	129	1751.2	1.2	229	1750.6	0.6
30	1750.6	0.6	130	1751.4	1.4	230	1751.0	1.0
31	1750.8	0.8	131	1750.1	0.1	231	1750.1	0.1
32	1750.6	0.6	132	1750.1	0.1	232	1750.1	0.1
33	1750.6	0.6	133	1750.1	0.1	233	1750.3	0.3
34	1750.8	0.8	134	1750.1	0.1	234	1750.5	0.5
35	1750.8	0.8	135	1750.3	0.3	235	1750.6	0.6
36	1750.8	0.8	136	1750.5	0.5	236	1750.6	0.6
37	1750.6	0.6	137	1750.3	0.3	237	1750.6	0.6
38	1750.8	0.8	138	1750.5	0.5	238	1751.0	1.0
39	1751.0	1.0	139	1750.6	0.6	239	1751.0	1.0
40	1751.4	1.4	140	1751.0	1.0	240	1751.4	1.4
41	1750.5	0.5	141	1750.1	0.1	241	1751.2	1.2
42	1750.5	0.5	142	1750.1	0.1	242	1751.0	1.0
43	1750.5	0.5	143	1750.1	0.1	243	1751.0	1.0
44	1750.5	0.5	144	1750.5	0.5	244	1751.2	1.2
45	1750.6	0.6	145	1750.5	0.5	245	1751.4	1.4
46	1750.6	0.6	146	1750.5	0.5	246	1751.4	1.4
47	1750.6	0.6	147	1750.6	0.6	247	1751.4	1.4
48	1750.6	0.6	148	1750.6	0.6	248	1751.5	1.5
49	1750.6	0.6	149	1750.3	0.3	249	1751.5	1.5
50	1750.6	0.6	150	1751.2	1.2	250	1751.9	1.9
51	1750.5	0.5	151	1749.4	-0.6	251	1750.3	0.3
52	1750.5	0.5	152	1749.4	-0.6	252	1750.3	0.3
53	1750.6	0.6	153	1749.4	-0.6	253	1750.5	0.5
54	1750.6	0.6	154	1749.6	-0.4	254	1750.5	0.5
55	1750.8	0.8	155	1749.6	-0.4	255	1750.6	0.6

OMEGA POINT LABORATORIES

Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-	Channel No.	Reading (°F)	+/-
56	1750.8	0.8	156	1749.6	-0.4	256	1750.8	0.8
57	1750.8	0.8	157	1749.7	-0.3	257	1750.8	0.8
58	1750.8	0.8	158	1749.7	-0.3	258	1751.0	1.0
59	1750.8	0.8	159	1750.1	0.1	259	1751.0	1.0
60	1751.2	1.2	160	1750.3	0.3	260	1751.5	1.5
61	1750.1	0.1	161	1749.2	-0.8	261	1750.6	0.6
62	1749.9	-0.1	162	1749.2	-0.8	262	1750.6	0.6
63	1749.9	-0.1	163	1749.2	-0.8	263	1750.8	0.8
64	1750.1	0.1	164	1749.6	-0.4	264	1750.6	0.6
65	1750.1	0.1	165	1749.4	-0.6	265	1750.8	0.8
66	1750.1	0.1	166	1749.4	-0.6	266	1751.0	1.0
67	1750.1	0.1	167	1749.6	-0.4	267	1751.0	1.0
68	1750.1	0.1	168	1749.7	-0.3	268	1751.2	1.2
69	1750.3	0.3	169	1749.9	-0.1	269	1751.4	1.4
70	1750.6	0.6	170	1750.1	0.1	270	1751.7	1.7
71	1749.7	-0.3	171	1749.2	-0.8	271	1750.1	0.1
72	1749.7	-0.3	172	1749.2	-0.8	272	1750.3	0.3
73	1749.7	-0.3	173	1749.2	-0.8	273	1750.3	0.3
74	1749.7	-0.3	174	1749.2	-0.8	274	1750.5	0.5
75	1749.7	-0.3	175	1749.6	-0.4	275	1750.5	0.5
76	1749.7	-0.3	176	1749.7	-0.3	276	1750.6	0.6
77	1749.9	-0.1	177	1749.7	-0.3	277	1750.6	0.6
78	1750.1	0.1	178	1749.9	-0.1	278	1750.6	0.6
79	1750.1	0.1	179	1750.1	0.1	279	1751.0	1.0
80	1750.5	0.5	180	1750.1	0.1	280	1751.4	1.4
81	1749.9	-0.1	181	1751.7	1.7	281	1749.7	-0.3
82	1749.9	-0.1	182	1751.5	1.5	282	1749.9	-0.1
83	1749.9	-0.1	183	1751.5	1.5	283	1749.9	-0.1
84	1749.7	-0.3	184	1751.5	1.5	284	1749.9	-0.1
85	1749.9	-0.1	185	1751.7	1.7	285	1750.1	0.1
86	1749.9	-0.1	186	1751.9	1.9	286	1750.1	0.1
87	1749.9	-0.1	187	1751.9	1.9	287	1750.1	0.1
88	1750.1	0.1	188	1751.9	1.9	288	1750.3	0.3
89	1750.1	0.1	189	1752.1	2.1	289	1750.5	0.5
90	1750.3	0.3	190	1752.6	2.6	290	1750.8	0.8
91	1750.6	0.6	191	1751.2	1.2	291	1749.7	-0.3
92	1750.6	0.6	192	1751.4	1.4	292	1749.9	-0.1
93	1750.6	0.6	193	1751.5	1.5	293	1750.1	0.1
94	1750.8	0.8	194	1751.5	1.5	294	1750.1	0.1
95	1750.8	0.8	195	1751.7	1.7	295	1750.3	0.3
96	1751.0	1.0	196	1751.7	1.7	296	1750.5	0.5
97	1751.2	1.2	197	1751.9	1.9	297	1750.5	0.5
98	1751.0	1.0	198	1751.9	1.9	298	1750.3	0.3
99	1751.2	1.2	199	1752.1	2.1	299	1750.6	0.6
100	1751.4	1.4	200	1751.9	1.9	300	1750.8	0.8

Tolerance for 1750°F Signal: **+2.6/-0.8**

Overall Tolerance for all Temperatures: **+2.6/-0.8**

	Lower	Upper
Allowable limits	1747.4	1752.6

Within specification for this temperature? yes

Performed by:

Mike Day — TECHNOLOGIST (Title) — 3-23-00 (Date)

Approved by:

[signature] — MGR. FLAMMABILITY TESTING (Title) — 3/29/00 (Date)

OMEGA POINT LABORATORIES

Q/A RECEIVING REPORT

CLIENT/PROJECT NAME Omega Point Labs
CLIENT/PROJECT NUMBER OPL Equipment
RECEIVED FROM Rathe
PROJECT LOCATION Omega Point Labs

REPORT NUMBER 1906 . OPL
DATE RECEIVED 7-20-99
DATE INSPECTED 7-20-99
INSPECTED BY: C Batten

ITEM DESCRIPTION	P.O. NO.	QUANTITY			I.D. NO.	COND MATL Y/N	CERT. RCVD Y/N	CONTAINER INTEGRITY	EXCEPTION	ACCEPTANCE			REMARKS
		Order	Rec'd	B.O.						Accept	Hold	Reject	
Hygrothermograph	11935Q	1	1	0	SN: 008685	Y	Y	Good	None	X			Hygrothermograph was received at Rathe out of tolerance by reading 3% low on R.H. Engineer said the amounts were not enough to be alarmed. Letter from engineer. See attached

FORM
1/29/93

OMEGA POINT LABORATORIES
16015 SHADY FALLS RD.
ELMENDORF, TEXAS 78112
PH. (210) 635-8100
FAX (210) 635-8101

PURCHASE ORDER

11935Q

Date6/3/99
Page: 1 of 1

Order From: Rothe Development Inc.
4614 Sinclair Road
San Antonio
TX 78222
210-648-3131

Deliver to: Omega Point Laboratories, Inc
16015 Shady Falls Road
Elmendorf
TX 78112
(210) 635-8100

Vendor No: 0161

Your Item Number / Item Description	Our Reference	Qty Ordered	Units	Unit Cost	Extension
	001	1.00	Each	$84.00	$84.00
Hygrothermograph-Calibration SN: 008685					

*See Special Instructions Regarding Purchasing Specifications for Quality Assurance Requirements."
QA Approval C Batten
Date 6-3-99

CALIBRATION CERT. REQUIREMENTS1.
Statement of NIST traceability
2. NIST test or I.D. number
3. As Found
4. As Left Values
5. Uncertainties of calibration measurements
6. Calibration data

Please Quote Purchase Order Number on all correspondence.

Special Instructions:
Please provide calibration services per attached Vendor Purchasing Specification and QA Requirements

Subtotal:	$84.00
Freight:	0.00
Tax Amount:	6.51
Total Value:	$90.51

380625

VENDOR PURCHASING SPECIFICATION AND QUALITY ASSURANCE REQUIREMENTS

Vendor Rothe

Purchase Order No. 119350

Any or all of the following Quality Assurance requirements shall be incorporated as conditions to this procurement when corresponding box is marked. Failure to comply with any requirement specified herein may result in rejection and/or return of shipment at seller's expense.

1.0 QUALITY PROGRAM

☒ Seller shall furnish all items on this Purchase Order in accordance with Quality Program approved by Buyer.

2.0 QUALITY VERIFICATION

When additional quality verification activities are required as a condition to this procurement, invoices will not be paid until satisfactory completion of such activities. Excessive rejection rates may result in removal from buyer's Approved Vendors List.

☒ Receiving Inspection - Buyer shall inspect items upon receipt to verify compliance with purchase order requirements. Rejected items shall be returned at seller's expense.

☐ Independent Laboratory Tests - Samples of materials furnished shall be tested independently for conformance to specification requirements prior to final acceptance. Rejected materials shall be returned at seller's expense.

☒ Document Review - Final acceptance shall be based on satisfactory review of required certifications and other supporting documents.

3.0 CERTIFICATIONS

When certifications are required as a condition to this procurement, the seller shall furnish one reproducible copy either with or prior to each shipment. Shipments will not be accepted and invoices will not be paid until certifications are in buyer's possession.

PURCHASING SPECIFICATIONS
PAGE 2 OF 3

VENDOR Rothe
PURCHASE ORDER NO. 11935Q

☐ Certificate of Compliance/Conformance Required - Certification that materials and/or services comply with purchase order requirements. Certification shall reference purchase order number and traceability numbers (when applicable).

☐ Certified Test Report Required - Certification that material complies with applicable material specification(s) and the purchase order. Include actual results of required tests.

☒ Certificate of Calibration Required - Certification shall be traceable to National Bureau of Standards. (Renamed NIST, Nat. Institute of Science & Technology)

4.0 AUDITS/RIGHT OF ACCESS

☒ The buyer reserves the right to audit your facility to verify compliance with purchase order, code and specification requirements with minimum of ten (10) days notice.

☒ Shipments shall only originate from facilities approved by the buyer.

☐ Buyer reserves the right to inspect any or all work included in this order at seller's facility with as early notice as practicable.

5.0 IDENTIFICATION

☐ Seller shall identify each item with a unique traceability number by physical marking or tagging. Traceability numbers shall be traceable to certifications and packing lists.

☒ Seller shall identify each container with a unique identification number. The identification number shall be traceable to certifications and packing lists.

6.0 10 CFR PART 21

☐ The material, equipment and/or services to be furnished under the provisions of this purchase order are involved in the testing of basic components of a Nuclear Regulatory Commission (NCR) licensed facility. Accordingly, the seller is subject to the provisions of 10 CFR, Part 21 (Reporting of Defects and Non-compliance)

PURCHASING SPECIFICATIONS
PAGE 3 OF 3

VENDOR Rothe
PURCHASE ORDER NO. 113-119356
QR 6-3-99

7.0 PACKING/SHIPPING

☒ All materials shall be packaged in air tight, moisture free containers and shall be free from all foreign substances such as dirt, oil, grease or other deleterious material.

☐ All materials and equipment shall be suitably crated, boxed or otherwise prepared for shipment to prevent damage during handling and shipping. Wherever practical, equipment shall be palletized for ease of unloading and storage at destination. each container shall be clearly marked with buyer's purchase order number.

QUALITY ASSURANCE APPROVAL C Patton DATE 6-3-99

EQUIPMENT DELIVERY RECEIPT

Date: 07/19/1999
Roth- Development, Inc.
Me gy Services Division
4 Sinclair Rd.
San Antonio, TX 78222-2099
(210)648-3131

Control: 556
Company: Omega Point Laboratories
Contact: Ms. Cleda Patton
Address: 16015 Shady Falls Road
City: Elmendorf, TX 78112-9784
Phone: 635-8100

Item	W.O. #	Customer P.O.	Mfgr.	Model	Serial No.	Description
1	72536	119350	Qualimetri	5021	008685	Hygrothermograph

1 ITEMS RECEIVED BY:
Name (Please Print):_____ Date:_____

Signature:_____

RDI 3003

Rothe Development, Inc.

4614 Sinclair Road San Antonio, Texas 78222
METROLOGY SERVICES DIVISION TRACEABLE TO NIST (210)648-3131 Fax (210)648-4091

209

CHARGE # 107 CONTROL # 556 - 23721 WORK ORDER # 12536

RECEIVED FROM: Omega Point Laboratories
ADDRESS: 16015 Shady Falls Road
Elmendorf, TX 78112-9784
CONTACT NAME: Ms. Gleda Patton
PURCHASE ORDER #: 119150
DATE: 06/07/1999
PHONE #: 635-8100
FAX #: 635-8101

ITEM
MFG: Gaithersburg
MODEL: 5021
NOMEN: Hygrothermograph
S/N: 008635
CUST ID:
ACCESS
RCVD:

CUSTOMER COMMENTS/REQUIREMENTS:
OUR PO:
DATA: REMOVE & ENTER DATA RECEIVED

RECEIVED:	RETURNED:	CALIBRATION INTERVAL: 12 mos.	CAL'D AT:
( ) IN TOLERANCE (✓) OUT OF TOLERANCE ( ) INOPERATIVE	(✓) IN TOLERANCE ( ) LIMITED CALIBRATION ( ) REPAIR ONLY ( ) NO ACTION OUT	CAL DATE: 14 Jul 00 DUE DATE: 14 Jul 00	(✓) RDMSD ( ) ON-SITE ( ) SUB

ENVIRONMENTAL CONDITIONS:	SPECIFICATIONS:	PROCEDURE:	RDMSD TECH:	SERVICE CODE:
73 °F 50 %RH	(✓) MFG ( ) RDMSD: _____ ( ) OTHER: _____	(✓) MFG ( ) RDMSD: _____ ( ) OTHER: _____	11	K

RESULT/SYMPTOM: Unit received indicating 72% R.H. Out of tolerance. Allowed ± 4%.

WORK PERFORMED: Adjusted & Calibrated

ID #'S: 30, 208, 243, 181, 170

LIMITED CALIBRATION:

COMMENTS:

QTY	PART #	DESCRIPTION	COST	REPAIR LABOR HOURS: _____
				PARTS TOTAL
				REPAIR LABOR
				SHIPPING
				TEAR DOWN CHARGE
				CALIBRATION 82.00
				TAX 7.7500 6.82
				TOTAL 94.82

APPROVED BY: DATE:

RDMSD 2002
07

RCVD BY
(SIGNED): _____ (PRINTED): _____

CERT. NUMBER: 59147

ROTHE DEVELOPMENT, INC.
METROLOGY SERVICES DIVISION
4614 SINCLAIR RD., SAN ANTONIO, TEXAS 78222 PH:210-648-3131

CERTIFICATE OF CALIBRATION

ISSUED TO: Omega Point Laboratories
16015 Shady Falls Road
Elmendorf, TX 78112-9704
635-8100

MFG: Qualimetri
MODEL: 5021
NOMEN: Hygrothermograph
S/N: 008685
CUST. ID:

CAL DATE: 07/14/1999
DUE DATE: 07/14/2000

CONTROL NO.: 556 - 23721
TECHNICIAN: 11
SPECIFICATIONS: MFG
PROCEDURE: MFG
WORK ORDER: 72536
CUSTOMER P.O.: 119350
RECEIVED CONDITION: OUT OF TOLERANCE
RETURNED CONDITION: IN TOLERANCE

CALIBRATION PERFORMED AT: RDMSD
CALIBRATION INTERVAL: 12mos.
TEMPERATURE: 73 °F
RELATIVE HUMIDITY: 38 %

DATE RECEIVED: 06/07/1999

COMMENTS:

ATTACHMENTS: CALIBRATION DATA

Calibrations performed at Rothe Development, Inc. Metrology Services Division meet the requirements of ANSI/NCSL Z540-1-94, ISO/IEC GUIDE 25, and ISO 10012-1, and are traceable to the National Institute of Standards and Technology. The collective uncertainty of the measurement(s) does not exceed 25% (TUR≥4:1) of the instrument specification(s) unless noted in the COMMENTS section.

TR#	MFG	MODEL	SERIAL NO.	DUE DATE
30	HP	3458A	2823A01926	08/19/1999
208	LOGAN	4150	9424-3	09/03/1999
243	LOGAN	4150	9350-1	06/29/2000
181	BROOKLYN	3721Y-FC	01635	08/18/2000
170	BROOKLYN	1721Y-FC	10400	01/16/2000

Calibration Certificate Acceptance

Item Hygrothermograph
SN 008685

	Q/A	Eng.
NIST Traceability Adequate		
As Found/As Left Values		
Calibration Data Sufficient		
Tolerance Range Adequate		
Date of Review:	7-20-99	7/21/99

OPL QA/QC Dept.
Eng./ Dept. Mgr.

APPROVED BY: Peter J. Klemmer ☑ CMS ☐ QCO DATE: 07/19/1999

ROTHE DEVELOPMENT METROLOGY SERVICES

CALIBRATION DATA: QUALIMETRICS 5021 HYGROTHERMOGRAPH

CUSTOMER: Omega Point Laboratories
WO NUMBER: 725310
SERIAL: 0086085
CUST ID:

DATE: 14 July 99
TECH: 11
INST NO: 23221

CALIBRATION DATA TAKEN

INCOMING ✓
OUTGOING

CONDITION OF EQUIPMENT

IN TOLERANCE
OUT OF TOLERANCE ✓ *

HUMIDITY ACCURACY

ACTUAL	TOLERANCE	READING
33	±1%	30 *
67	±1%	64 *

TEMPERATURE ACCURACY

ACTUAL	TOLERANCE	READING
73	±1.1°	73

ROTHE DEVELOPMENT METROLOGY SERVICES

CALIBRATION DATA: QUALIMETRICS 5021 HYGROTHERMOGRAPH

CUSTOMER: Omega Point Laboratories
WO NUMBER: 72536
SERIAL: 008685
CUST ID:

DATE: 14 July 99
TECH: 11
INST NO: 23721

CALIBRATION DATA TAKEN

INCOMING
OUTGOING ✓

CONDITION OF EQUIPMENT

IN TOLERANCE ✓
OUT OF TOLERANCE

HUMIDITY ACCURACY

ACTUAL	TOLERANCE	READING
36	±1%	36
70	±1%	70

TEMPERATURE ACCURACY

ACTUAL	TOLERANCE	READING
73	±1.1°	73

Memorandum

Date: August 13, 1999

To: Cleda Patton, Senior Administrative Assistant

From: Ernst Schmidt, Manager of Flammability Testing

Re: Hygrothermograph (SN 008685)

This memo shall reference a hygrothermograph with a serial number of 008685. The hygrothermograph was received from Rothe Development, Inc. with a report that stated it was reading 3% low on the Relative Humidity scale. The humidity in the conditioning room is maintained at 50% R. H.. Most standards that Omega Point Laboratories tests to require a Relative Humidity of 55% or less. There are a few standards which require a Relative Humidity of 45% to 55%. Since the Relative Humidity in the conditioning room is maintained at 50%, the actual humidity would have been 53% R. H.. This Relative Humidity would fall into the ranges that are allowable by the standards. This hygrothermograph which was out of calibration while in use in the conditioning room would not pose a problem to the quality control system that we have in place at the laboratory. This is due to the fact that the actual Relative Humidity in the conditioning room would fall into the allowable ranges set forth in the standards that are used for testing.

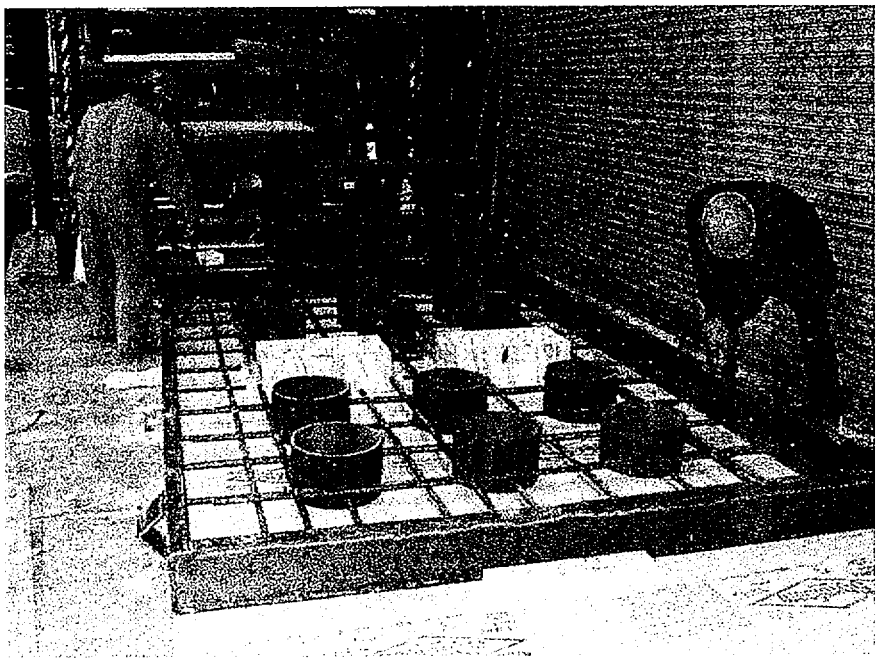
If there are any further questions regarding the use of this hygrothermograph, please see me.

Ernst L. Schmidt, Jr.
Manager, Flammability Testing

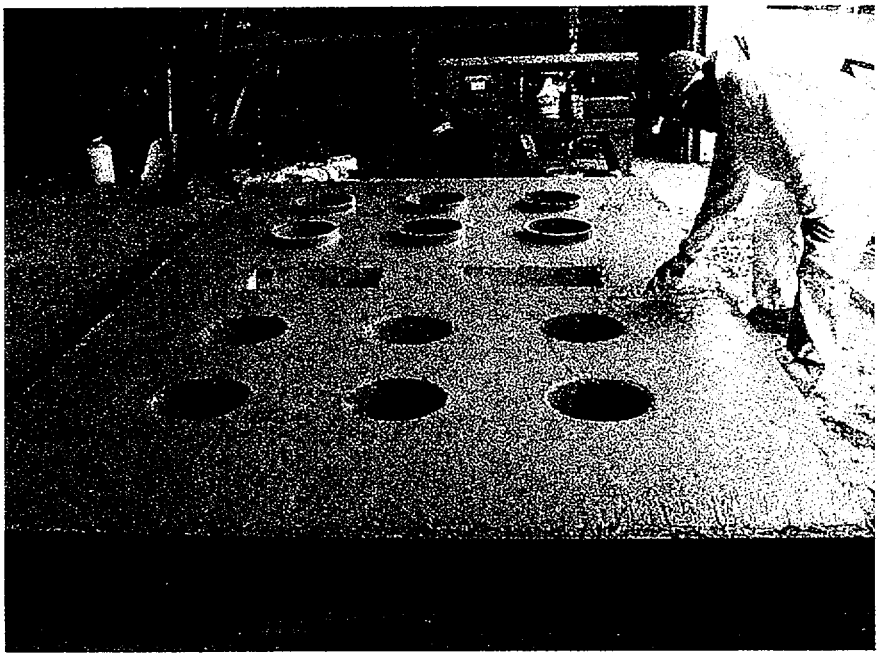
Date: 8/13/99

Appendix F

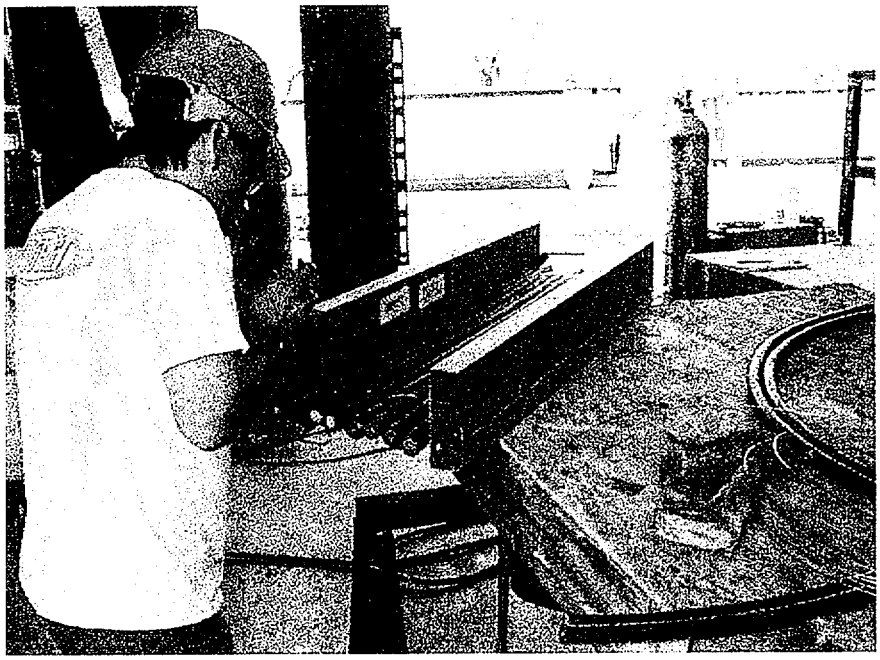
PHOTOGRAPHS



#1: Slab ready for concrete.

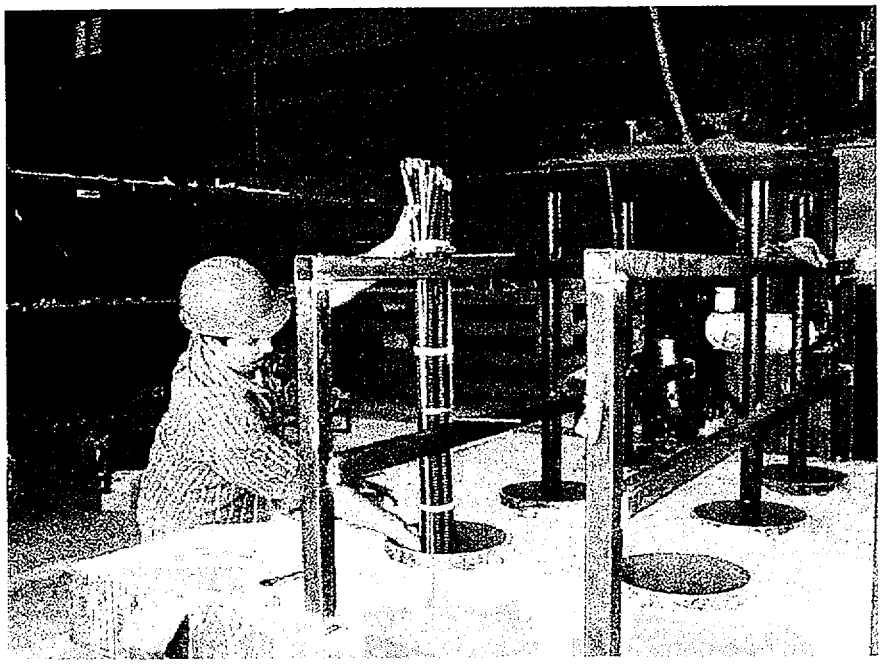


#2: Concrete in place being finished.

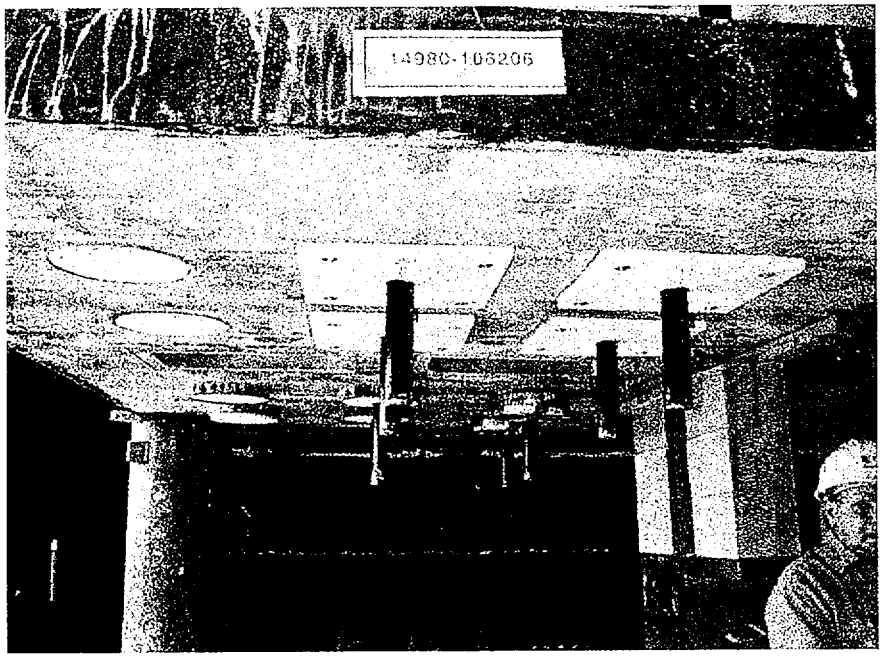


#3: Installing cables into a tray.

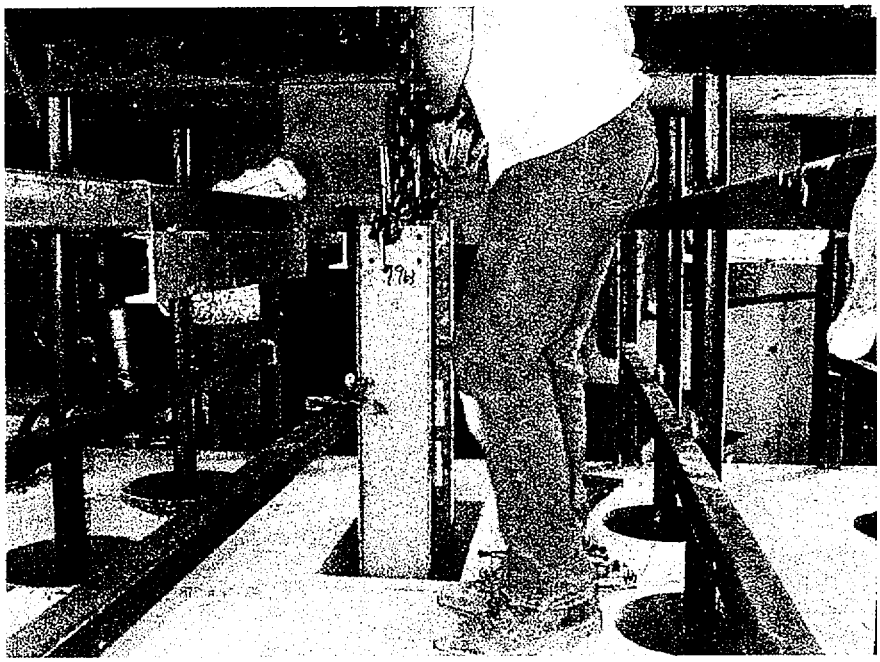
#4: Assembling the cable bundles.



#5: Installing cable bundle.

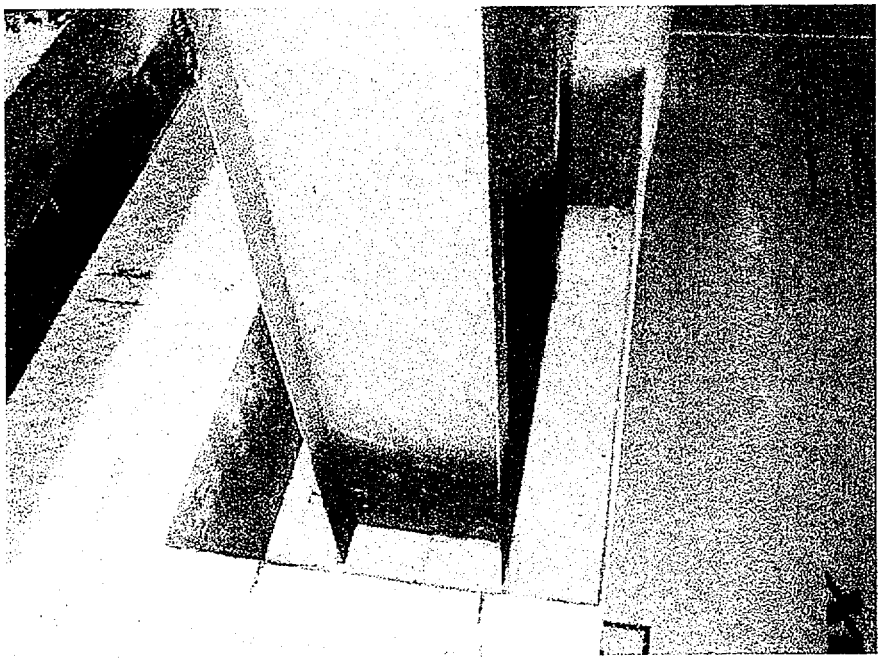


#6: Under side of slab during construction.



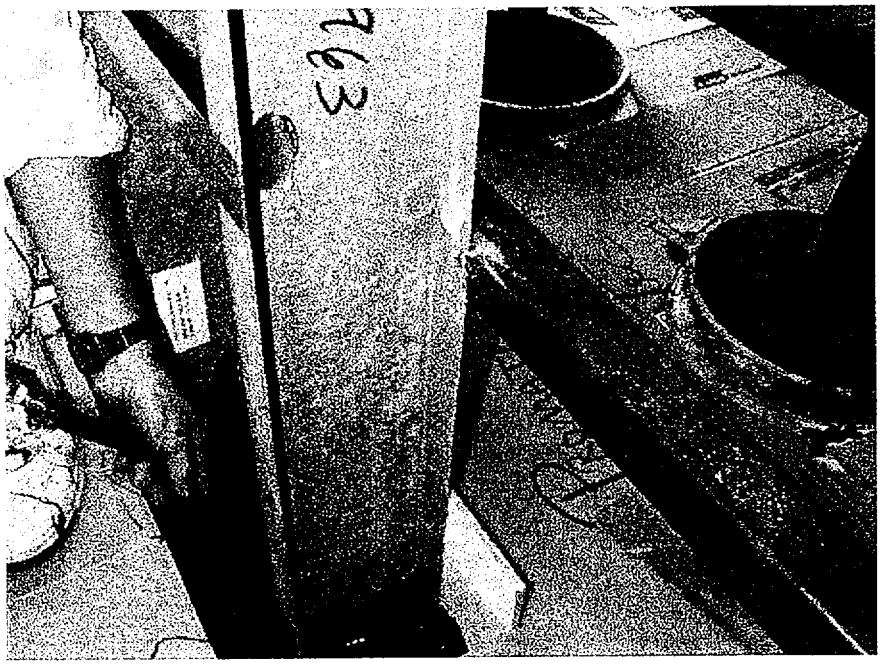
#7: Installing loaded tray into the slab.

#8: Damming around cable bundle.

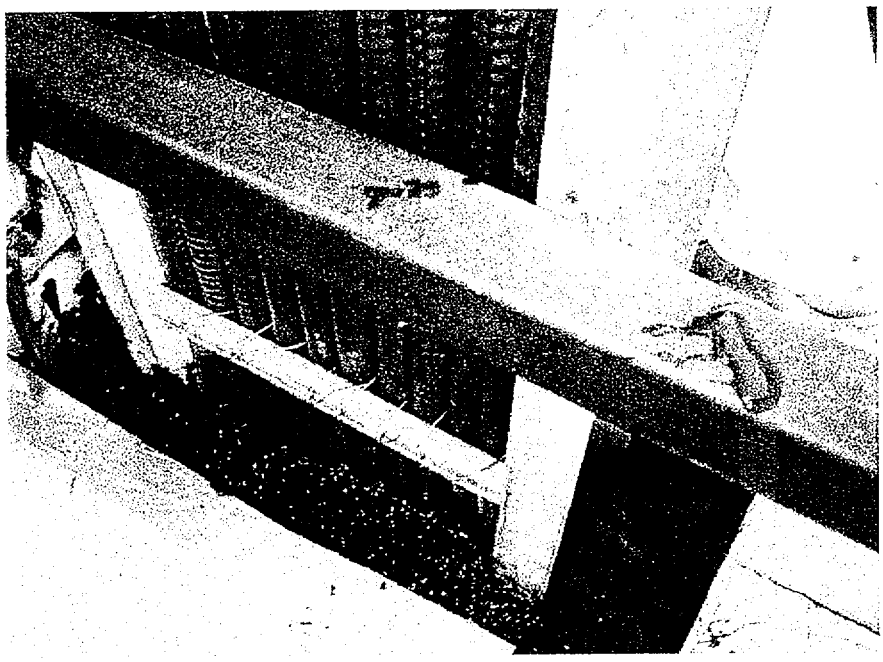


#9: Damming at bottom of tray seal.

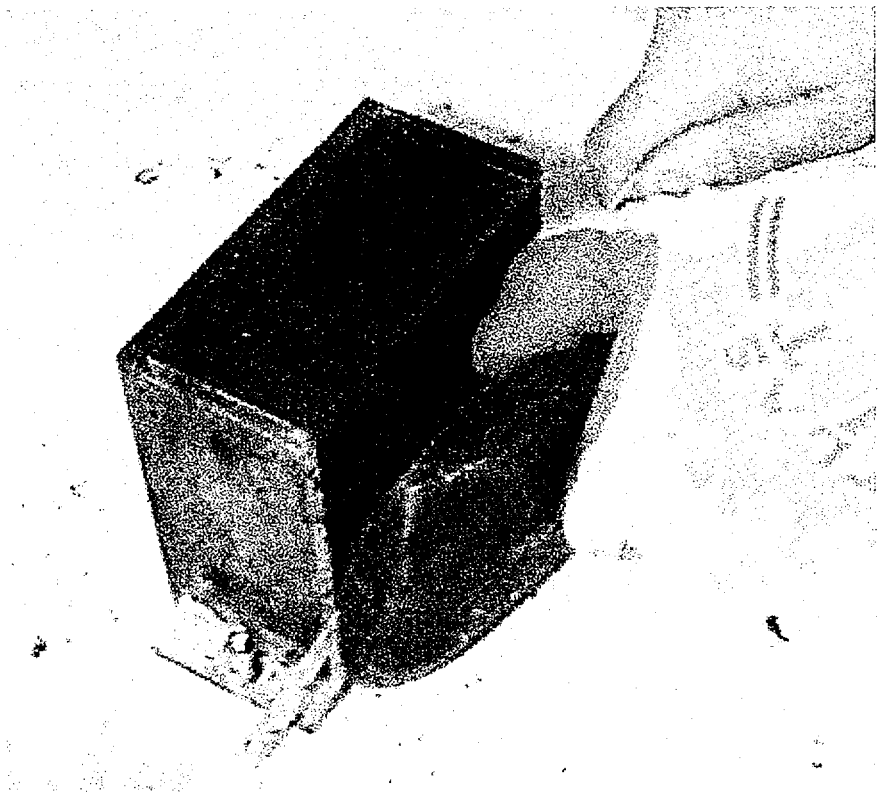
#10: Installing foam around a pipe.



#11: Installing foam into tray system.

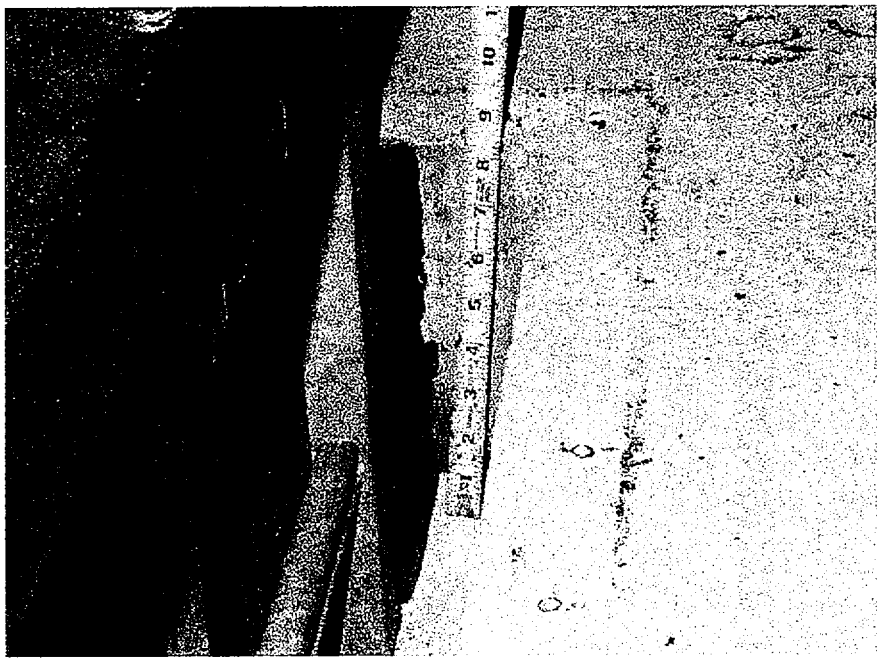


#12: Installing poor quality foam into repair.

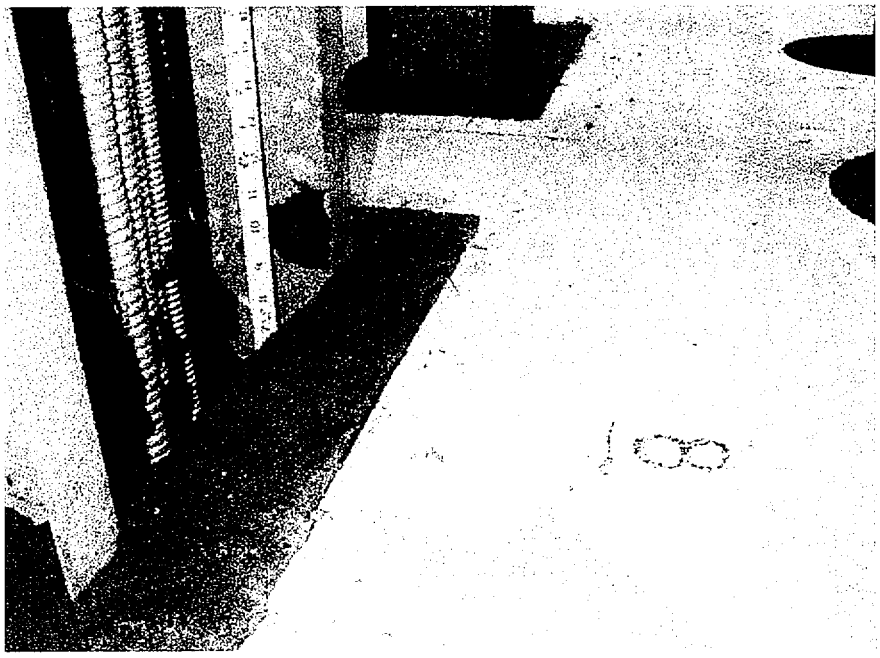


#13: Measuring the density of the foam.

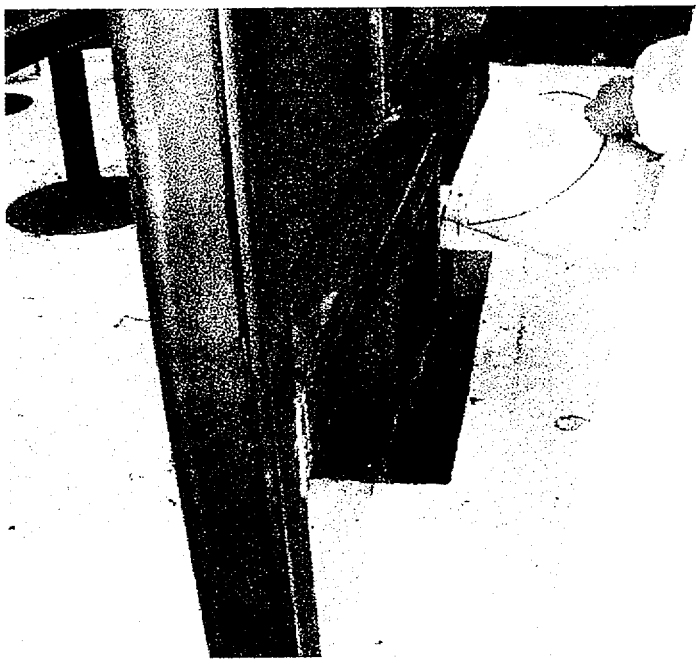
#14: Trimming foam level with the slab.



#15: Depth of the repair.

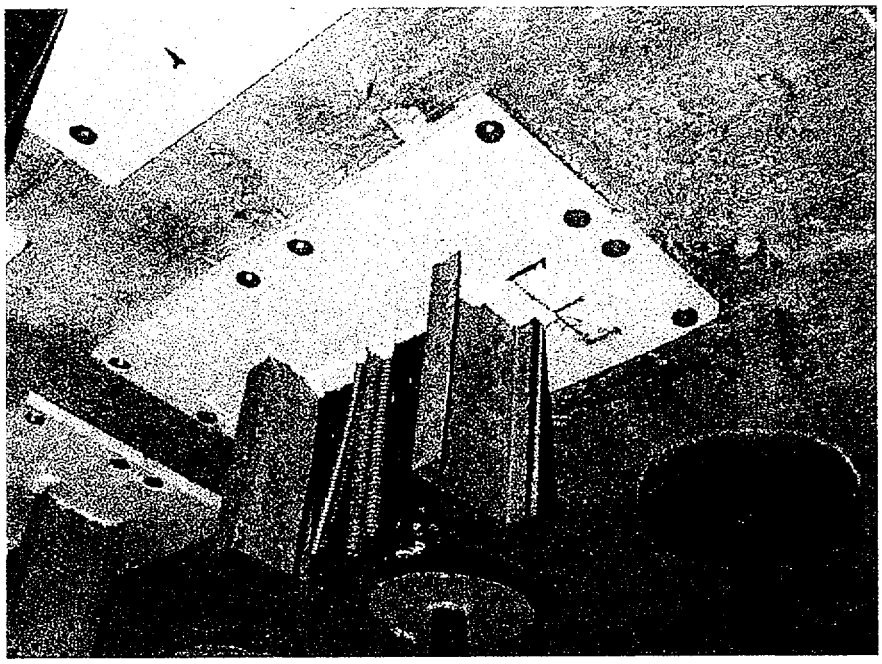


#16: Depth of the repair.

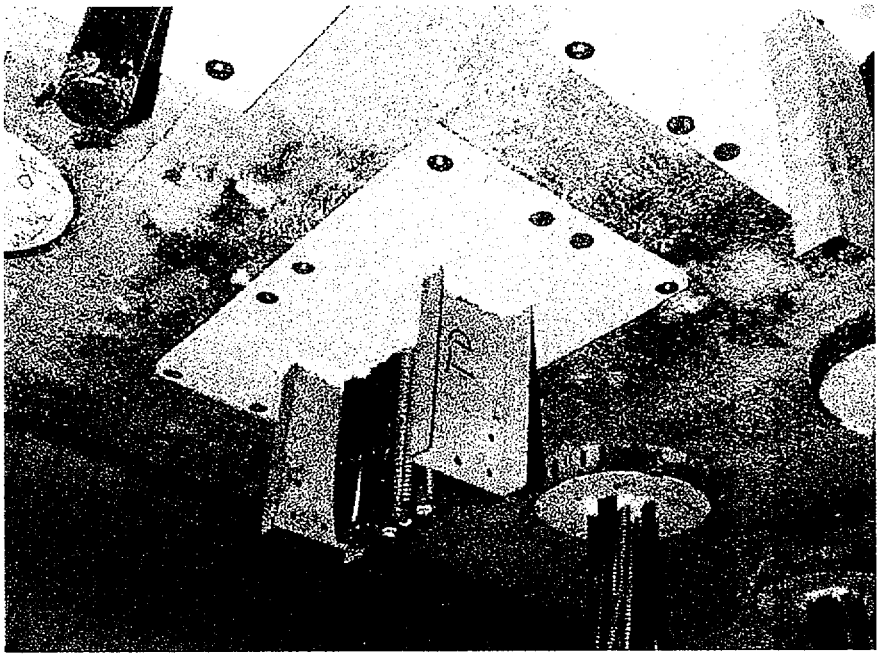


#17: Completing the pour.

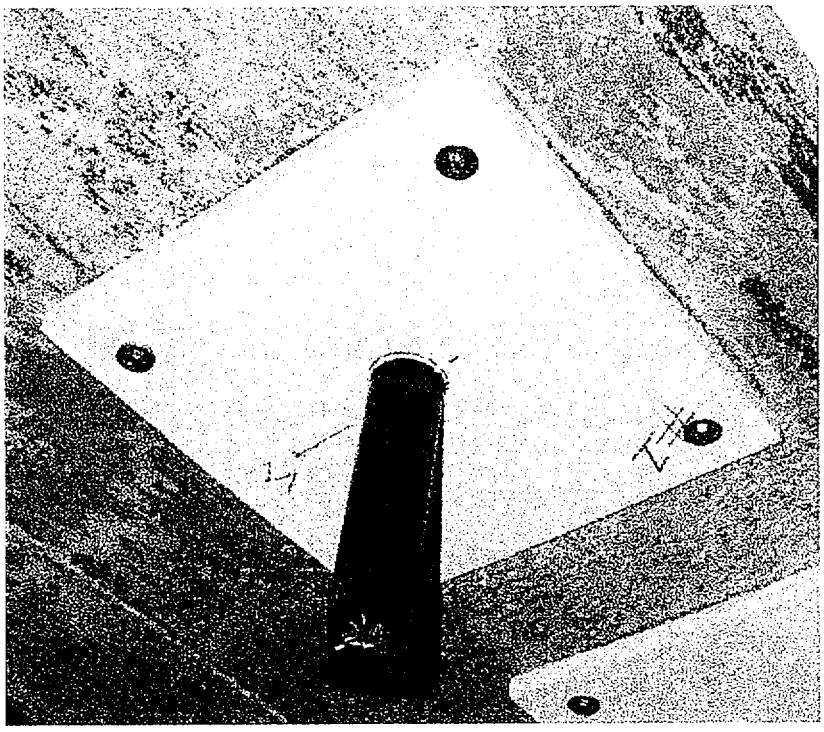
#18: Under side of the completed slab.



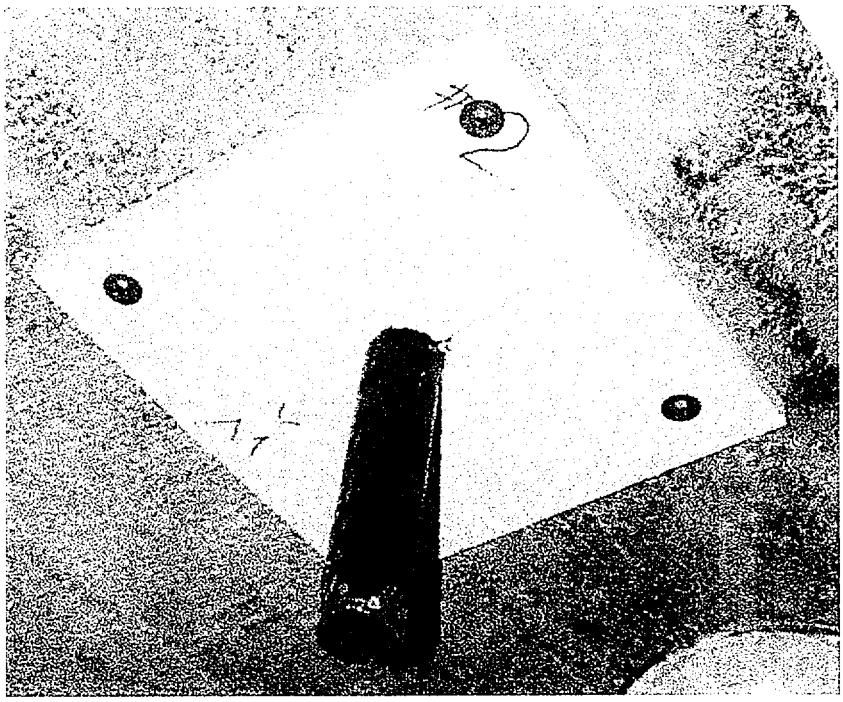
#19: Exposed surface of Pen. 7.



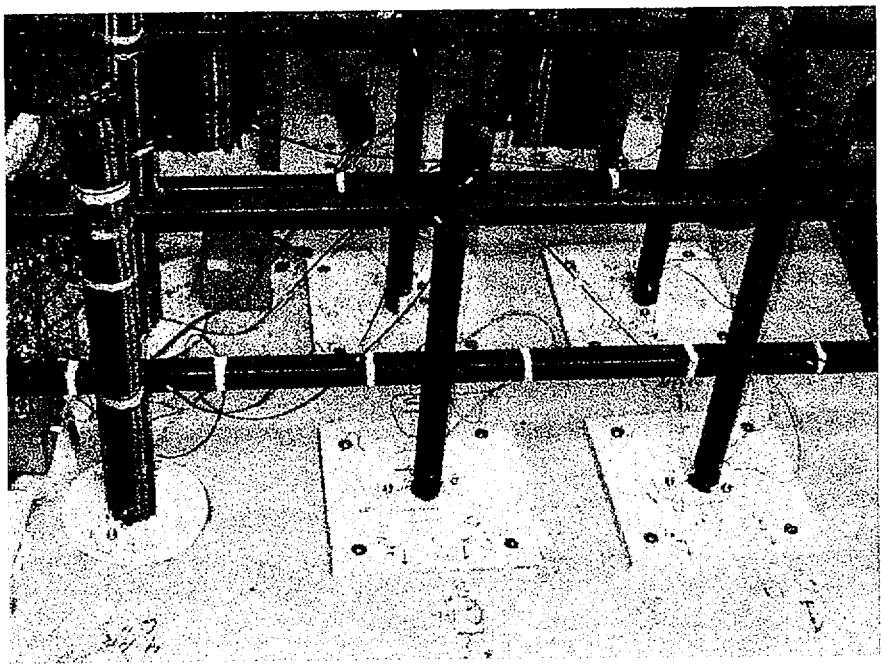
#20: Exposed surface of Pen. 8.



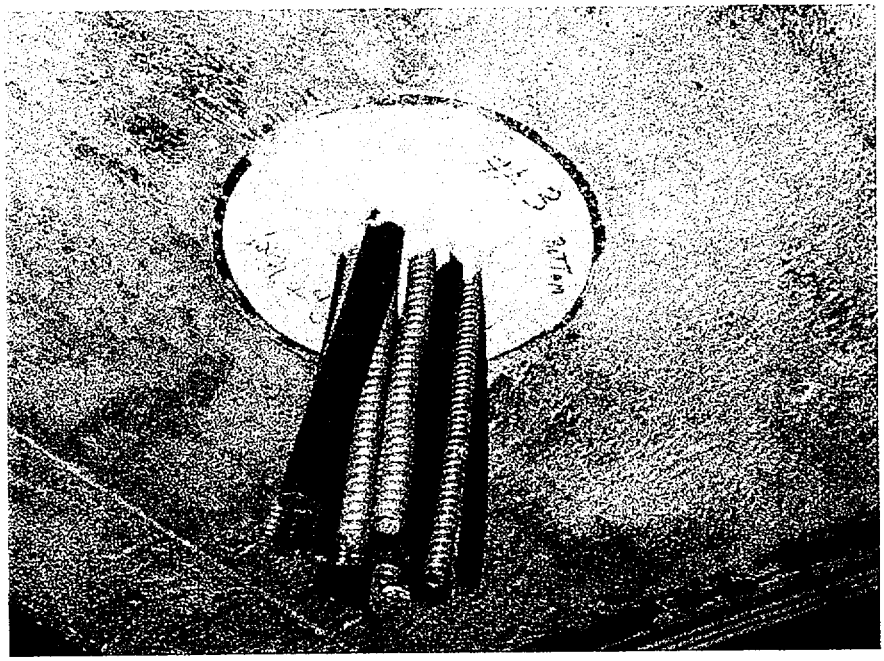
#21: Exposed surface of Pen. 1.



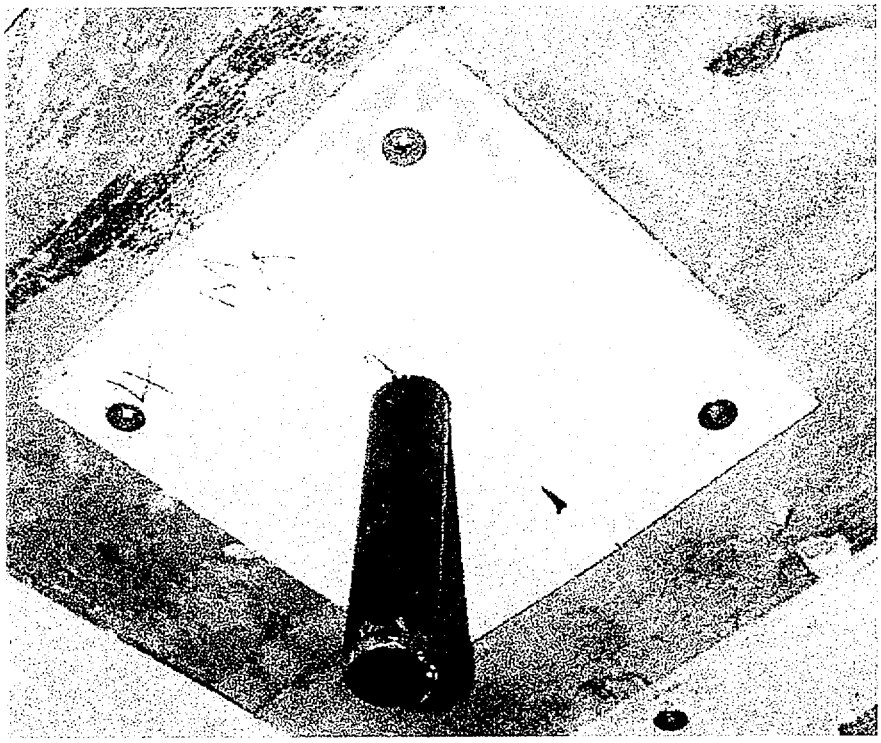
#22: Exposed surface of Pen. 2.



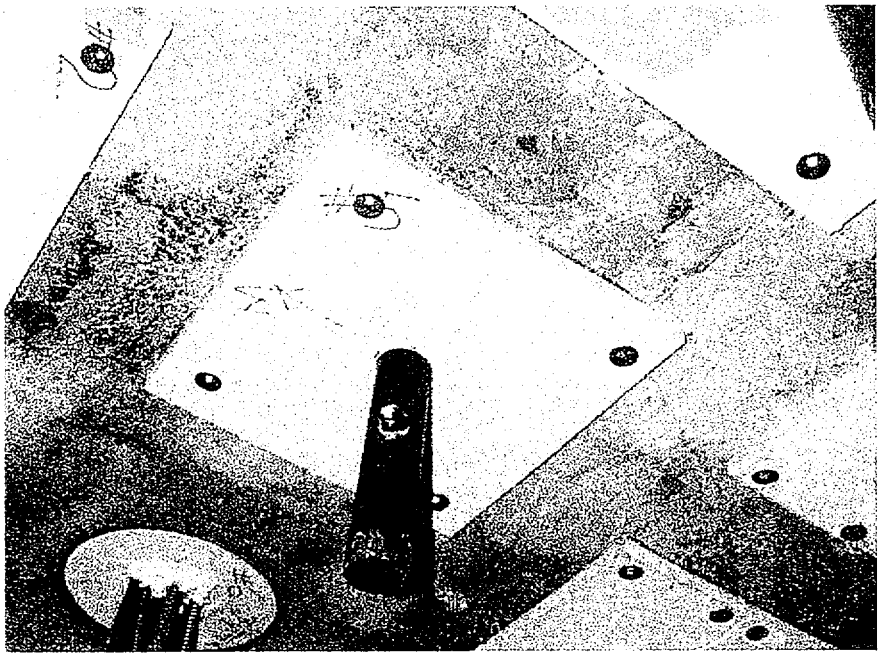
#23: Thermocouples installed on penetration seals.



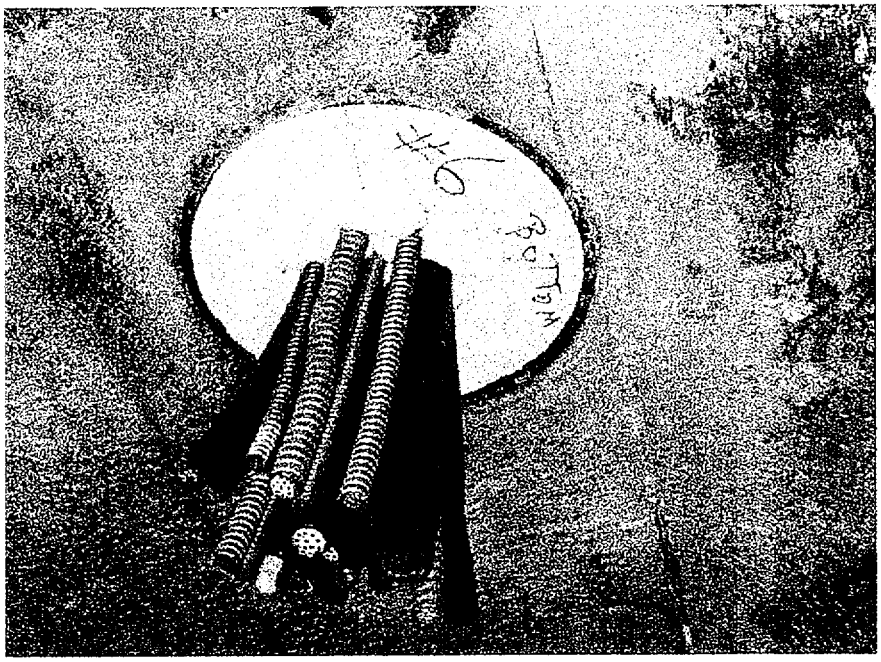
#24: Exposed surface of Pen. 3.



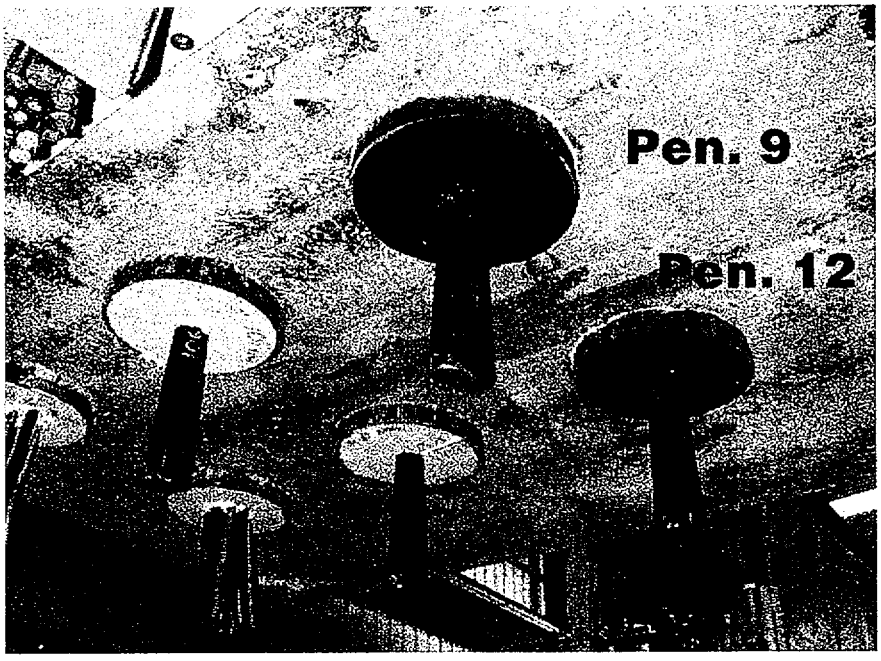
#25: Exposed surface of Pen. 4.



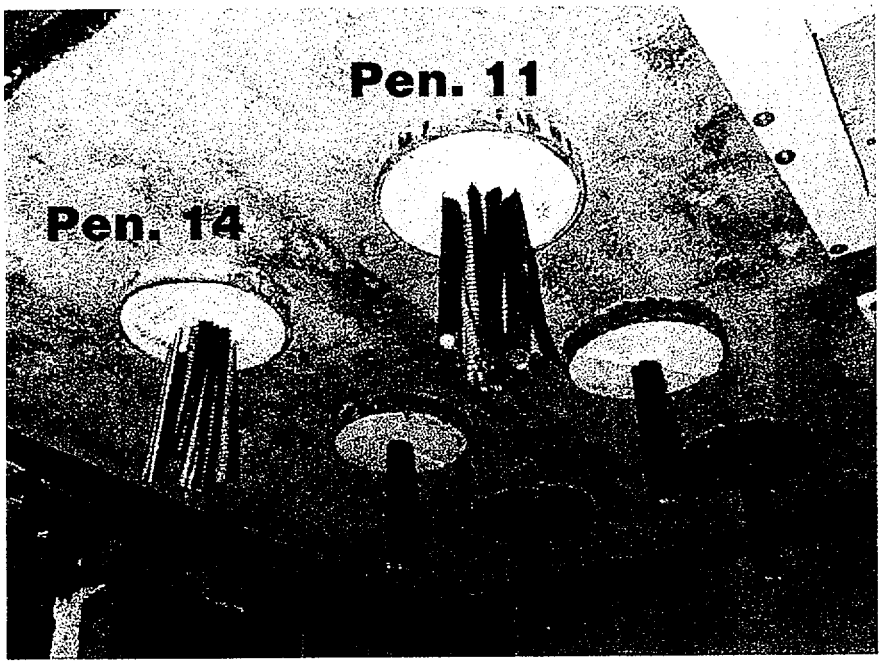
#26: Exposed surface of Pen. 5.



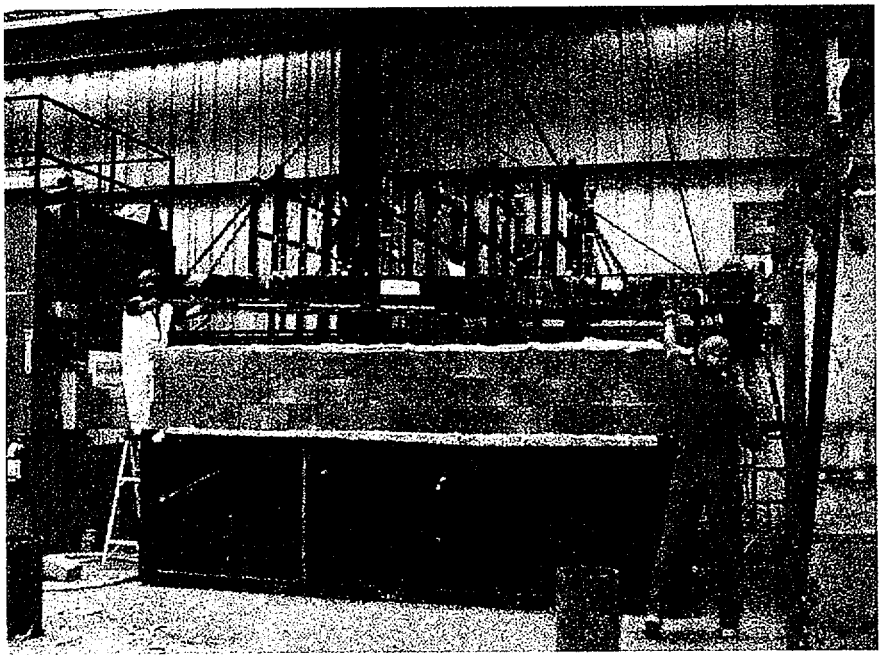
#27: Exposed surface of Pen. 6.



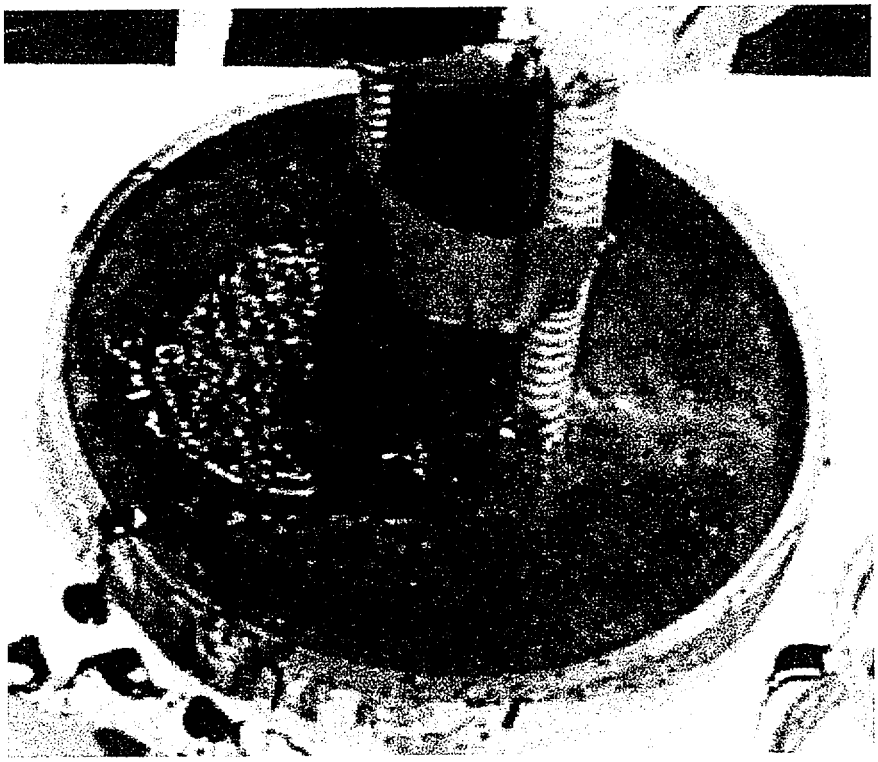
#28: Exposed surface of Pens. 9 – 14.



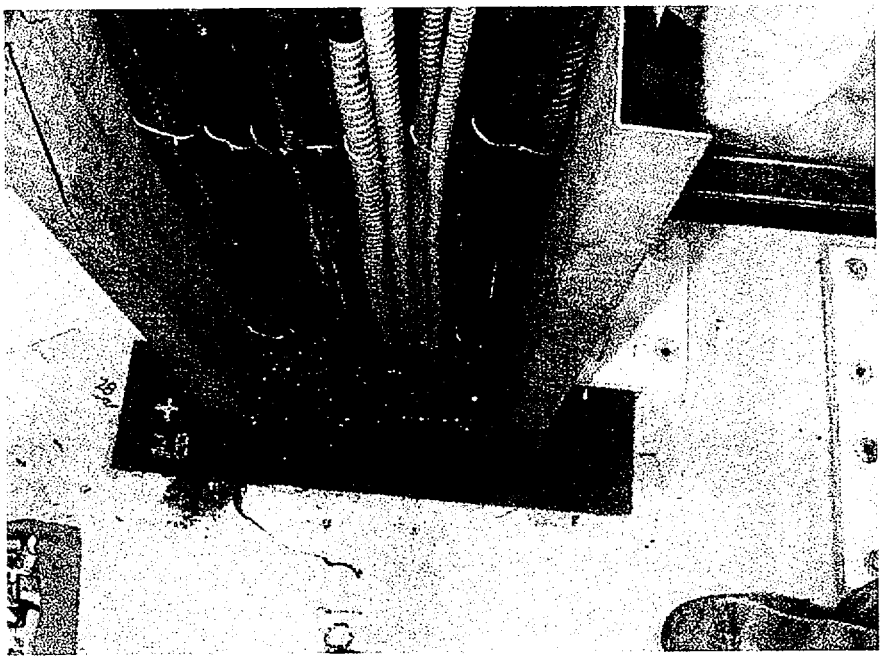
#29: Exposed surface of Pens. 9 – 14.



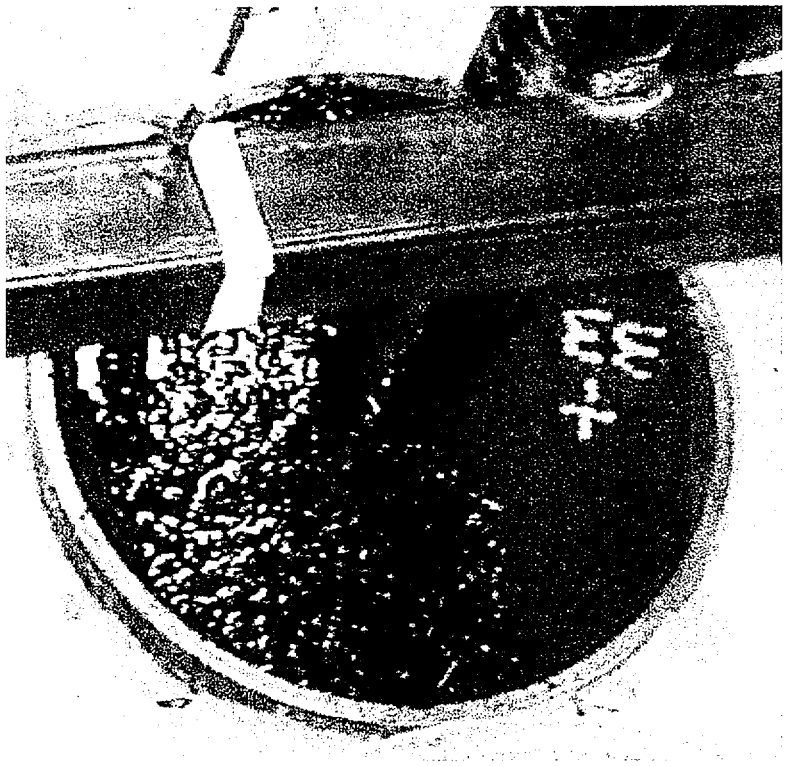
#30: Placing the test article on the furnace.



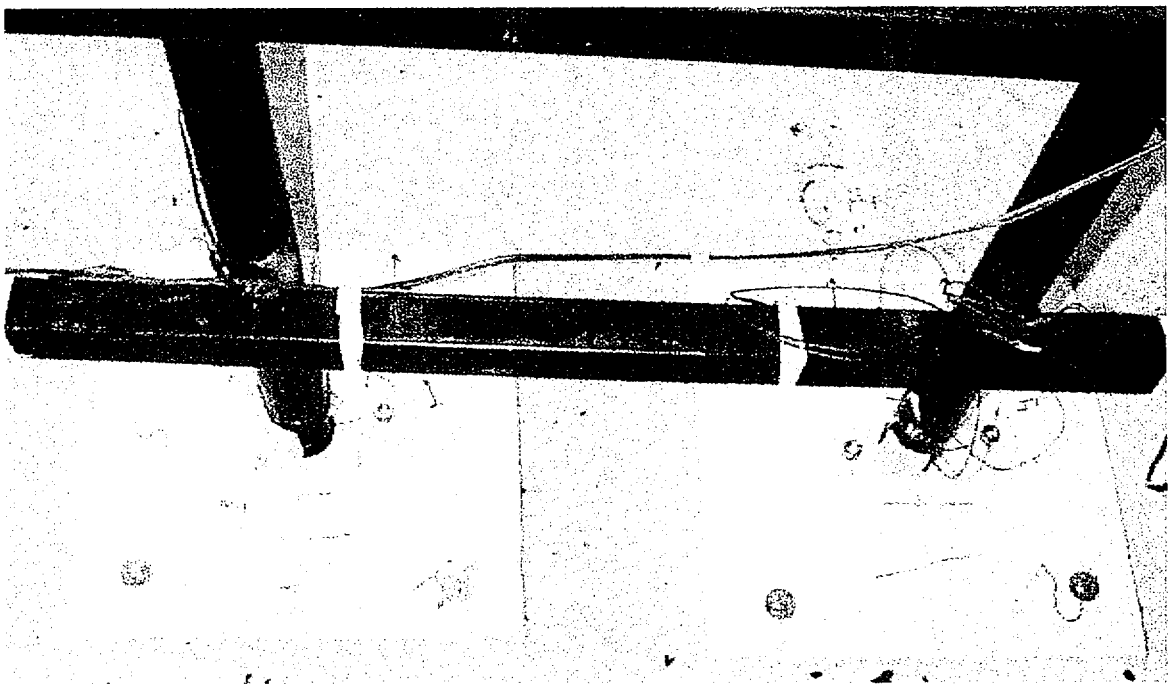
#31: Installing a repair foam in Pen. 14.



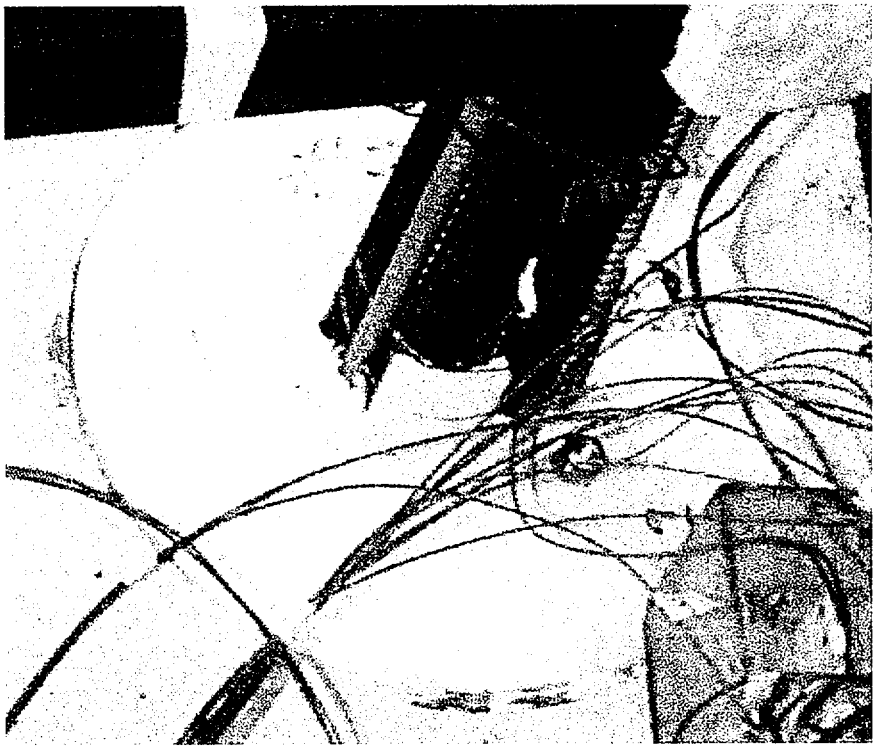
#32: Top of Pen. 8.



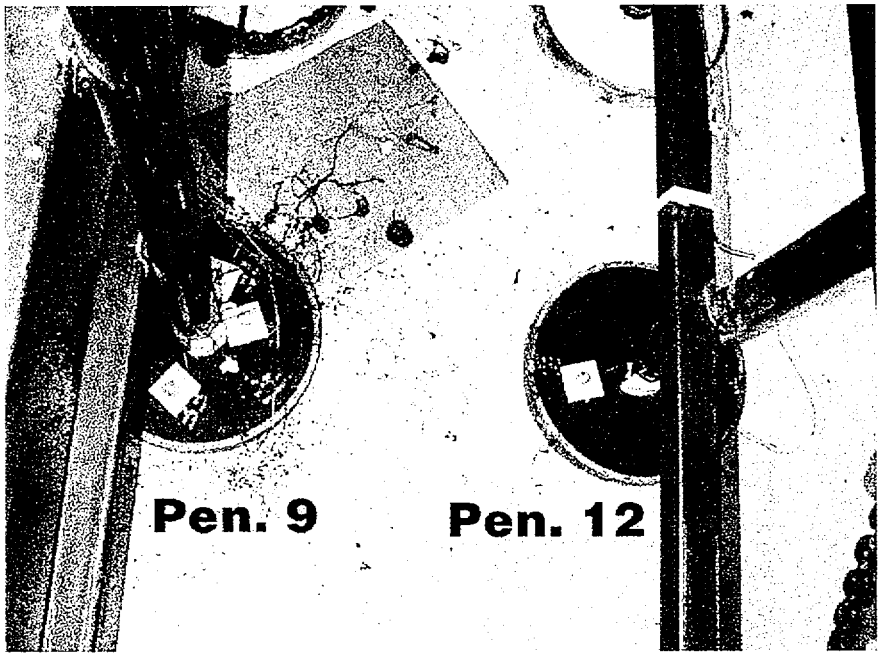
#33: Top surface of Pen. 12.



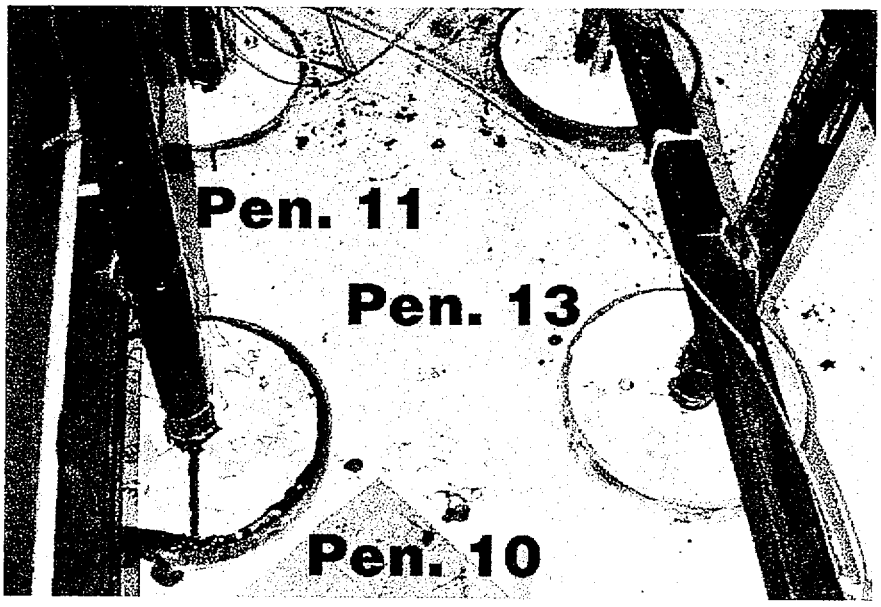
#34: Top of Pens. 1 & 2.



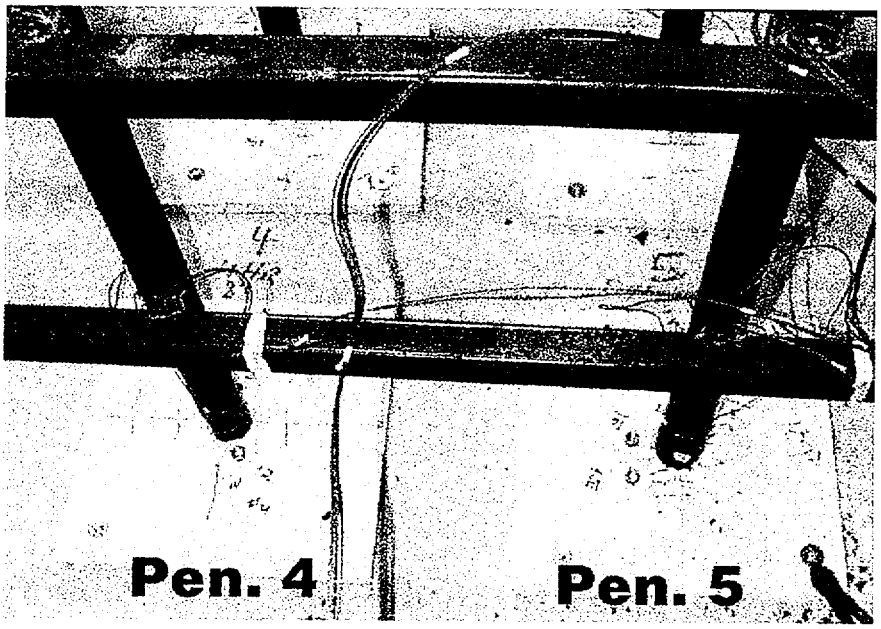
#35: Top of Pen. 3.



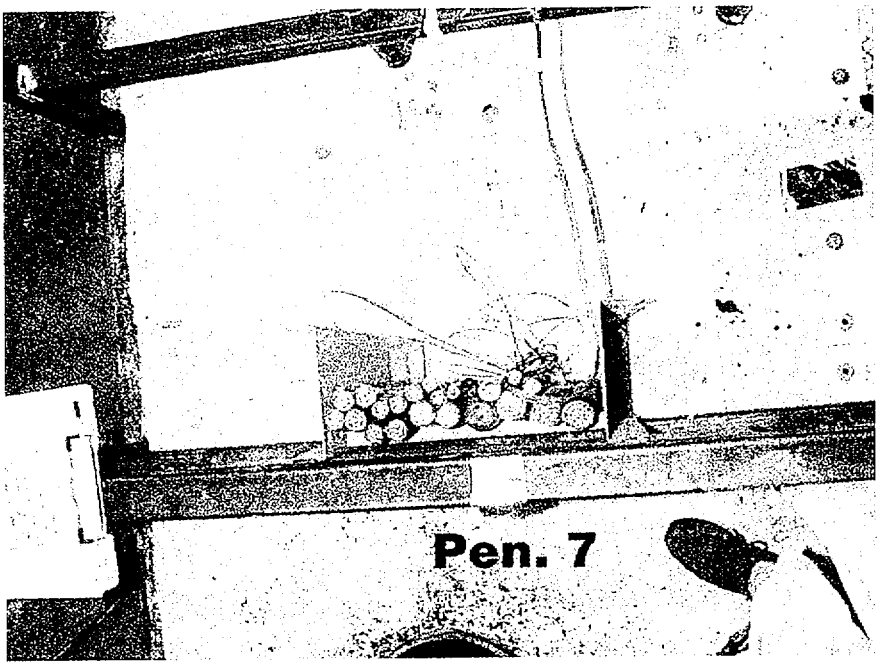
#36: Top surfaces of Pens. 9 & 12.



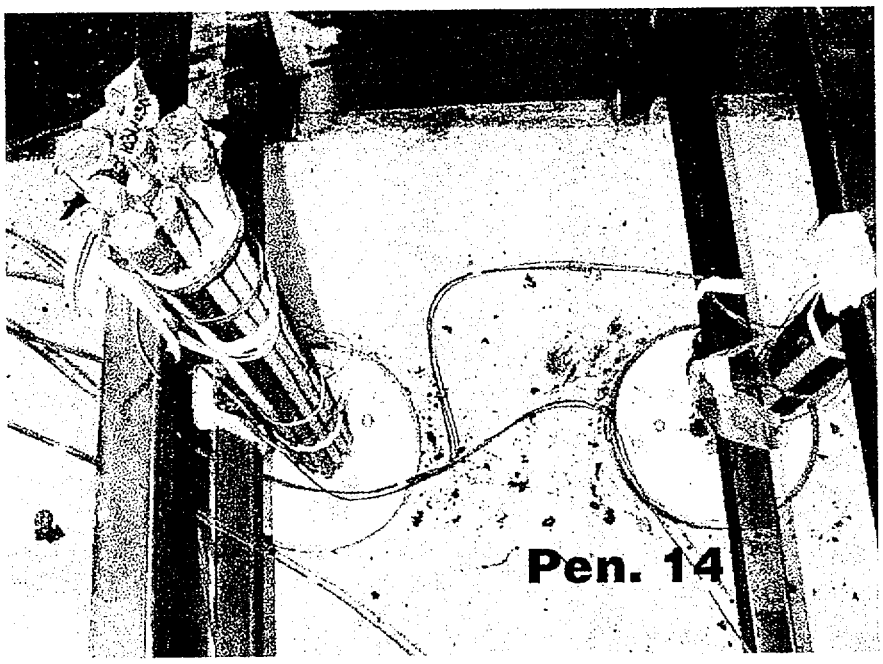
#37: Top surfaces of Pens. 10, 11, 13 & 14.



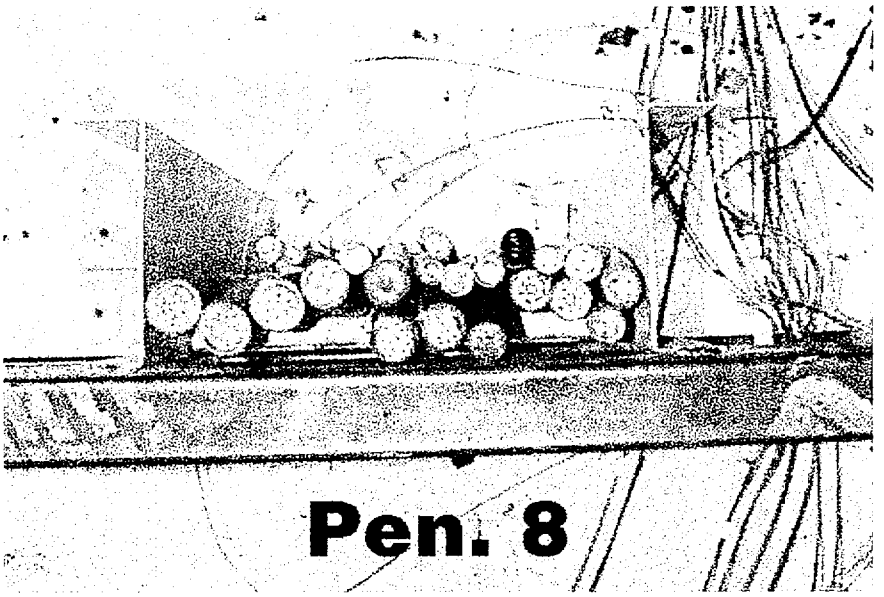
#38: Tops of Pens. 4 & 5.



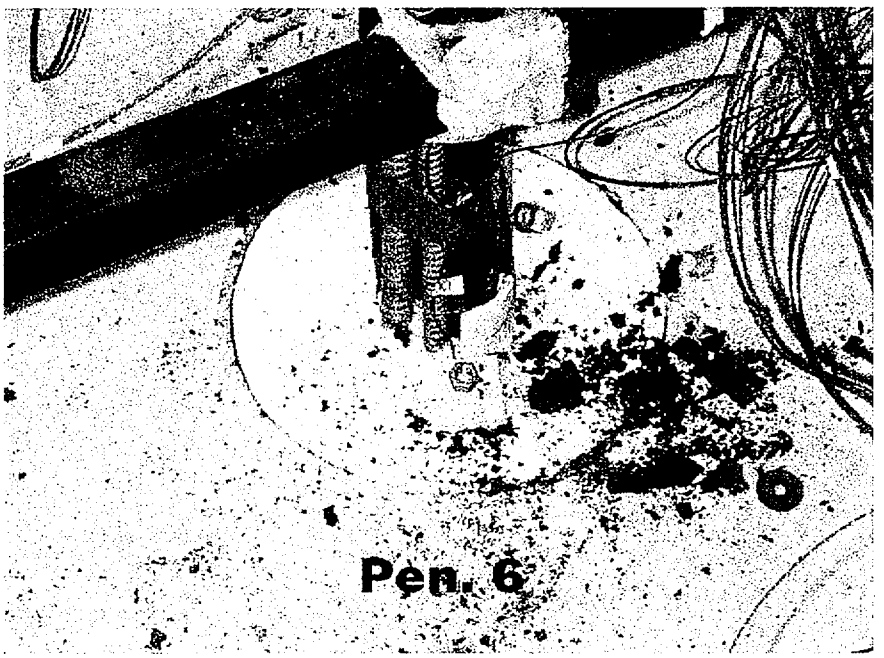
#39: Top of Pen. 7.



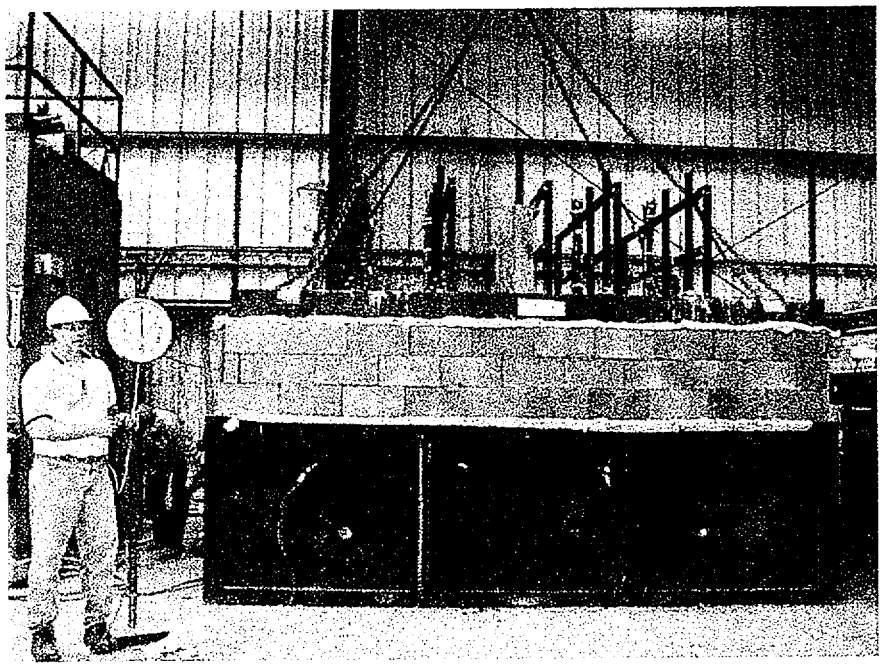
#40: Top surface of Pen. 14.



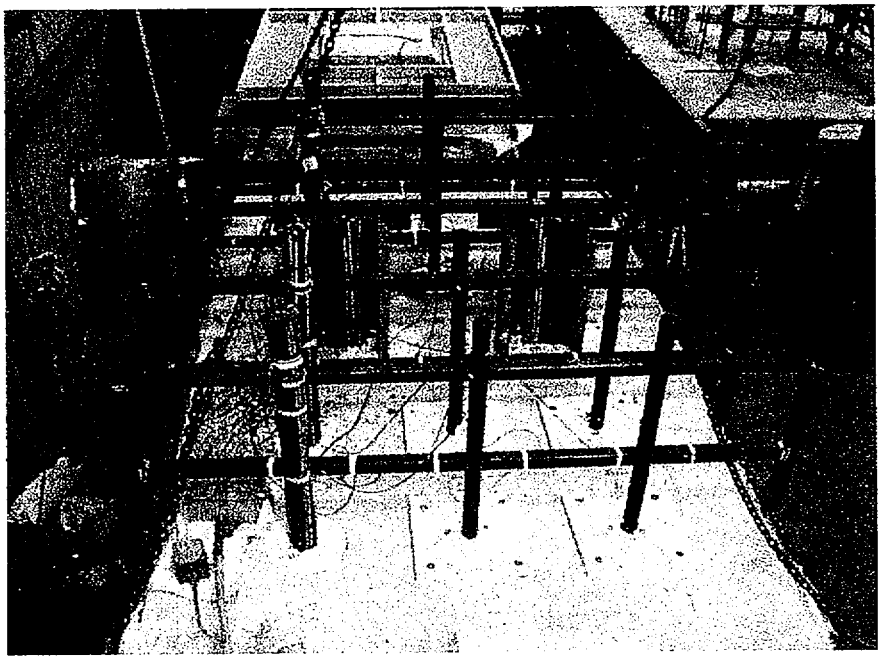
#41: Top surface of Pen. 8.



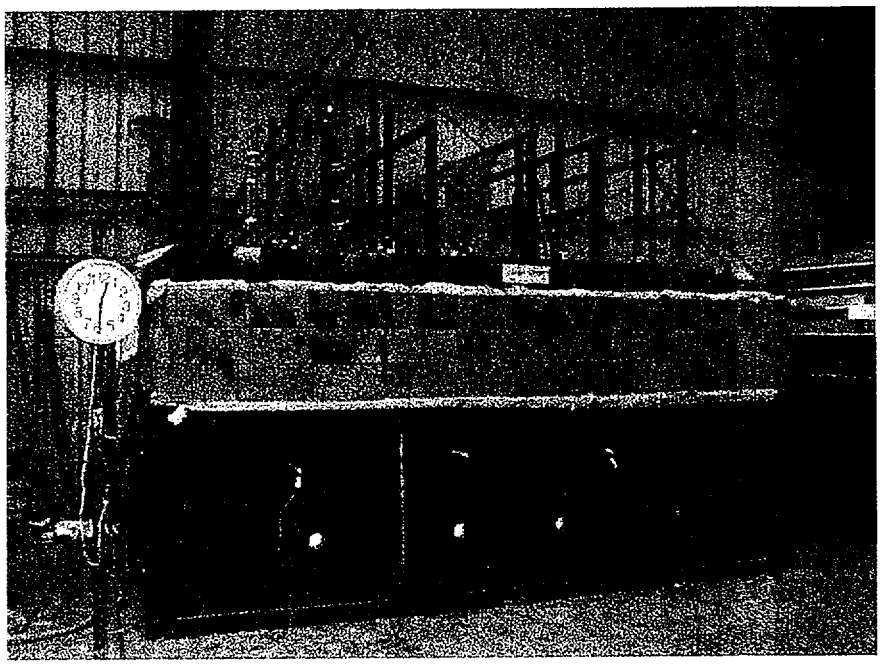
#42: Top surface of Pen. 6.



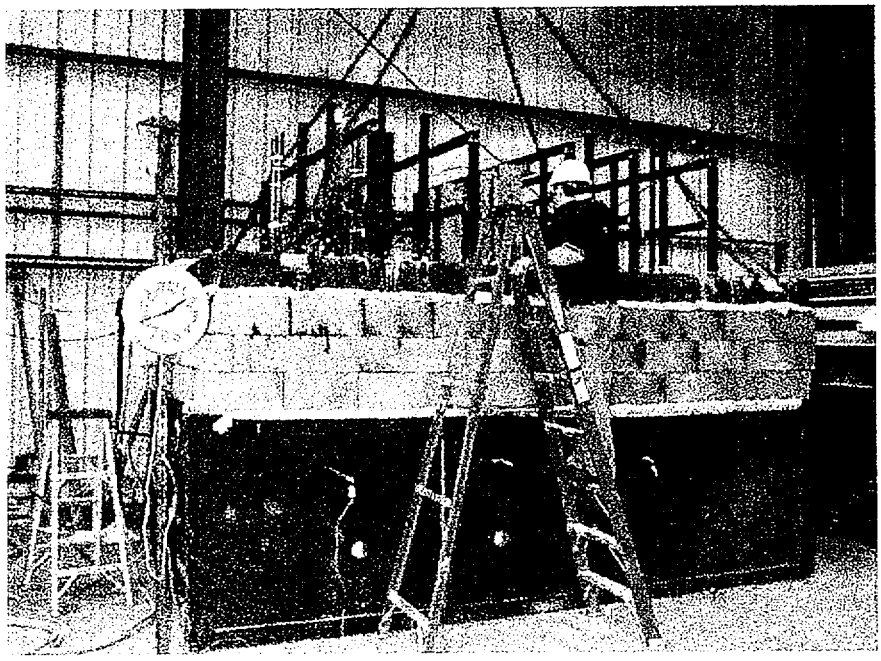
#43: Start of test.



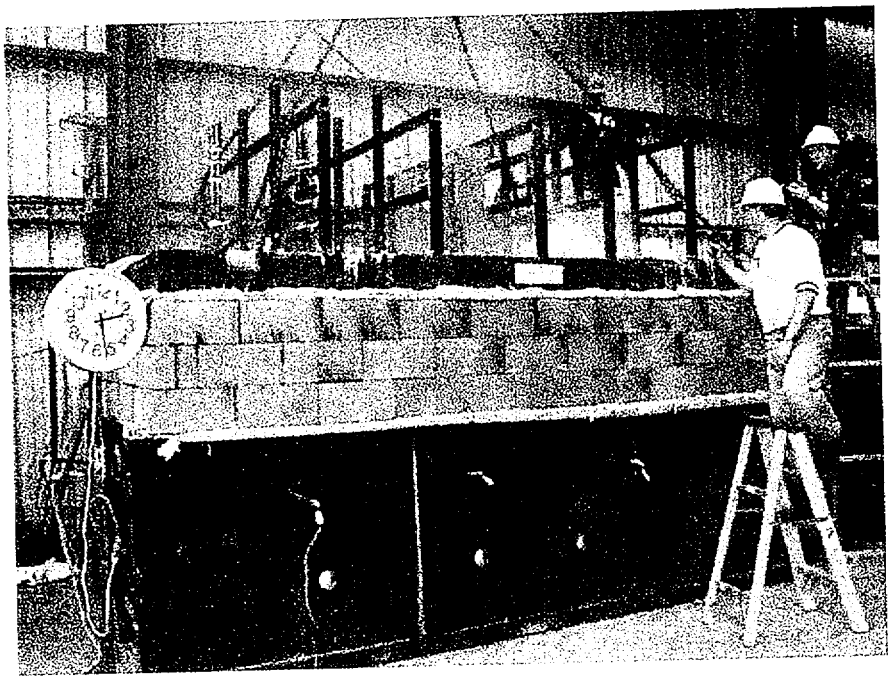
#44: Top surface at start of test.



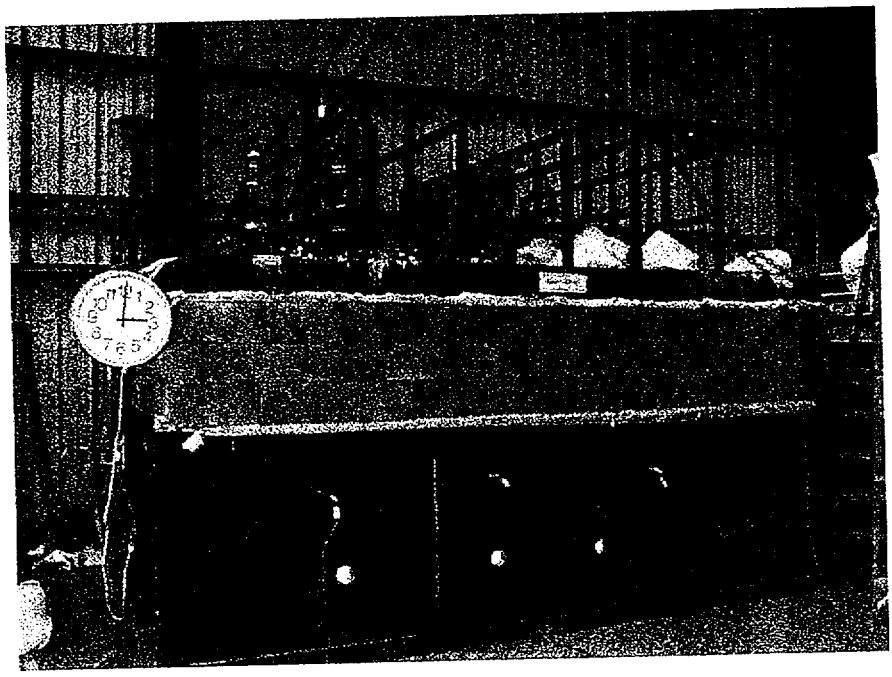
#45: Test article after 30 minutes of fire exposure.



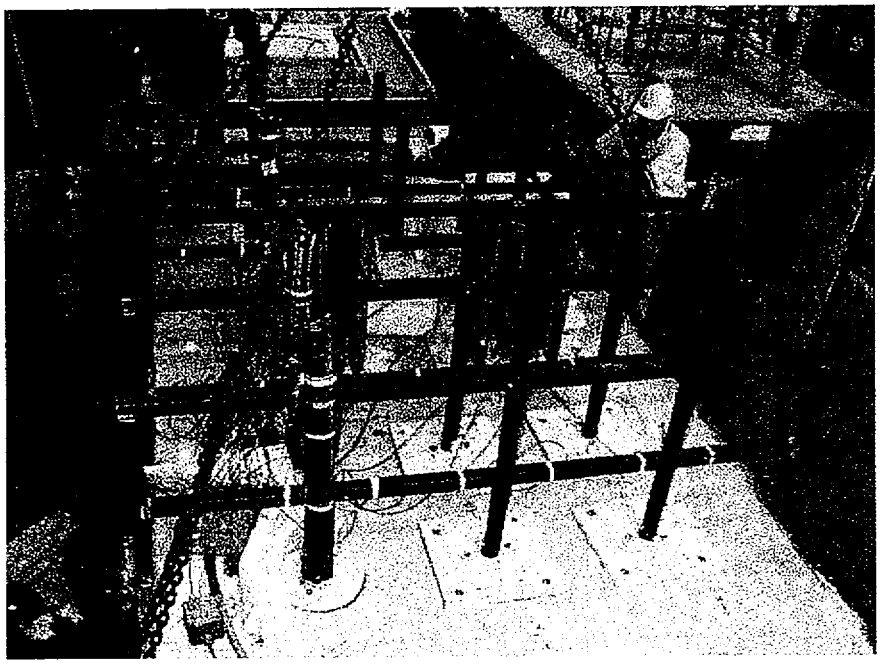
#46: Test article after 1:41 h:min exposure.



#47: Test article after 2:28 h:min exposure.

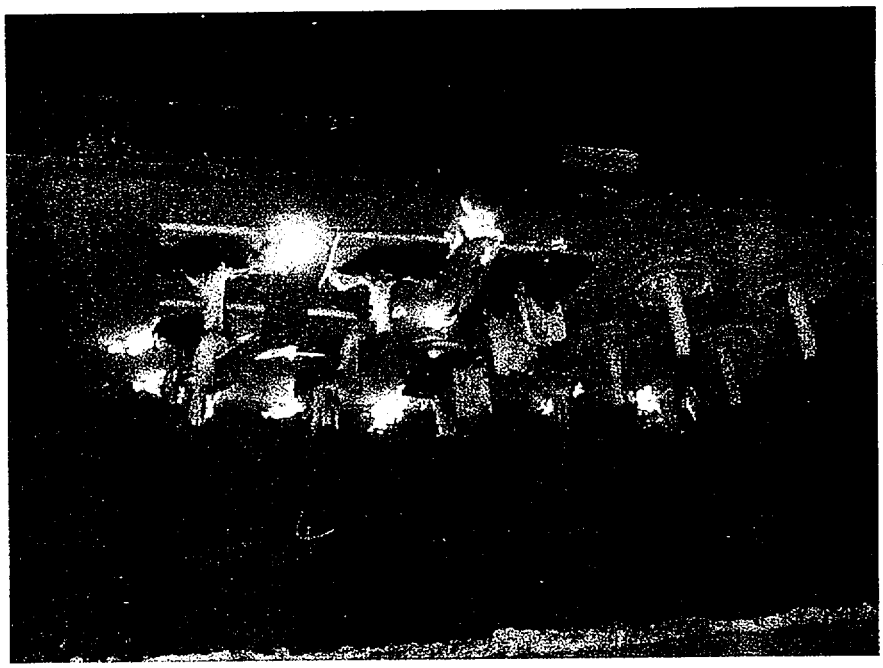


#48: Test article at the end of the test.

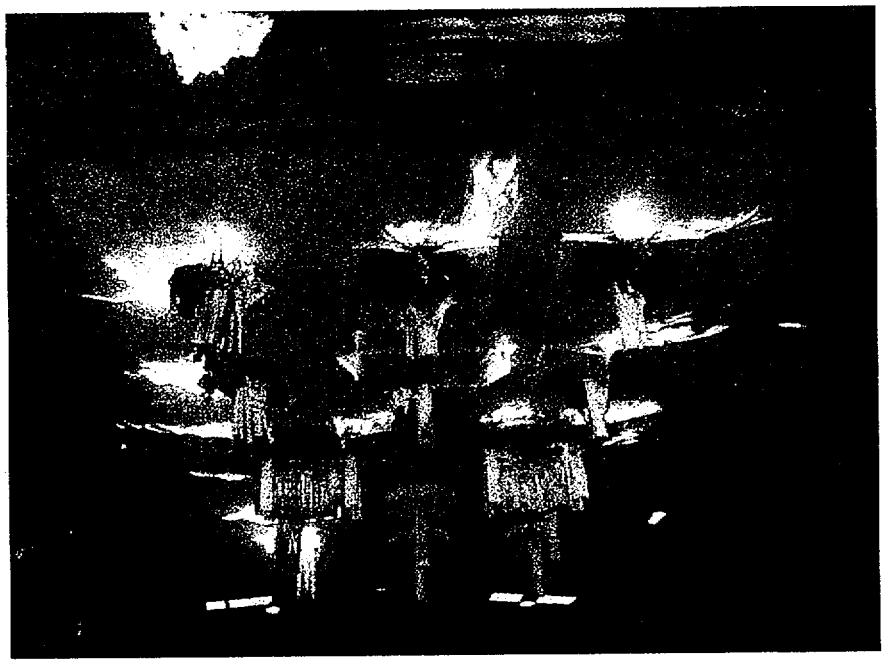


#49: Top surface at the end of the test.

#50: Lifting the slab from the furnace.

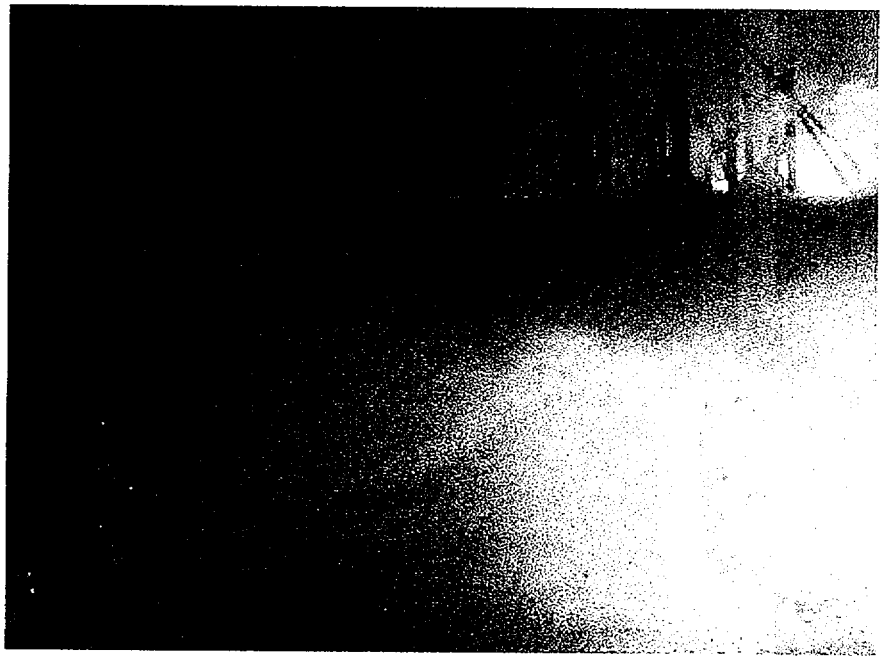


#51: Bottom of slab after test.



#52: Bottom of slab after test.

#53: Bottom of slab after test.

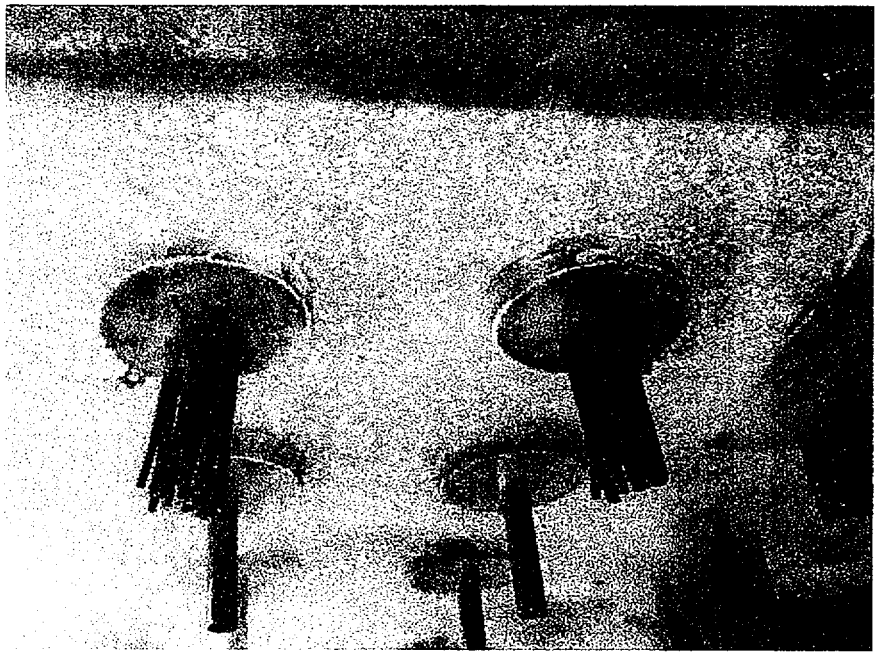


#54: Hose stream test.

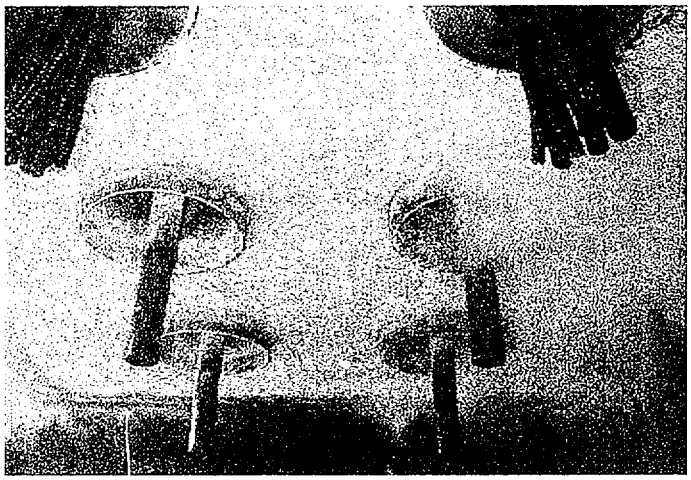
#55: Hose stream test.

#56: Hose stream test.

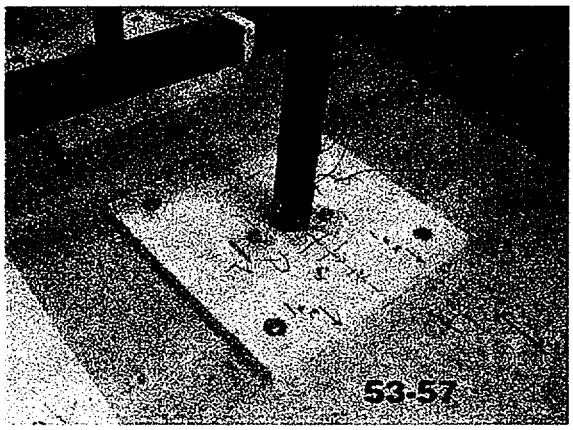
#57: Immediately after the hose stream test.



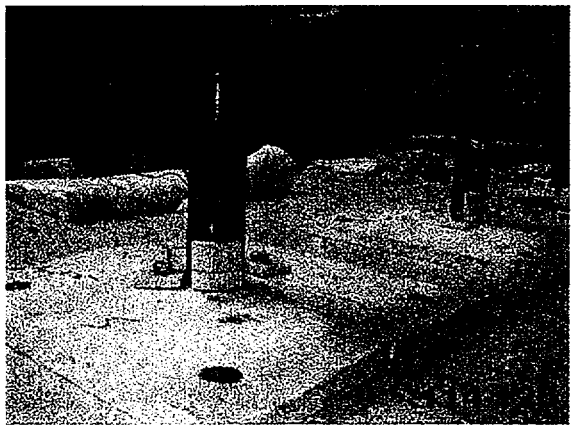
#58: Immediately after the hose stream test.



#59: Immediately after the hose stream test.

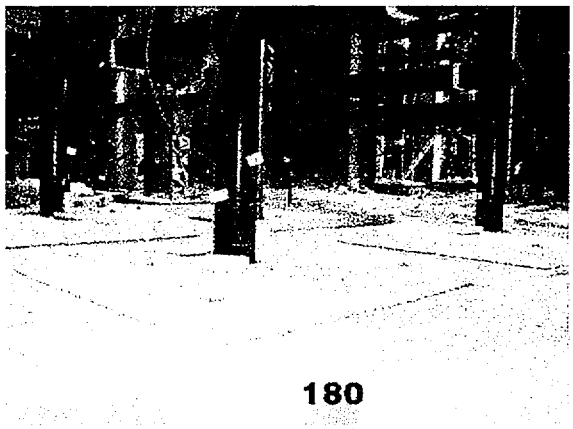


Penetration #1 at 53-57 minutes.

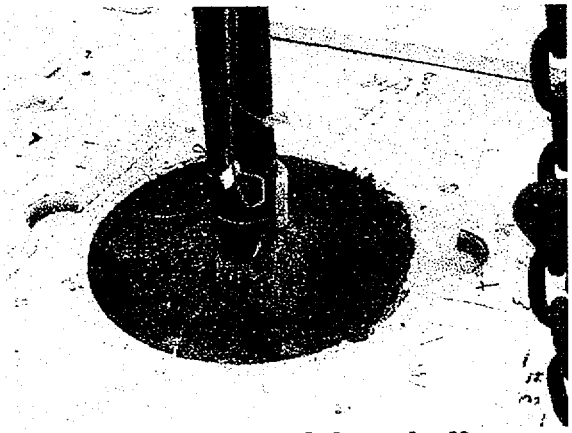


Penetration #1 at 114-120 minutes.

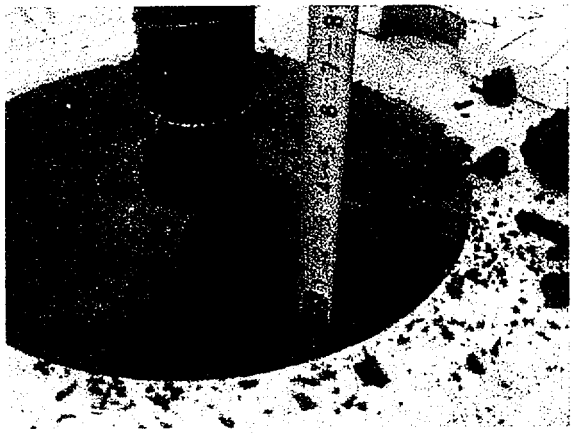
Penetration #1 at 170-175 minutes.



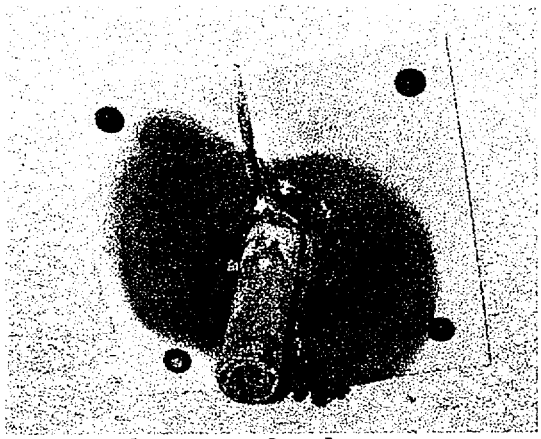
Penetration #1 at 180 minutes.



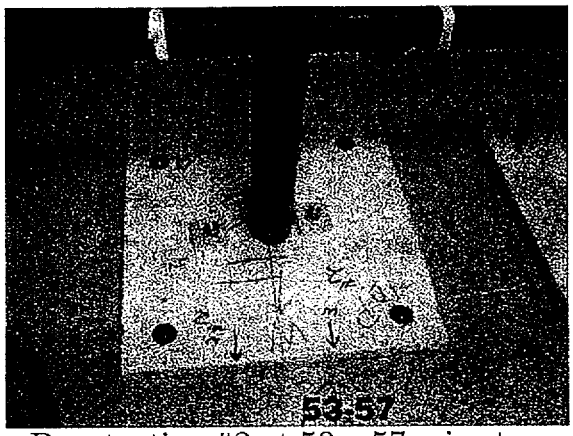
Pen. 1 top with board off.



Pen. 1 cut away.

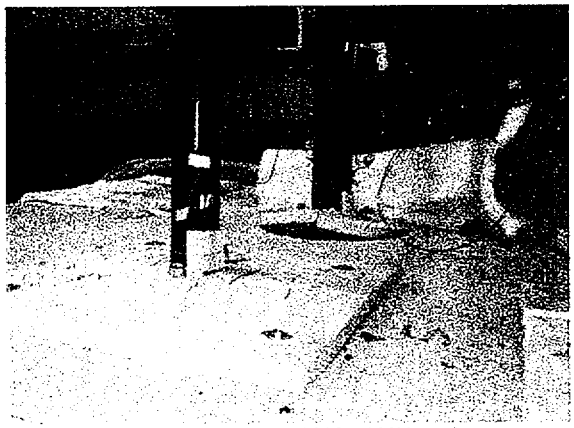


Pen. 1 bottom after hose stream.



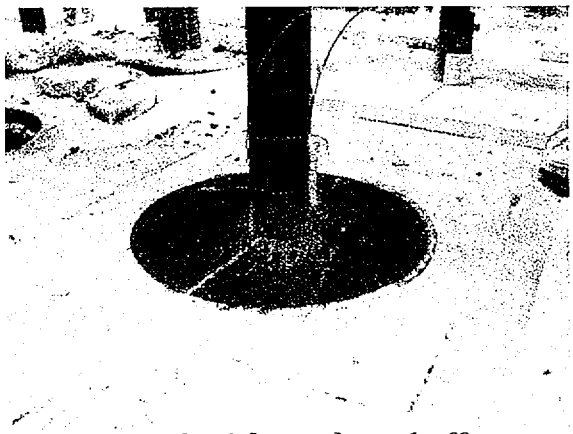
Penetration #2 at 53 – 57 minutes.

Penetration #2 at 114-120 minutes.

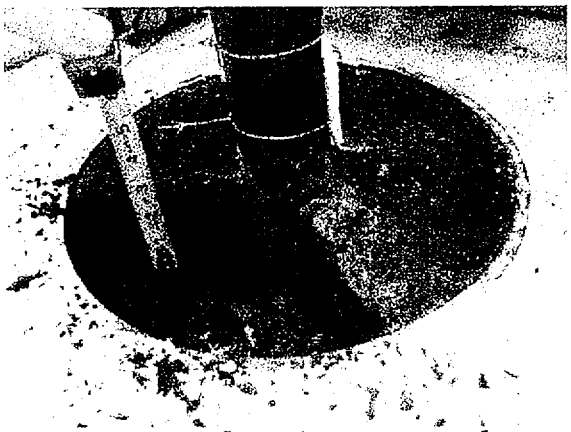


Penetration #2 at 170-175 minutes.

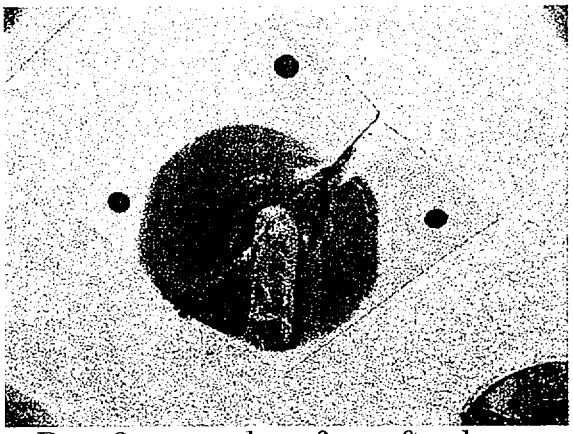
Penetration #2 at 180 minutes.



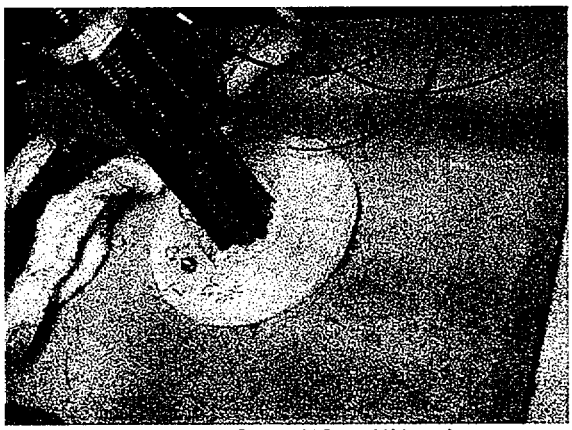
Pen. 2 with top board off.



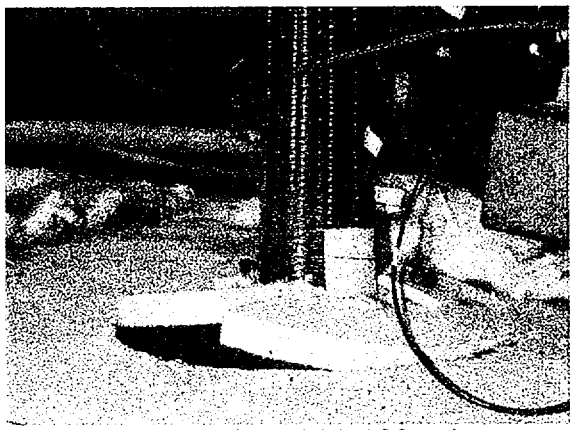
Pen. 2 with a piece removed.



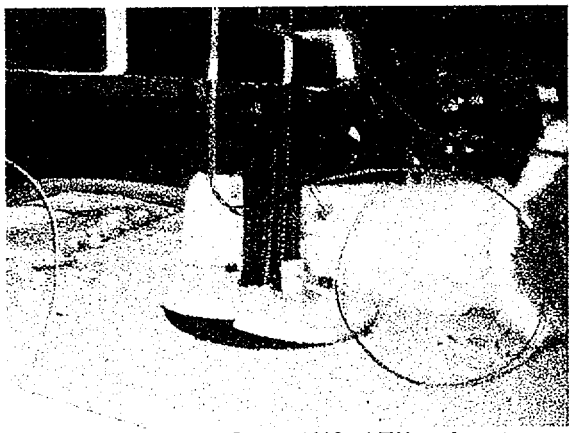
Pen. 2 exposed surface after hose.



Penetration #3 at 53 – 57 minutes.



Penetration #3 at 114-120 minutes.



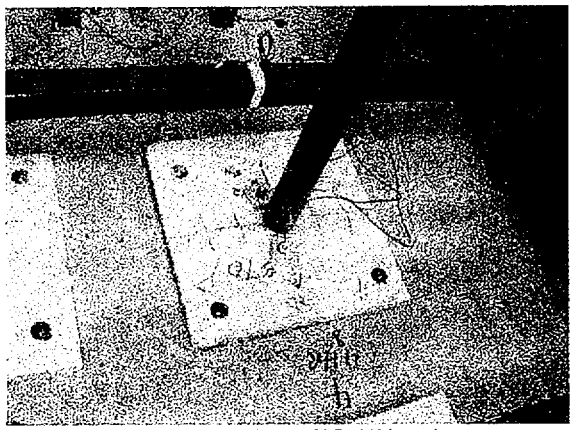
Penetration #3 at 170-175 minutes.

Pen. 3 smoking post hose stream.

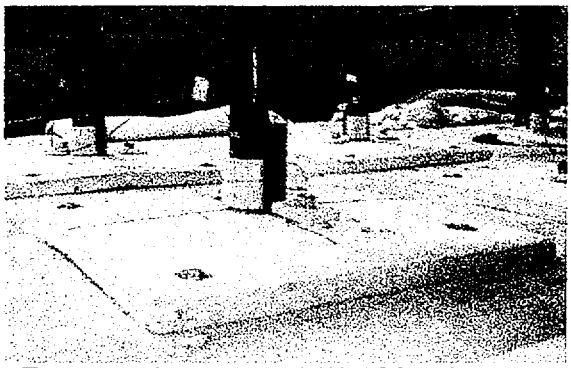
Pen. 3 smoking post hose stream.

Pen. 3 after cooling.

Pen. 3 exposed surface after cooling.



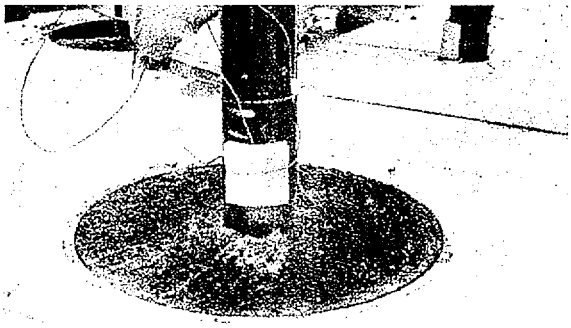
Penetration #4 at 53-57 minutes.



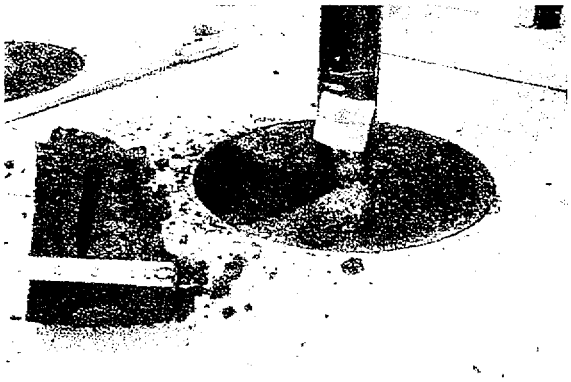
Penetration #4 at 117-120 minutes.

Penetration #4 at 170-175 minutes.

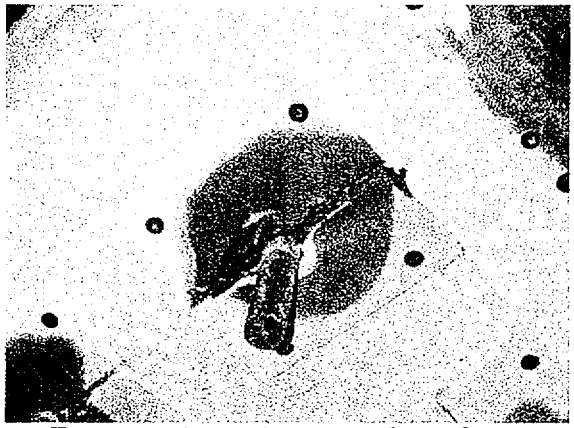
Penetration #4 at end of the test.



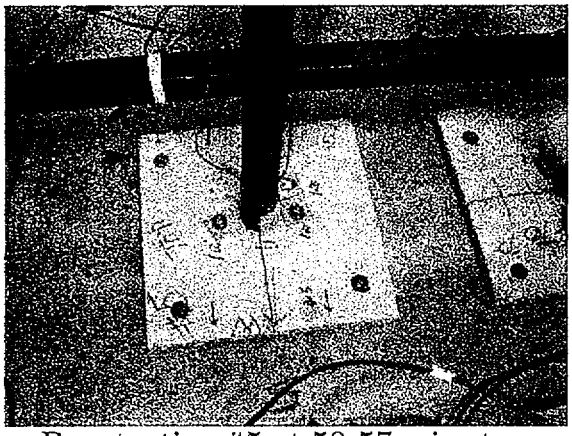
Penetration #4 with cover board off.



Penetration #4 dissected.



Penetration #4 exposed surface.

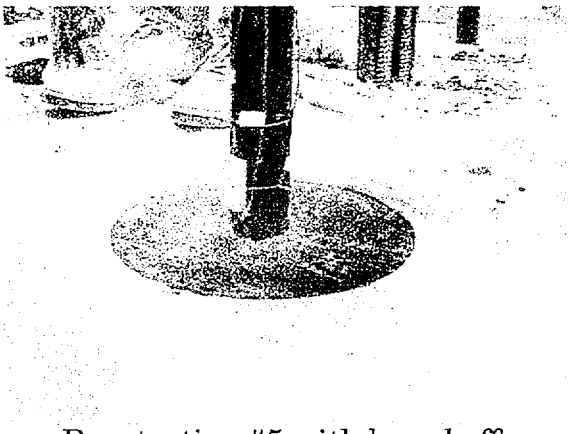


Penetration #5 at 53-57 minutes.

Penetration #5 at 117-120 minutes.

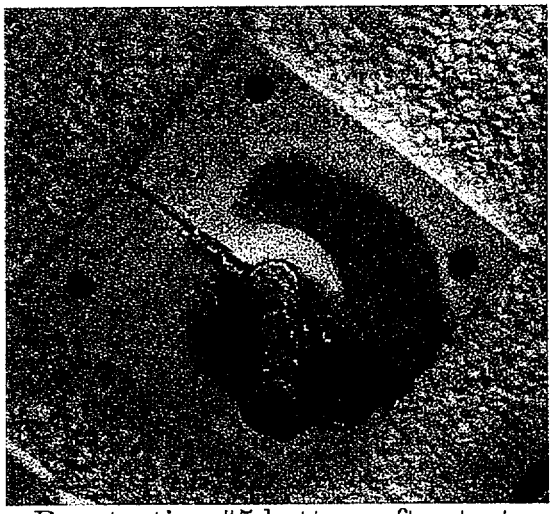
Penetration #5 at 170-175 minutes.

Penetration #5 at end of test.

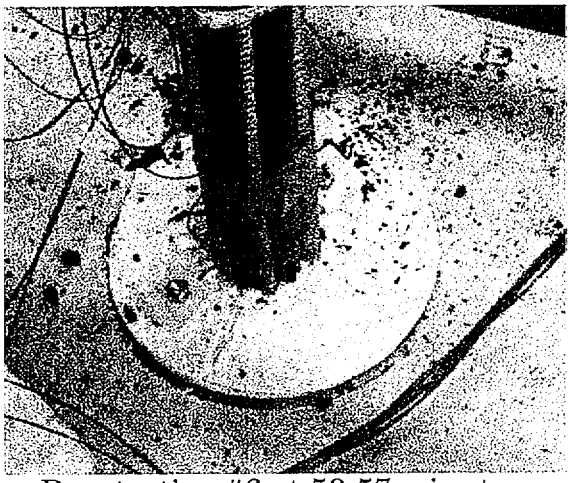


Penetration #5 with board off.

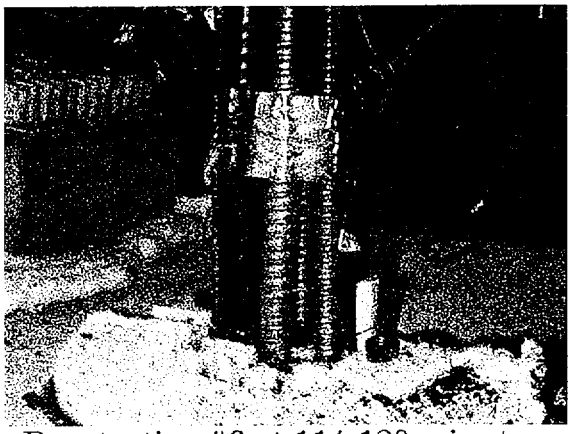
Penetration #5 dissected.



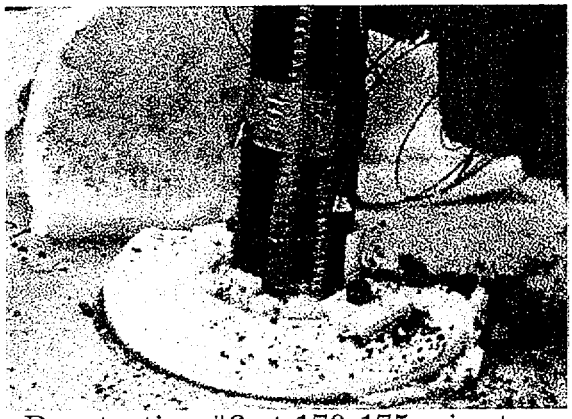
Penetration #5 bottom after test.



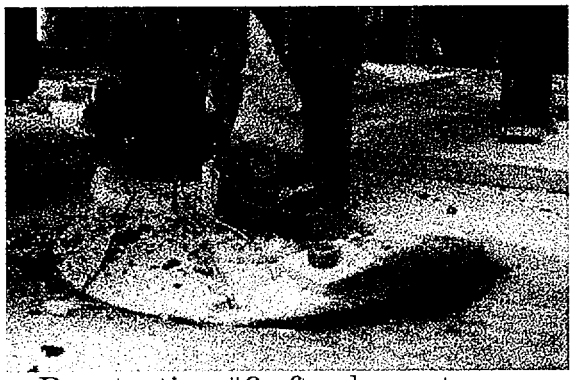
Penetration #6 at 53-57 minutes.



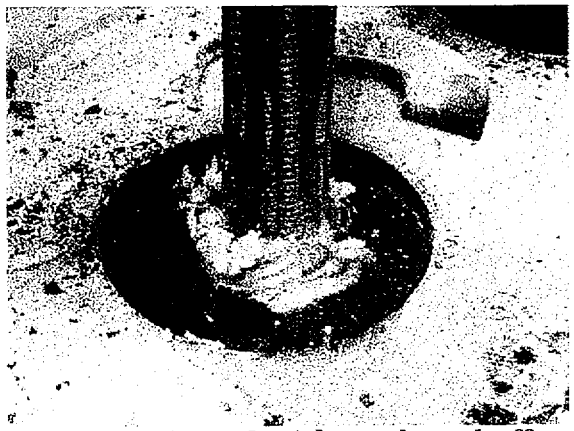
Penetration #6 at 114-120 minutes.



Penetration #6 at 170-175 minutes.

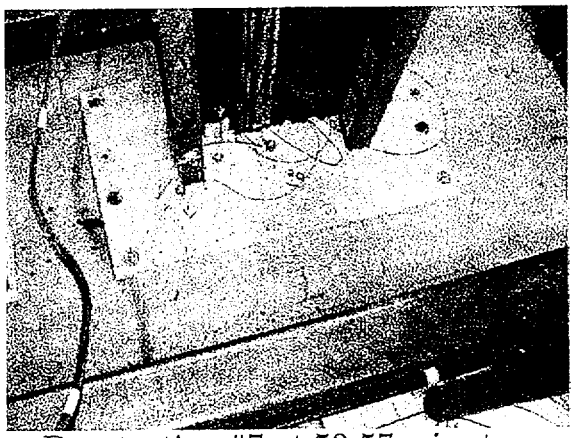


Penetration #6 after hose stream.



Penetration #6 with top board off.

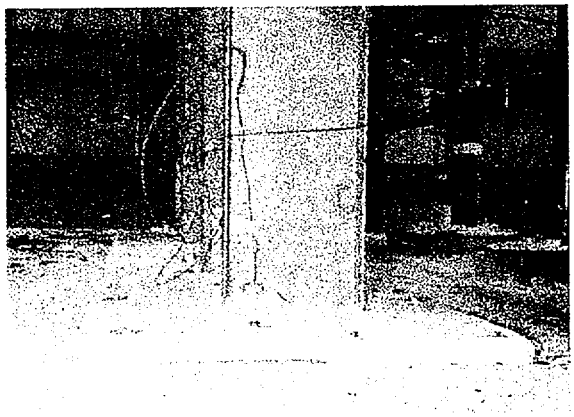
Penetration #6 bottom after test.



Penetration #7 at 53-57 minutes.

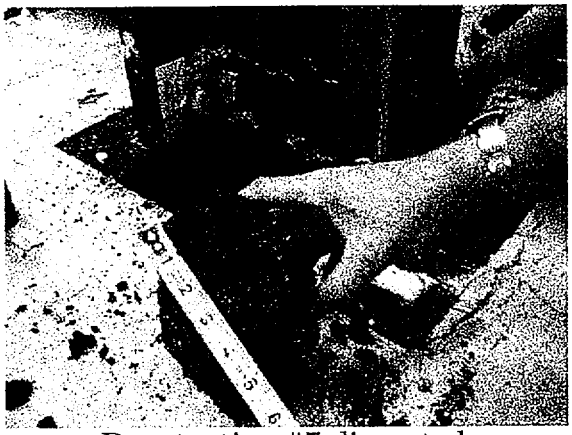
Penetration #7 at 117-120 minutes.

Penetration #7 at 170-175 minutes.

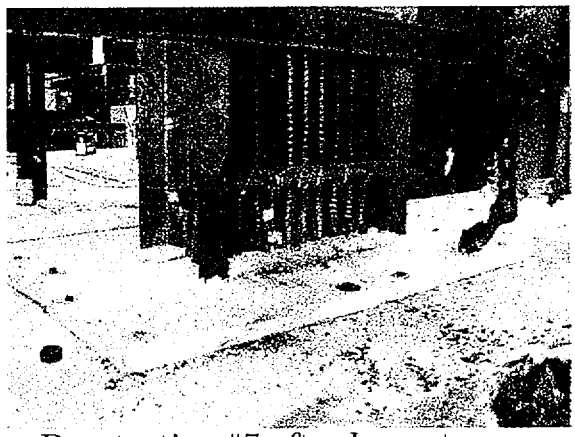


Penetration #7 at end of test.

Penetration #7 dissected.

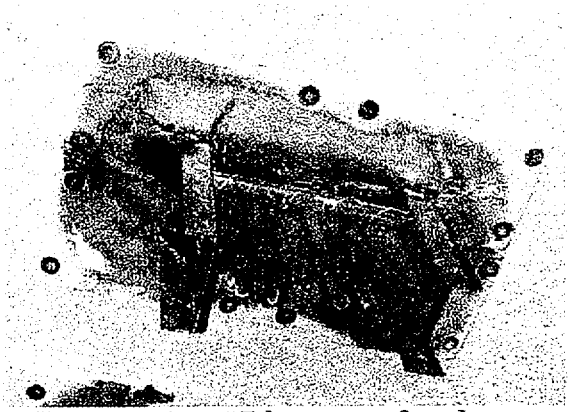


Penetration #7 dissected.

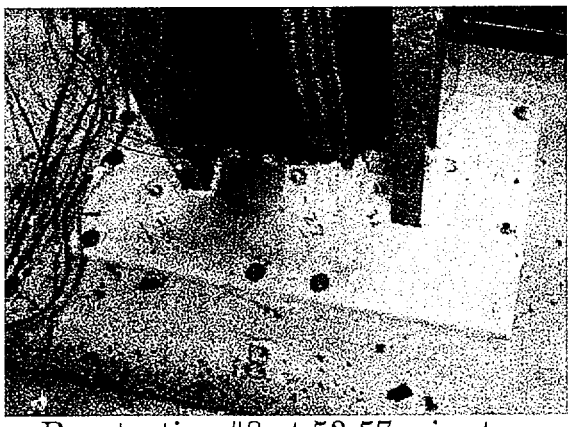


Penetration #7 after hose stream.

Penetration #7 top after hose stream.

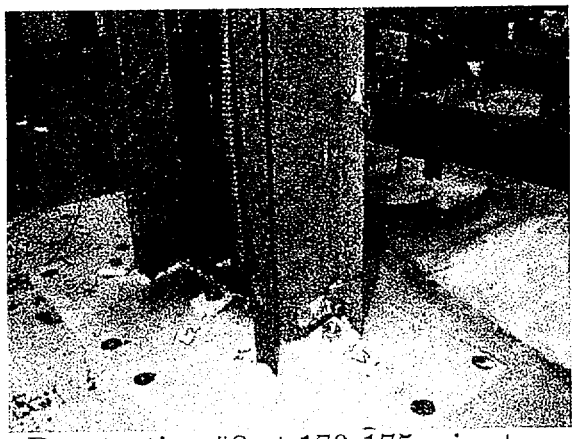


Penetration #7 bottom after hose.



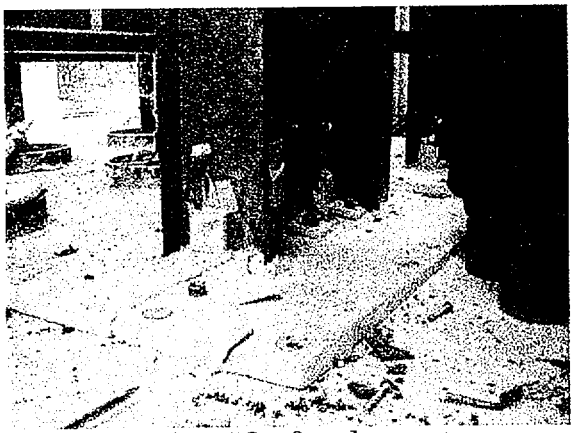
Penetration #8 at 53-57 minutes.

Penetration #8 at 114-120 minutes.



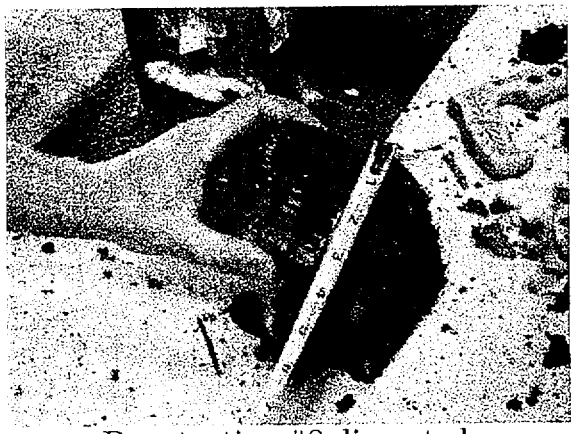
Penetration #8 at 170-175 minutes.

Penetration #8 after hose stream.

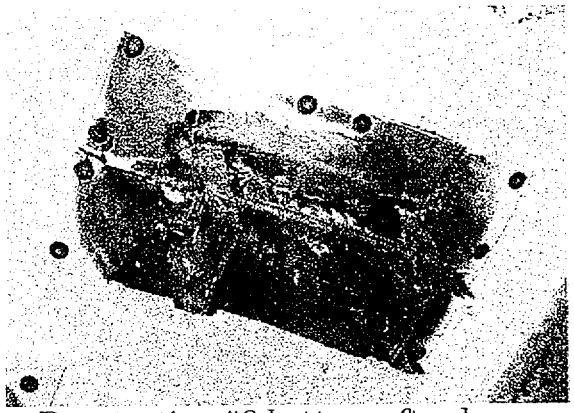


Penetration #8 after hose stream.

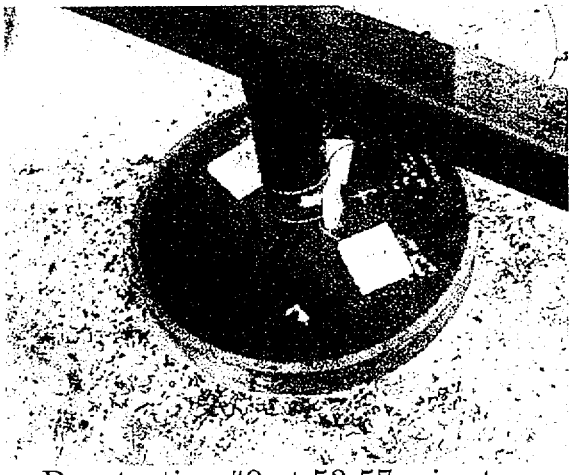
Penetration #8 dissected.



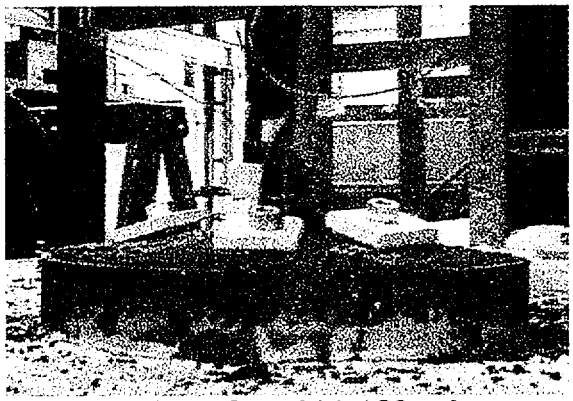
Penetration #8 dissected.



Penetration #8 bottom after hose.



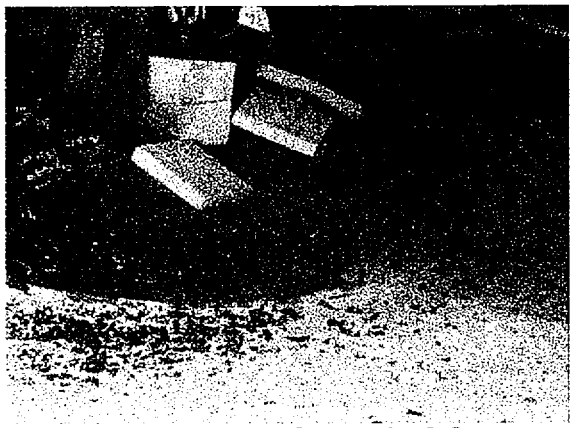
Penetration #9 at 53-57 minutes.



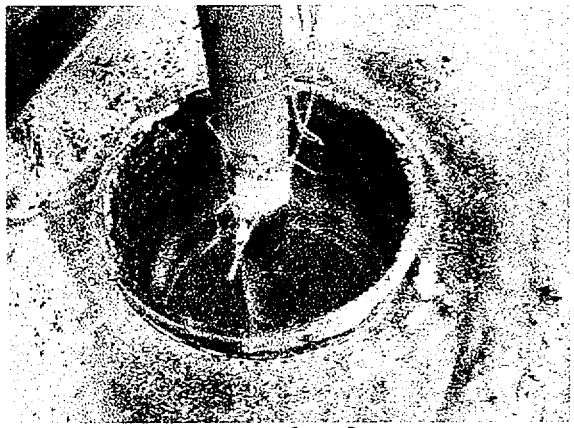
Penetration #9 at 114-120 minutes.

Penetration #9 smoking at 2 h.

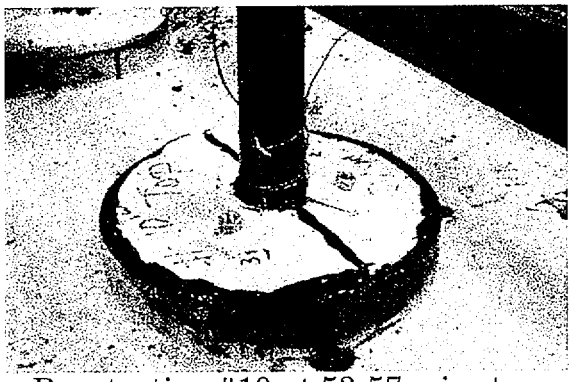
Penetration #9 smoking at 2.5 h.



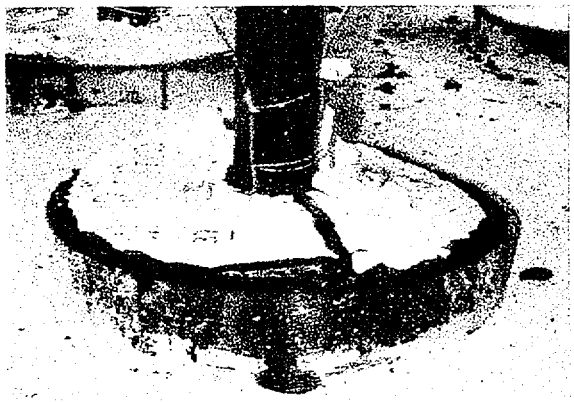
Penetration #9 at the end of the test.



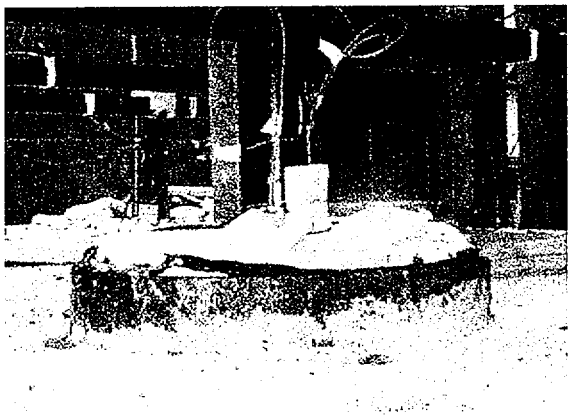
Penetration #9 after hose stream.



Penetration #10 at 53-57 minutes.

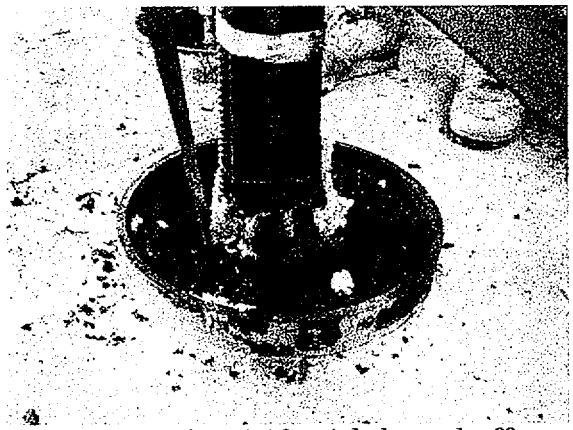


Penetration #10 at 90 minutes.



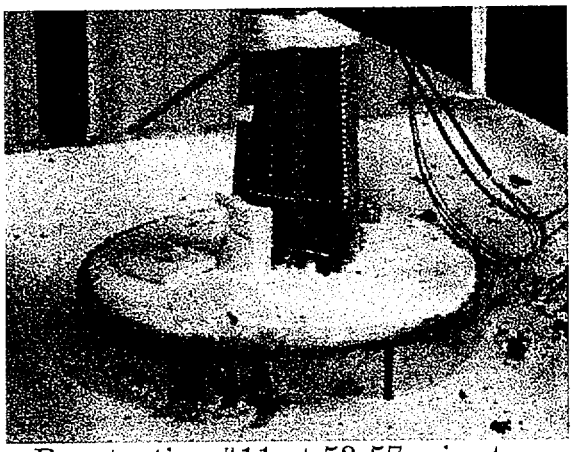
Penetration #10 at 114-120 minutes.

Penetration #10 at the end of the test.

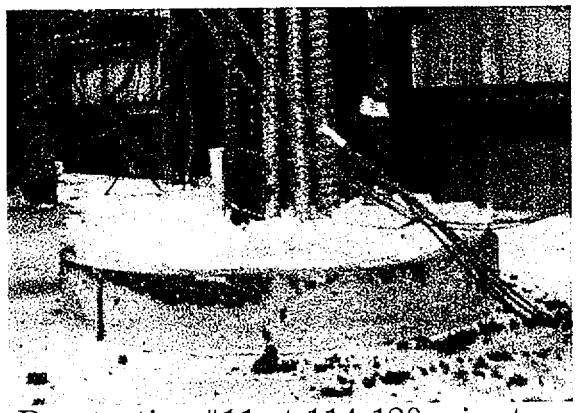


Penetration #10 with board off.

Penetration #10 dissected.



Penetration #11 at 53-57 minutes.

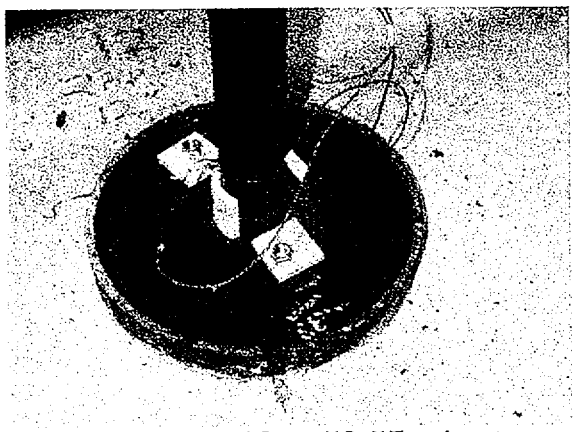


Penetration #11 at 114-120 minutes.

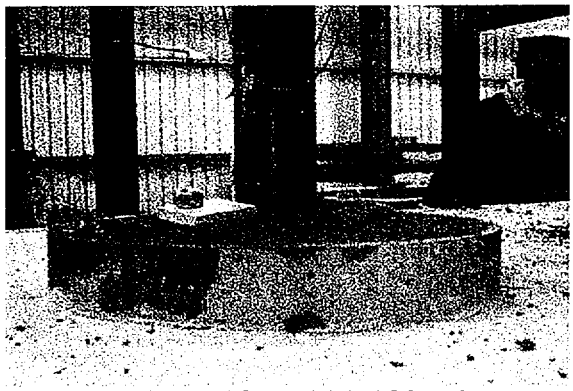
Penetration #11 at 170-175 minutes.

Penetration #11 after hose stream.

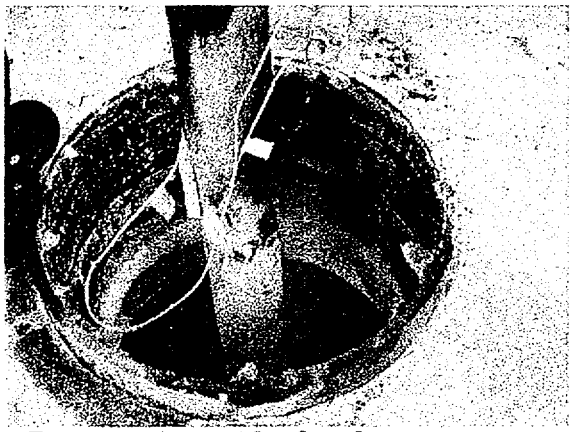
Penetration #11 after hose stream.



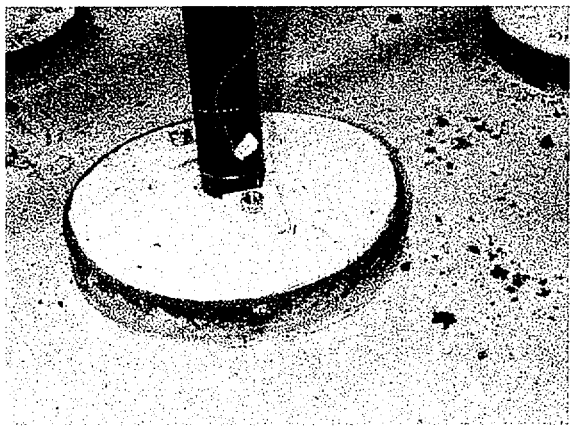
Penetration #12 at 53-57 minutes.



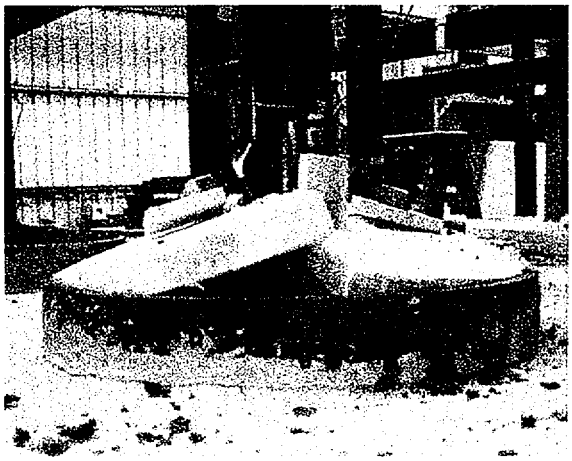
Penetration #12 at 114-120 minutes.



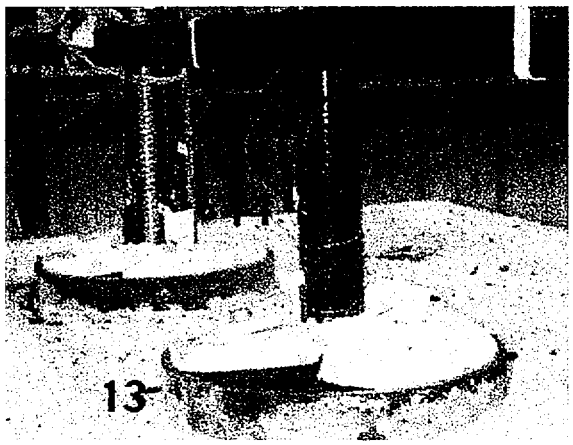
Penetration #12 after hose stream.



Penetration #13 at 53-57 minutes.



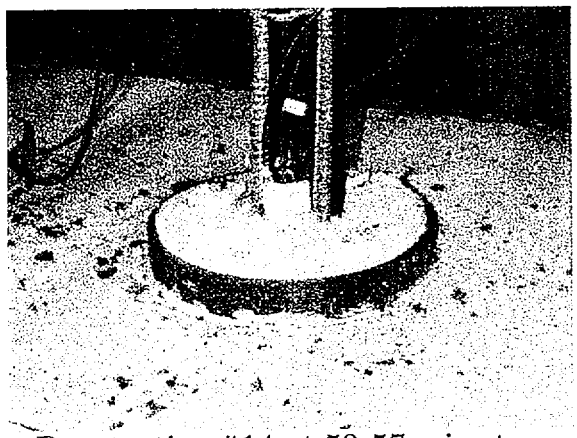
Penetration #13 at 114-120 minutes.



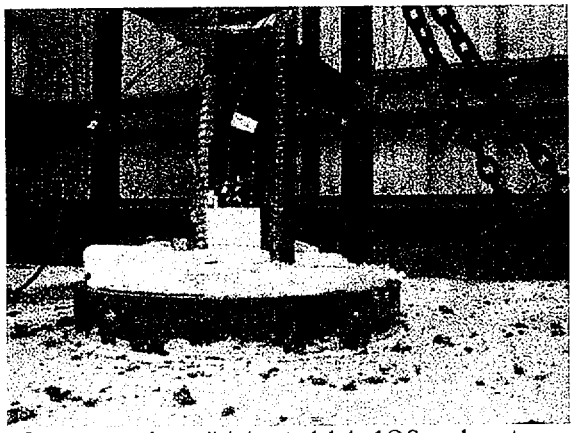
Penetration #13 at 90 minutes.

Penetration #13 at failure.

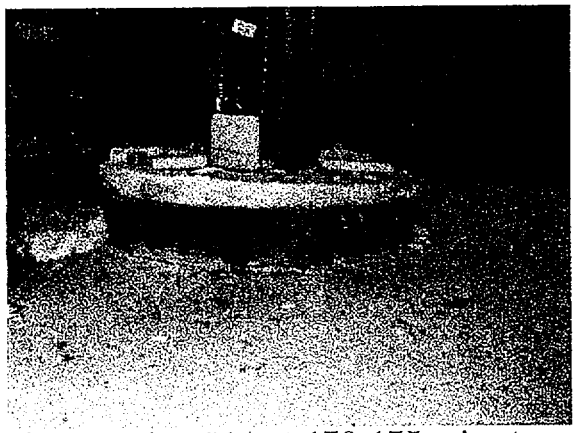
Penetration #13 after hose stream.



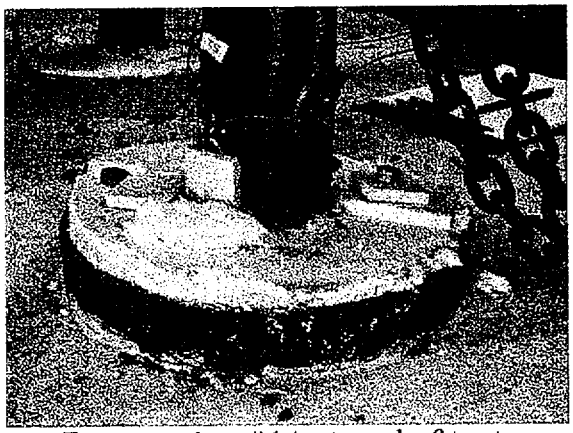
Penetration #14 at 53-57 minutes.



Penetration #14 at 114-120 minutes.



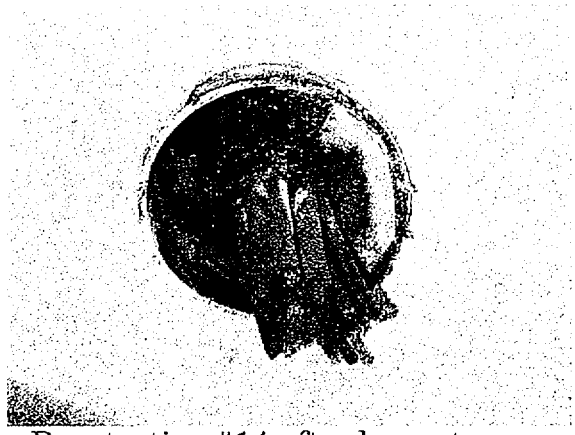
Penetration #14 at 170-175 minutes.



Penetration #14 at end of test.

Penetration #14 with top board off.

Penetration #14 dissected.



Penetration #14 after hose stream.