TEST REPORT

ON

THE EFFECTS OF COMBINED

GAMMA AND NEUTRON RADIATION

ON

BORATED SILICONE MATRIX

CT-40-NS TYPE "B"

INSTALLED

WITHIN THE REACTOR CAVITY

OF THE

NORTH ANNA NUCLEAR STATION

UNITS 1 AND 2

STONE AND WEBSTER P.O. NO: NA 1574

DATE ISSUED: February 23, 1981

Chemtrol Corporation

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Attchments

1.0 OBJECTIVE

The objective of this test program is to simulate the shield material's specified operating conditions and possible one-time abnormal condition. Also to demonstrate, under these one-time conditions, the neutron shielding material will not decompose, crumble, dissolve, or melt in any significan egree and will not evolve quantities of combustible gases or become a fire haza d. The shield material need not remain functional as a shield after this one-time event.

The specified normal operational requirements are as follows:

1. NORMAL OPERATION

   1.1). Ambient temperatures between 86° F to 105° F.

   1.2). Relative humidity form 0 to 100 percent.

   1.3). Containment pressures of 9 PSIA to 11 PSIA.

   1.4). The neutron shield material shall be cap ble of withstanding an integrated gamma radiation dose of 3.3×10^{10} rads over its design life of 40 years.

1.5). The shield material shall be capable of withstanding neutron fluence over its design life of 40 years of:

1.5.1). $E < .11$ Mev - 6.0×10^{18} neutrons/sq.cm.

1.5.2). $.11 \leq E \leq 1.1$ Mev - 3.0×10^{18} neutrons/sq.cm.

1.5.3). $E > 1.1$ Mev - 1.5×10^{17} neutrons/sq.cm.

1.6). The neutron shielding material will be in direct contact with sections of the reactor vessel and nozzle insulation. During normal reactor operations, the continuous contact surface temperature of the shield at the insulation-to-shield interface will be 247°F to 393°F.

2. ABNORMAL ONE-TIME CONDITIONS

As specified, the shielding material may be subjected to the following abnormal one-time condition:

2.1).

TIME	TEMPERATURE	PRESSURE	PH
0 to 2 min.	440°F	45 PSIG	5-11
2 to 60 min.	280°F	45 PSIG	5-11
60 min to 30 days	150°F	0 PSIG	7-9

2.2). 100 percent relative humidity.

2.3). Steam and water jet at 600° F in a localized area for a one minute period.

2.4). A boric acid solution soak (2.000 to 2,500 PPM) with sodium hydroxide added, ph 5.0 to 11.0 at 150 F for 30 days.

2.0 TESTING CRITERIA

In order to properly accomodate the above normal and abnormal operational requirements, some test criteria integration was required. This integration resulted in the following test requirements.

1.0 The Shield Material In Pre-Operational Mode

- a). Quantify chemical values.
  - a.1). Hydrogen
  - a.2). Carbon
  - a.3). Oxygen
  - a.4). Silicone
- b). Quantify physical values.
  - b.1). Specific Gravity
  - b.2). Durometer
  - b.3). Stress/Strain
- c). Quantify LOCA Resistance
  - c.1). Steam Impingement
  - c.2). Borated Water Soaking

2.0 The Shield Material In Operational Mode

- a). Gamma and Neutron radiation exposure to 2 levels of integrated doses.

a.1). Sample 1 - 8.25×10^{9} Rads/Gamma

1.5×10^{18} N/sq.cm. $E < .11$ Mev

7.5×10^{17} N/sq.cm. $.11 \leq E \leq 1.1$ Mev

3.5×10^{16} N/sq.cm. $E > 1.1$ Mev

Above dose equivelant to 10 operational reactor years.

a.2). Sample 2 - 3.3×10^{10} Rads/Gamma

6.0×10^{18} N/sq.cm. $E < .11$ Mev

3.0×10^{18} N/sq.cm. $.11 \leq E \leq 1.1$ Mev

1.5×10^{17} N/sq.cm. $E > 1.1$ Mev

Above dose equivelant to 40 operational reactor years.

Since the shield material is to be in contact with reactor vessel and nozzle insulation, the shield material shall experience normal operating temperatures of 247° F to 393°F and therefore, shall undergo radiation exposure testing under equivalent conditions of 380°F ± 20°F.

b). Quantify Chemical values (See Item 1.0 above)

c). Quantify Physical values (See Item 1.0 above)

d). Quantify LOCA Resistance

d.1). Steam Impingement (Sample 1 and 2) e). Quantify Impact Resistance

e.1). Accelerate Sample 1 and 2 above to 1500 F.P.S. to simulate Loss of Coolant piping rupture. Recover accelerated material and submit to Borated Water Soaking.

f). Quantify LOCA Resistance

f.1). Borated Water Soaking.

3.0 Chemtrol CT-40-NS Type "B" Samples Preparation

The preparation of sample specimens was carried out at the Chemtrol facilities April 11, 1979. No elaborate procedure were involved in the proper compounding of the matrix other than those approved by the Chemtrol QA/QC. These procedures basically reflect compounding normally associated with dual component polymers.

For the sake of traceability (Quality Control), all samples produced were labeled to provide continuity of samples. A series of samples were labled A1 thru A12 with another series B1 thru B12. The A series of samples were submitted to the University of Michigan (Phoenix Memorial Laboratory) for experimental purposes; i.e., identification of a reliable irradiation mode within the Ford Nuclear Reactor. As soon as reliability was estabilished the B series of samples were submitted to the University of Michigan for the required irradiation process.

Due to limitations within the reactor irradiation area, the above A and B series of samples were molded into 1"x7"x3/8" long specimens. This geometry provided symmetry of testing since the 380° F environmental heating required during the irradiation process did not allow sample specimens of greater size. Moreover, the sample geometry allowed greater ease of physical properties testing.

In conujunction with the above sample preparation, four additional sample specimens were prepared with an approximate size of 4"x4"x4". These unirradiated samples were submitted to Wyle Laboratories for the purpose of undergoing exposure testing per Loss of Coolant Accident conditions.

Note should be taken of the fact that the compounding of Chemtrol CT-40-NS Type "B" Silicone matrix involves the additional compounding of Boron Carbide (B4C) in fine powder form within the basic silicone polymer. This compounding is the 2nd step in the 2 step process. In the first step, the basic 2 part silicone components A and B are mixed in equal weights or volumne. Immediately thereafter, the boron carbide (B4C) is added to mix as the second step in mixing process. The amount of B4C to be added to the basic polymer mix is sufficient to result in a net 1.5% minimum weight of boron of the matrix weight.

An additional note to be made is that ancillary samples were prepared for the purpose of assuring reliability of boron homogenity within the silicone matrix. Said sample testing resulted in such assurance.

4.0 Chemtrol CT-40-NS Type "B" Samples Irradiation

The purpose of the neutron shielding material irradiation study is to determine the changes to physical and chemical properties of the shielding material as a function of irradiation exposure under conditions similar to those present within the reactor cavity of the North Anna Nuclear Station.

In a radiation field, elastomeric materials are the most sensitive to radiolysis of all construction materials. Likewise, radiation progressively deteriorates the initially optimized properties of elastomers. The general effect is to increase the modulus of elasticity and hardness while decreasing ultimate elongation and tensile strength.

The general process whereby such changes occur is ionization. The transfer of energy from the radiation beam to the atoms of the polymer directly or indirectly causes the ejection of orbital electrons. The energetic electrons produce secondary ionizations. The ions formed by the ejection of orbital electrons recombine with free electrons to form enerjectic, unstable molecules. The excited molecules quickly dissipate their excess energies, largely by bond scission, physical transfer, and possibly molecular rearrangement. The bond scissions produce free radicals and unsaturation, and most of the subsequent overt effects result from these. Cross linking, chain scission, molecular rearrangement, and chemical reaction with environmental agents, especially oxidation and ozonization, occur and constitute the preponderant changes. Essentially all the changes in physical properties of the elast er material ensue from these basic processes. Although the primary and secondary processes are obviously not temperature sensitive, the resultant chemical reactions are temperature dependant.

A secondary point of importance, is the effect of dose rate on the elastomer compound. Prior experimentation has shown that there is no dose-rate effect for elastomers within the broad range of 10^4 through 10^7 rads/hr. i.e.; at least over this range, any variation in dose rate does not significantly effect the change in physical properties of the elastomer compound. What does matter is the total amount of radiation energy absorbed and the uniformity of absorption.

A final point to be made is that prior experimgntation has revealed no significant post-irradiation effects in the compound. Measurements of hardness and elasticity has shown no change over a period of three months after irradiation.

The irradiation test program was comprised of two parts. The first part involved irradiation of test specimens for a period equivalent to 10 years of reactor operation i.e., to the same level of accumulative gamma and neutron doses. The second part of the test program involved the irradiation of test specimens to 40 years equivalent reactor operation. The above irradiation process was to be conducted with material samples in a 380 F ± 20 F environment.

All of the above irradiations were performed at the University of Michigan Ford Nuclear Reactor operated by the Michigan Memorial Laboratory. These facilities were chosen for these test experiments simply because the Ford Reactor flux profiles accomidated the majority of incident flux profiles required for the material testing. In addition, the University of Michigan reactor material testing personnel had considerable experimental experience with similar material testing requirements.

The respective irradiation exposure levels required along with the actual accumulated doses are as follows:

10 Year Exposure Level		
Irradiation	Desired	Actual
Integrated Gamma Exposure	8.25×10^{9} Rads	8.4×10^{9} Rads
Neutrons E < .11 Mev	1.5×10^{18} N/sq.cm.	2.0×10^{18} N/sq.cm.
Neutrons .11 ≤ E ≤ 1.1 Mev	7.5×10^{17} N/sq.cm.	8.7×10^{17} N/sq.cm.
Neutrons E > 1.1 Mev	3.5×10^{16} N/sq.cm.	7.1×10^{17} N/sq.cm.

40 Year Exposure Level		
Type	Desired	Actual
Integrated Gamma Exposure	3.3×10^{10} Rads	4.1×10^{10} Rads
Neutrons E < .11 Mev	6.0×10^{18} N/sq.cm.	9.8×10^{18} N/sq.cm.
Neutrons .11 ≤ E ≤ Mev	3.0×10^{18} N/sq.cm.	4.3×10^{18} N/sq.cm.
Neutrons E > 1.1 Mev	1.5×10^{17} N/sq.cm.	3.5×10^{18} N/sq.cm.

The above exposure levels were administred at the following incident flux levels.

10 Year and 40 Year Exposure Level		
Irradiation	Measured Dose Rate	Dose Rate -10%
Gamma	8.4×10^{7} rad/hr.	7.6×10^{7} rad/hr.
E > .11 Mev	5.6×10^{12} n/cm^2/sec.	5.0×10^{12} n/cm^2/sec.
.11 Mev ≤ E ≤ 1.1 Mev	2.4×10^{12} n/cm^2/sec.	2.2×10^{12} n/cm^2/sec.
E > 1.1 Mev	2.0×10^{12} n/cm^2/sec.	1.8×10^{12} n/cm^2/sec.

The 10 year exposure level required 110 hours of exposure to reach its desired accumulated dose while the 40 year level required 545.6 hours of exposure. The actual exposure levels were in excess of the desired levels, i.e.; the 40 year specimen received 20% more gamma and over 50% more neutron exposure than specified.

An additional deviation from the norm is the above referenced measured dose rates. A 10% reduction was applied to all gamma and neutron incident flux rates to allow for shielding of the samples 1/4" wall aluminum container. This value reduction was applied per estimates generated by University of Michigan Ford Reactor Engineering personnel. These estimates are highly conservative.

From the standpoint of irradiation exposure and resulting physical and chemical data, the 40 year material sample specimens are not representative to conditions within the reactor cavity of the North Anna Nuclear Station. The material's physical and chemical properties may have undergone radical change beyond irradiation to 3.3×10^{10} Rads. A more than 50% over exposure to neutrons in the thermal energy range surely had a prominent role in end data. Each thermal neutron to hydrogen reaction (capture) results in the release of a single 2.2 mev gamma photon. The magnitude of this problem was somewhat reduced since B4C compounding reduced the potential for the H + N event. Instead, a neutron + Boron 10 event results in gamma emissions of .5 mev. However, the accompanying release of a highly energetic alpha particle does provide a mechanism for localized ionization. The magnitude of this event is appreciated when one equates the thermal flux rate, and atoms of Boron 10 as a function of cross section.

The temperature environment sustained by the material samples during the irradiation process most assuredly contributed to Loss of Chemical and Physical properties. Cross radiation damage is accelerated by heating or stressing the elastomeric material.

On the matter of material activation, the 10 year sample reflected a gamma dose rate on contact of approximately 50 Mrem/hr. 16 days after removal from the reactor core area. The identified activation species were CO-60, ZN-65, SB-124, SC-46 and CS-134. No data was obtained for the 40 year exposure sample.

5.0 Chemtrol CT-40-NS Type "B"

Physical Analysis

In its cured state, Chemtrol CT-40-NS Type "B" has the following physical properties:

Specific Gravity---------------------------------1.36

Durometer (Shore A)------------------------------55

(Lb) Tensile Force	(In) Sample Length	(In) Sample Elongation	(PSI) Stress	(In/In) Strain
0	Lo=2.50	0	0	0
1	2.58	.08	8.40	.032
2	2.68	.18	16.81	.072
3	2.75	.25	25.21	.100
4	2.85	.35	33.61	.140
9.5	UTS		79.83	.250

Subsequent to irradiation exposure (10 year exposure level) the shield material manifested charges in all areas of physical properties tested. These changes adhered to the general effect of increased hardness and modules of elasticity while decreasing ultimate elongation and tensile strength.

Specific Gravity------------------------1.57 g/cc

Durometer (Shore A)---------------------95

(Lb) Tensile Force	(In) Sample Length	(In) Sample Elongation	(PSI) Stress	(In/In) Strain
0	1.80	0	0	0
20	1.80	0	204.08	0
	UTS			

No physical data was obtained from the 40 year exposure level sample other than specific gravity due to difficulty in handling sample. Generally speaking said sample was fragile upon handling. As discussed in Section 4.0, the over-irradiation most likely resulted in an exagerated representation of expected physical affects to shield material.

The impact resistance testing simulating accelerations as a result of loss of coolant accident was conducted by the Southwest Research Institute of San Antonio, Texas. The institute received the 10 year and 40 year exposure samples from Wyle Laboratories who had the initial test responsibility of subjecting the samples to steam impingement exposure.

The general results of the impact testing, i.e., accelerating samples to 1500 FPS, was to reduce the sample specimens both (10 year and 40 year) to a fine powder with a density much greater than water.

6.0 Chemtrol CT-40-NS Type "B"

Chemical Analysis

Since the primary function of the above referenced shield material system is to act as a neutron shield, careful elemental analysis is required. With this fact in mind, Chemtrol Corporation was able to retain the services of Dow Corning Corporation to perfom the chemical analysis. Dow Corning Corporation is the main supplier of the base silicone polymer utilized in the formulation of the shield material and therefore, is well familiar with silicone analysis techniques.

Initially, one control sample (non-irradiated) and one of the 10 year exposure level specimens were submitted to them for analysis. Soon thereafter, the 40 year exposure level specimen was also submitted to them for the required analysis.

The following is the elemental data obtained from the control, 10 year and 40 year exposed samples:

Element/Property	Control	10 Year Sample	40 Year Sample
Carbon (C)	17.77 + .17%	14.22 + .14%	5.96 + .06%
Hydrogen (H)	4.38 + 12%	3.00 + .09%	1.07 + .03%
Silicon (Si)	40.5 + .2%	41.2 + 0.2%	40.2 + .5%
Oxygen (O)	37.35 + .2%	41.58 + .2%	58.42 + .5%
Specific Gravity	1.359 + .005%	1.571 +.005%	1.68 + .005

Oxygen Values by Difference.

A review of the elemental data reflects a significant loss in hydrogen and carbon.

It should be noted that the irradiated samples were thin strips which were given a near uniform irradiation under uniform temperature. The installed shield material's thickness and orientation allow for self shielding and a temperature gradient throughout its thicknes. Accumulated dose and resultant degradation of material properties would, therefore, be attenuated as a function of shield thickness. In addition, the test specimens were given an approximate 50% excess irradiation, as discussed in Section 4.0.

In conclusion, the test specimens demonstrated a definite degradation in shielding properties. The degree of degradation or efficiency which will be experienced by the installed shield material, however, can only be accurately determined by a plant survey program of neutron dose vs. life of shield material.

7.0 Chemtrol CT-40-NS Type "B" Pre and Post Irradiation LOCA Exposure Testing

Qualification testing was conducted on CT-40-NS Type "B" to simulate Loss of Coolant Accident (LOCA) conditions. The test program was performed by Wyle Laboratories of Huntsville, Alabama.

The test program was differentiated into two basic programs. One program element reflected qualification testing of unirradiated shield material, while the other element involved qualification testing of the 10 year and 40 year irradiated material samples. In conjunction with the second program and subsequent to the initial steam impingement portion of the LOCA testing, the material samples were submitted to Southwest Research Institute for impact testing (refer to Section 5.0 and Exhibit E). Thereafter, Southwest Research Institute returned the impact test specimens back to Wyle Laboratories for continuation of LOCA Testing Requirements (Borated Water Submersion Test).

The initial LOCA testing involved unirradiated material samples (4 ea. - 4"x4"x4") comprising of steam impingement (600 F steam - 60 sec.) and submersion in borated water at 150 F for 30 days.

The effects of steam impingement on the sample specimens were non-existant. However, the results from the Borated Water Submersion Test merits some discussion. The area of discussion only relates to the generation hydrogen off-gassing since all four material samples appeared to be unchanged in all other physical respects after removal from the borated water test cylinder.

The LOCA test cylinder had a free volume of approximately .7 cubic foot (20 liters). Of this free volume, approximately 75% (15 liters) was occupied by borated water and 4 unirradiated material sample specimens. Gas that evolved collected in the remaining 5 liters of the cylinder at 150 F (66 C) and 1 psi (1.07 atmospheres). Gas analysis, performed at room temperature and atmospheric pressure, resulted in 32 volume percent hydrogen. Five liters of gas at 1.07 atmospheres and 150 F is equal to approximately 4.31 liters at room temperature and standard pressure (STP). The hydrogen component under the same conditions would be 32% of 4.31 liters, or approximately 1.38 liters. The evolution of gas is a function of the surface area of 2.7 sq.ft. Therefore, the evolution of hydrogen per square foot of material is .62 liters/sq.ft.

Chemtrol's CT-40-NS Type "B" Neutron Shielding Material has been installed in the North Anna Unit 1 and 2 Nuclear Facility with an exposed surface of approximately 10,000 sq.ft. This material surface area, in an unirradiated form, would generate 6,200 liters of hydrogen gas in the event of LOCA. The area of installation (containment) has an approximate volume of 1.8 x 10^6 cubic feet (5.1 x 10^7 liters). Therefore, the hydrogen gas evolved would account for less than 1.24 x 10^{-4} percent of the containment volume. This volume percent does not even remotely approach the LEL for hydrogen in air (4%).

The introduction of the methane (1.1%) and ethane (.01%) components of the off-gassing to the above equation does not alter the basic conclusions.

The LOCA testing on the 10 year and 40 year irradiated specimens was somewhat different in that the test specimens for the Borated Water Submersion were in powder form as a result of impact testing. Nevertheless, the basic results with the exception of increased ethane off-gassing and much reduced hydrogen off-gassing. The overall off-gassing was minute in quantity and therefore, does not provide a potential for concern.

A comparative evaluation of CT-40-NS Type "B" (irradiated vs. unirradiated) shield material system as a function of LOCA exposure testing reveals that as the shield system undergoes irradiation exposure, its potential for off-gassing is greatly reduced.

ATTACHMENT A

J.O. No. 13075.20
NAS 1007

June 8, 1979

Specification for

SUPPLEMENTAL NEUTRON SHIELDING

North Anna Power Station - Unit 1
Virginia Electric and Power Company
Richmond, Virginia

	Rev.0	Rev.1	Rev.2
S&W Originator	R.R. Clisler 6-7-79		
S&W Lead Engineer	[signature] 6-8-79		
S&W Specialist	J.H. Carter 6/7/79		
S&W Project Engineer	[signature] 6/8/79		
VEPCO Project Engineer			
VEPCO QA Supervisor			
VEPCO Approved			

I. GENERAL

The reactor neutron shielding will be used to attenuate neutrons escaping from the reactor vessel during normal plant operations. The shielding will be located between and around the reactor nozzles and will be supported on top of the neutron shield tank. The shielding will remain in place during all phases of operation except when portions of the nozzle shields must be removed for periodic inspection of welds. The shield is designed to contain both hydrogen and boron to attenuate and absorb neutrons, thus reducing exposure to operating personnel.

II. SCOPE

1. The work includes fabrication, quality control, and delivery of silicone-based neutron shielding material to the North Anna jobsite.

   The supplier will be provided with previously fabricated molds (50° and 70° shields) as shown on the attached sketches, 13075-MKS-13, sheets 1 and 2. These prefabricated molds are to be filled with the silicone neutron shielding material.

   The supplier shall also supply molds and mold the silicone material into the various shapes shown on the attached sketches, 13075-MKS-13, sheets 3 through 10. Quantities shall be as specified.

2. The prefabricated molds require that the 10 gage, inside diameter be supported along its vertical length such that it is not distorted during injection of the liquid silicone neutron shield material by the liquid hydrostatic force. The purchaser will provide this support. The supplier shall inform the purchaser of any restrictions on the support material. Items to be considered are cure temperature that the support may experience and other supplier identified considerations. This information is required as part of the supplier's bid.

III. OPERATING CONDITIONS

The neutron shielding will be located within the containment building in close proximity to the reactor vessel. It will be subjected to containment atmospheric conditions as follows:

1. Normal operation 1.54

   a. Ambient temperatures between 86°F to 105°F 1.56

   b. Relative humidity from 0 to 100 percent 1.57

   c. Containment pressures of 9 psia to 11 psia 2.1

   d. The neutron shield material shall be capable of withstanding an integrated gamma radiation dose of 3.3×10^{10} rads over its design life of 40 yr. 2.2 2.3

   e. The materials shall be capable of withstanding neutron fluence over its design life of 40 yr of: 2.4

      1. E<.11 Mev - 6.0×10^{18} nutrons/sq cm 2.6

      2. .11≤E≤1.1 Mev - 3.0×10^{16} neutrons/sq cm 2.8

      3. E>1.1 Mev - 1.5×10^{17} neutrons/sq cm 2.10

   f. The neutron shielding material will be in direct contact with sections of the reactor vessel and nozzle insulation. During normal reactor operations, the continuous contact surface temperature of the shield at the insulation-to-shield interface will be 247°F to 393°F. 2.13 2.14 2.15 2.16

2. The shielding material may be subjected to the following abnormal one-time condition in addition to those listed in III.1. 2.18 2.19

a. Time	Temperature	Pressure	pH	
				2.22
0 to 2 min	440°F	45 psig	5-11	2.25
2 to 60 min	280°F	45 psig	5-11	2.26
60 min to 30 days	150°F	0 psig	7-9	2.27

   b. 100 percent relative humidity 2.32

   c. Steam and water jet at 600°F in a localized area for a one-minute period 2.33

   d. A boric acid solution soak (2,000 to 2,500 ppm) with sodium hydroxide added, pH 5.0 to 11.0 at 150°F for 30 days. 2.34 2.35

Under these one-time conditions, the neutron shielding material must not decompose, crumble, dissolve, or melt in any significant degree and must not evolve quanitites of combustible gases or become a fire 2.37 2.38

hazard. The degree and type of degradation expected 2.39
under the one-time conditions shall be indicated in
the supplier's bid. The shield material need not 2.40
remain functional as a shield after this one-time
event.

IV. DESIGN REQUIREMENTS 2.43

1. The shielding material shall be of a Dow Corning 2.46
"Sylgard 170" base with a boron loading of 2 percent 2.47
by weight. If there are any exceptions or changes in 2.49
the Seller's proposed composition, list under the
"Exception to Requirements" section of the proposal. 2.50
The following information shall be provided in the bid 2.51
package:

Specific gravity (Minimum 1.3 g/cc)	______________	2.54 2.55
Thermal conductivity	______________	2.57
Hydrogen density after 32EFPY (Minimum 0.055 g/cc)	______________	3.1 3.2
Carbon (percent)	______________	3.4
Silicone (percent)	______________	3.7
Oxygen (percent)	______________	3.9
Hydrogen (percent)	______________	3.11
Boron (percent)	______________	3.13

2. Toxicity: The material shall exhibit no toxic effects 3.18
to personnel handling it.

3. Fire resistance: The following requirements are set 3.20
forth in the U.S. Regulatory Guide 1.120, Revision 1,
dated November 1977. The material should be 3.22
noncombustible or listed by a nationally recognized
testing laboratory such as Factory Mutual Underwriters 3.23
Laboratory, Inc., for:

   1. Surface flamespread rating of 50 or less when 3.25
   tested under ASTM E-84.

   2. Potential heat release of 3,500 Btu/lb or less 3.26
   when tested under ASTM D-3286 or NFPA 259.

The supplier shall provide the test data necessary to 3.28
support ANI and NRC acceptance. Any test data which 3.29
is not available shall be identified in the supplier's
bid.

4. The cured shielding material shall be sufficient 3.31
strength to be self-supporting when subjected to the 3.32
normal and one-time operating conditions specified in 3.33
Section III above. The supplier shall certify that 3.34
the neutron shield material will exhibit the above
physical and chemical properties for 40 yr under the 3.35
operating condition (Section III) specified above.

5. The silicone neutron shield material shall be cured by 3.36
the Seller to ensure that it will exhibit the physical 3.37
and chemical properties listed above in Section IV
when subjected to the normal and one-time operating 3.38
conditions of Section III. The supplier shall ensure 3.39
that void spaces in the silicone material are
minimized during mold injection. The supplier shall 3.40
provide his curing procedure as part of his bid.

V. INSTRUCTIONS AND DOCUMENTATION 3.43

1. The Seller shall furnish the buyer with any available 3.46
documentation required for support of licensing 3.47
applications. This would include such things as fire 3.49
protection, radiation resistance, quantity of hydrogen
offgassing during the one-time conditions of 3.50
Section III, chemical properties, physical properties,
etc.

2. The Seller shall furnish with his bid the proposed 3.51
quality control procedures to ensure that the supplied 3.52
neutron shield material meets the above-listed
(Section IV) physical and chemical properties and the
method for which void spaces are minimized during 3.53
manufacturing.

3. The Seller shall furnish with this bid a schedule of 3.54
fabrication and shipping milestones for the material 3.55
identified in Section II.

VI. IDENTIFICATION AND PREPARATION FOR SHIPMENTS

1. Packing slips or other identification papers shall accompany all shipments and must bear the following:

   Supplementary Neutron Shielding
   North Anna Power Station - Unit 1
   Purchase Order No. __________
   Item No. __________

2. Each item shall be marked with the appropriate item number.

3. The Seller or subcontractor shall prepare and weatherize all articles for shipment in a good commercial manner so as to protect the material from damage to which it might reasonably be subjected, both in transit and handling. Packaging shall allow for temporary outdoor storage.

VII. QUALITY ASSURANCE PROGRAM

Each bidder shall submit with his original proposal one copy of his quality assurance procedure, covering the quality control and quality assurance measures (1) imposed by him on his work and (2) imposed by him upon subsuppliers or subcontractors.

A procedure acceptable to the Engineers shall be a prerequisite for a bidder being chosen as Seller.

The Seller and his subsuppliers shall have in effect in their shops at all times an inspection, testing, and documentation program that will ensure that the equipment furnished under this technical document meets in all respects with the requirements of this technical document.

The Seller shall implement and maintain this procuedure carrying out the requirement of this technical document, and all proposed major changes shall be submitted to and approved by the Engineers prior to implementation.

In order to attain assurance that the neutron shielding material will give satisfactory, dependable, trouble-free service, this technical document requires that a "Ceritificate of Conformance" be submitted by the Seller, verifying that the neutron shielding material is in conformance with the set-forth requirements.

The Seller shall specifically ensure that a copy of this technical document with all addenda thereto, or

appropriate work instructions which include the technical 4.38
document requirements are readily available at each of his 4.39
fabricating or production locations where work covered by
this document is in progress.

VIII. INSPECTION 4.42

The Seller shall give the Purchaser or Engineers 4.45
notification 72 hours prior to initial pouring of molds
for possible inspection. 4.46

Authorized shop inspectors or other representatives of the 4.48
Purchaser or the Engineers shall be allowed access to the 4.49
engineering offices, shops, and working area of the Seller
and his subsuppliers at all reasonable times. They shall 4.51
have the right to such information as is necessary to
demonstrate that engineering, procurement, and production 4.52
are proceeding in accordance with the established
schedules. They shall also have the right to inspect the 4.53
materials or equipment, or the Seller's or subsupplier's
production and inspection procedures, to confirm that the 4.54
requirements of this document are being complied with; the
Seller or subsupplier shall provide all tools, 4.55
instruments, etc, necessary to facilitate these
inspections. A final inspection will be made prior to 4.56
shipment of the neutron shielding material.

IX. GUARANTEE 5.1

The materials furnished shall be new and guaranteed to 5.4
perform as required herein. Materials and workmanship 5.6
shall be guaranteed to meet the requirements set forth
above. Should any defect in material, workmanship, or 5.7
performance develop during the first year following 5.8
initial commercial operation of the plant, the Seller
shall agree to make repairs or necessary replacements free 5.9
of charge as long as the materials were not subjected to
unusual operating conditions or other hazardous
requirements. 5.10

The Seller shall repair or replace any item which is torn, 5.11
gouged, or broken upon receipt. The proposed repair 5.12
procedure shall be submitted with the supplier's bid.

X. PROPOSAL DATA 5.15

1. The bidder shall include in his proposal sufficient 5.18
data and other information to completely describe the 5.19
material to facilitate a thorough evaluation. The 5.21
proposal information shall include, but not be limited
to, the following:

a. Completed summary of proposal 5.23

b. Warranty statement 5.24

c. Material specification and data sheets 5.25

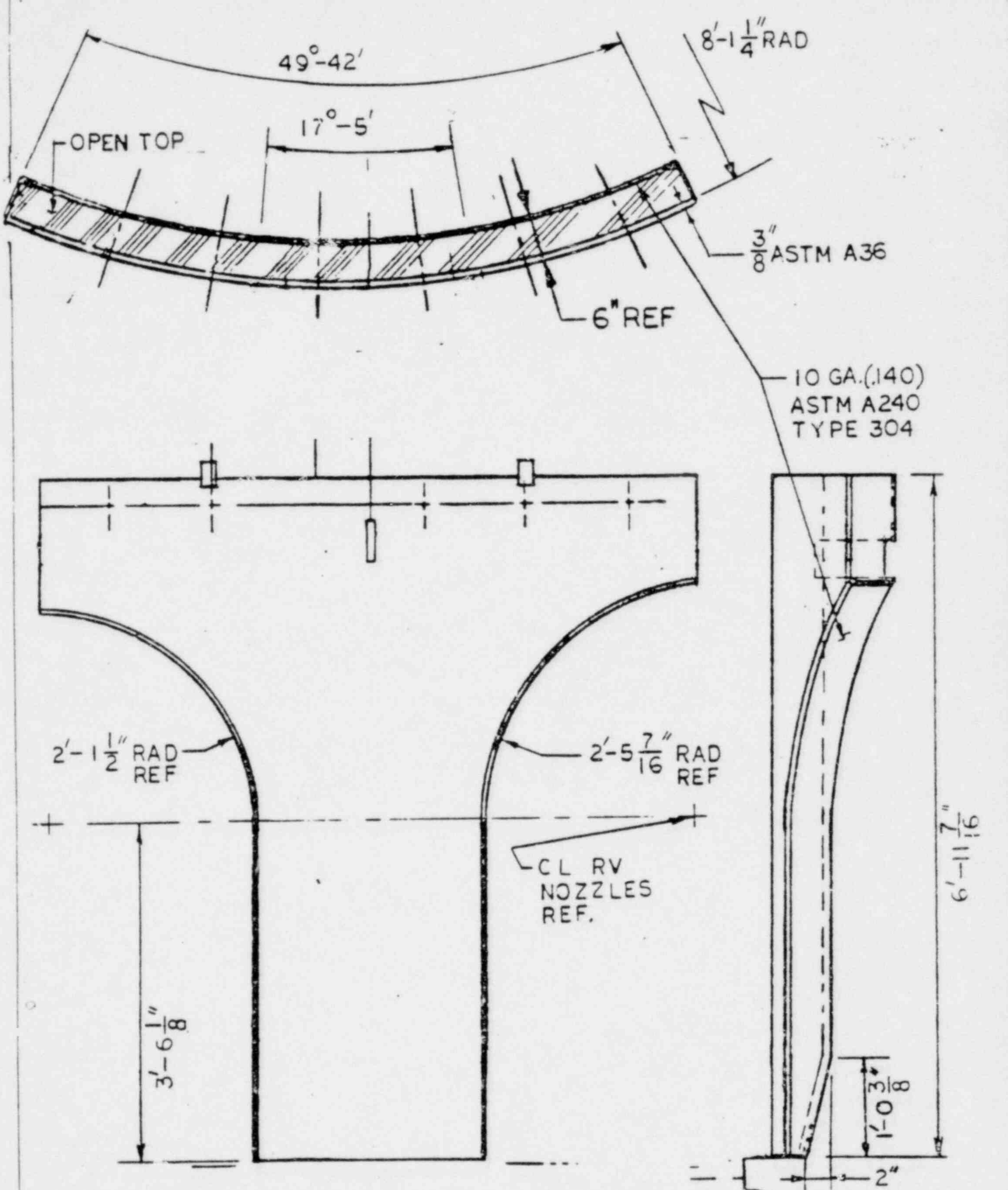
d. Performance test reports 5.26

e. Quality Assurance and Quality Control procedures 5.27
to be followed during the mixing and injecting of 5.28
the neutron shielding material.

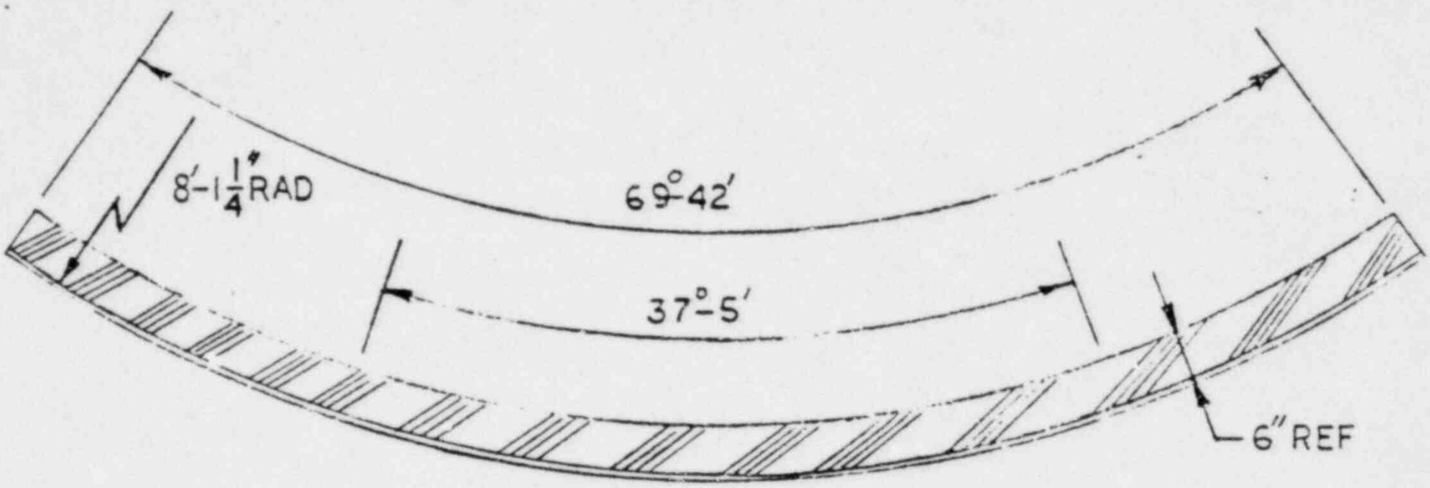
f. Any other data or information requested elsewhere 5.29
in this document.

g. Any other information that may assist the 5.30
Purchaser or Engineers in evaluating the bidder's
proposal.

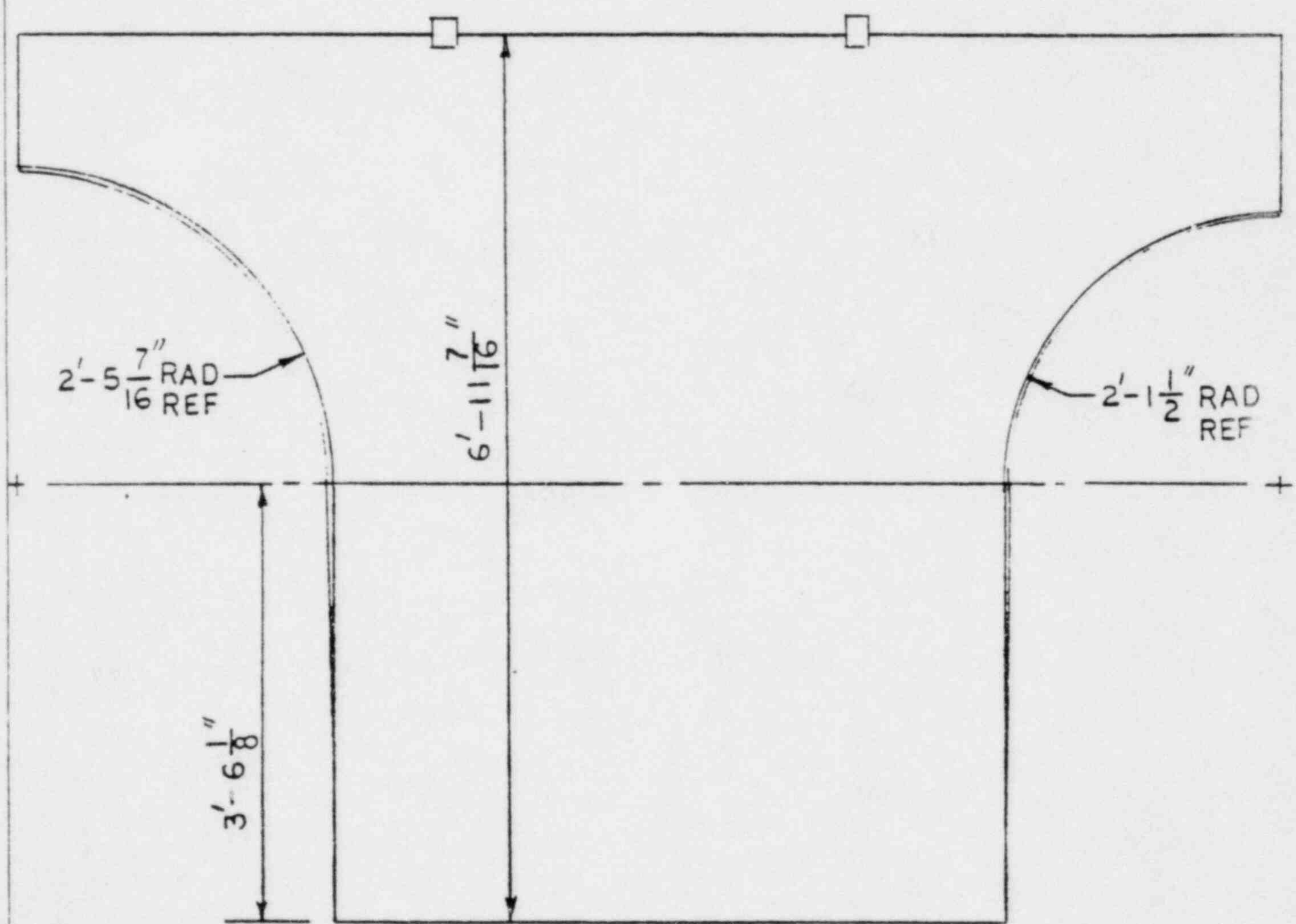
2. If the bidder takes exception to any of these 5.32
requirements, these exceptions should be listed
separately under the heading "Exceptions to 5.33
Requirements." Any exceptions should reference the 5.34
paragraph to which exception is taken. If no 5.35
exceptions are taken, the bidder should so state.



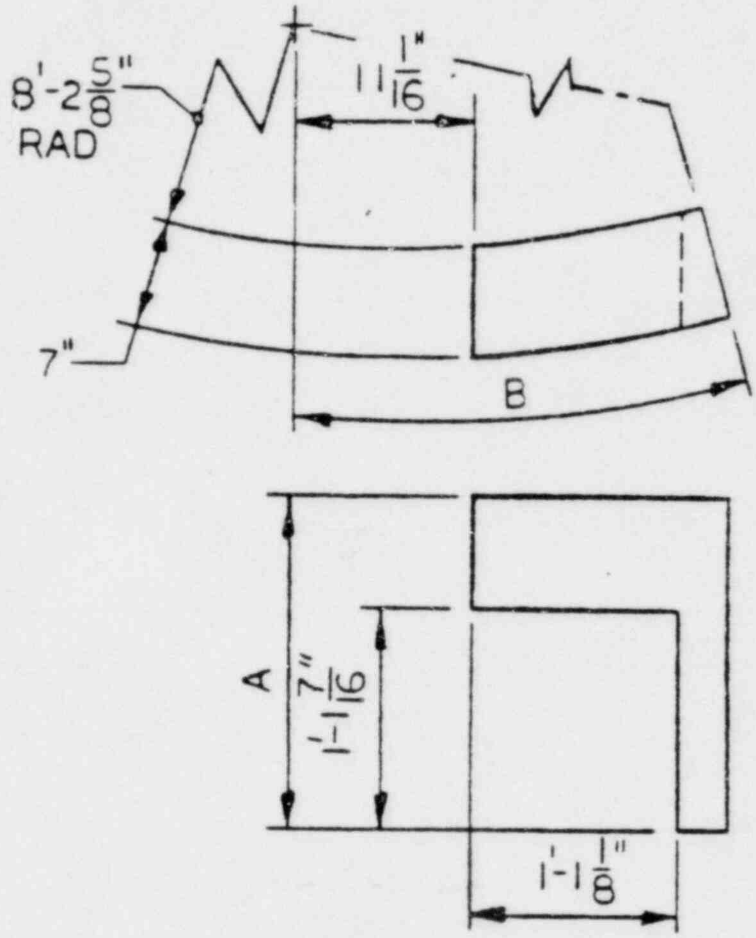
POWER INDUSTRY GROUP	TITLE 50° SHIELD (QTY-3)	SCALE: NONE
CHECKED ARClicke		DATE: 5-24-79
CORRECT		SKETCH NUMBER SH. 1 of 10
APPROVED		13075-MKS-13
REVISIONS ② ③ ④ ⑤		



NOTE: MATERIALS OF CONSTRUCTION AND SIDE VIEW DETAILS SHOWN ON 50° SHIELD



POWER INDUSTRY GROUP	TITLE	SCALE: NONE
CHECKED	70° SHIELD	DATE: 5-24-79
CORRECT	(QTY-3)	SKETCH NUMBER SH. 2 of 10
APPROVED		13075-MKS-13
REVISIONS ② ③ ④ ⑤		

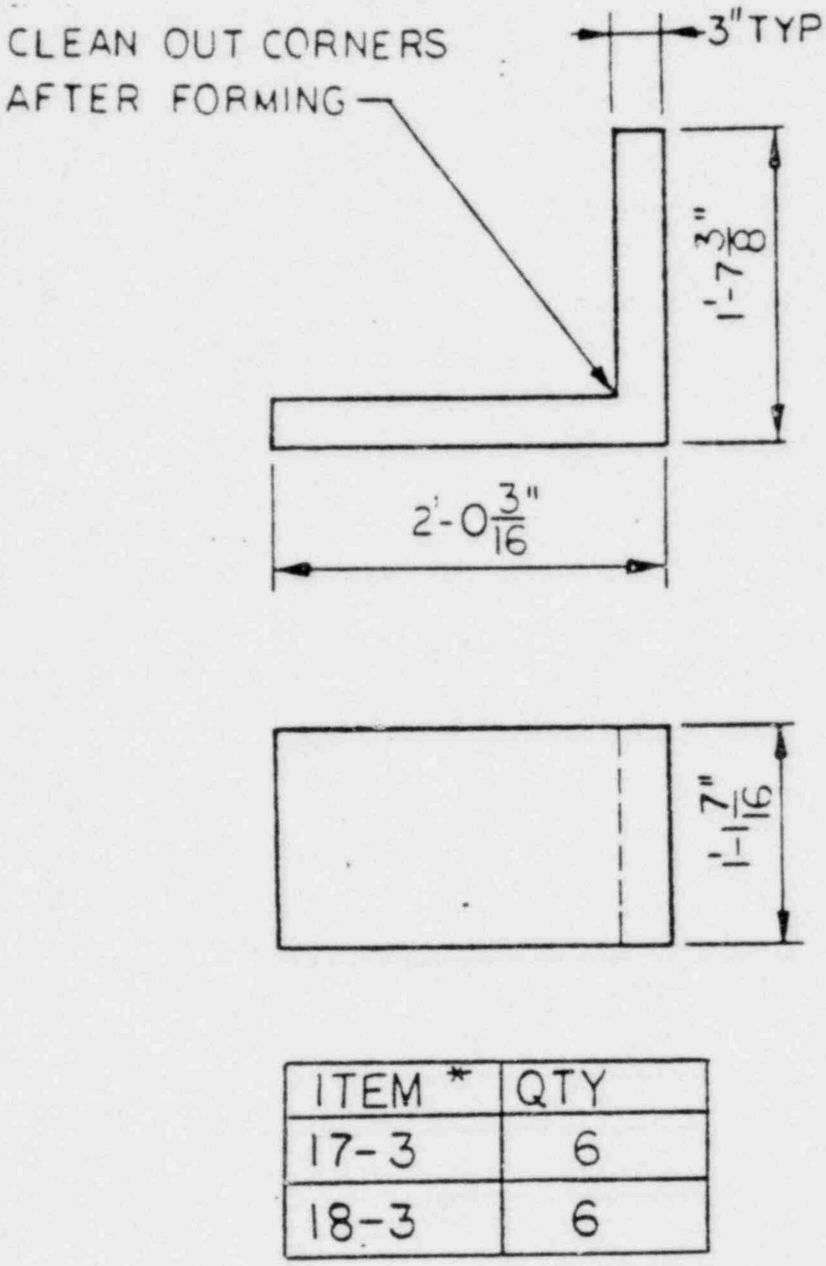


ITEM	A	B	TYPE	QTY
17-1	1'-5 15/16"	18°39'	AS SHOWN	3
17-2	1'-5 15/16"	18°39'	OPP HAND	3
18-1	1'-8 7/16"	16°10'	AS SHOWN	3
18-2	1'-8 7/16"	16°10'	OPP HAND	3

DIM TOLERANCES			
0-6"	>6"-1'-0"	>1'-0"	ANGLES
± 1/32"	± 1/16"	± 1/8"	±0°-30'

(initials) VMC.

POWER INDUSTRY GROUP		TITLE	SCALE: NONE
CHECKED	(signature)	BLOCK	DATE 5-24-79
CORRECT	(signature)		
APPROVED	(signature)		SKETCH NUMBER SH 3 of 10
REVISIONS	② ③ ④ ⑤		13075-MKS-13



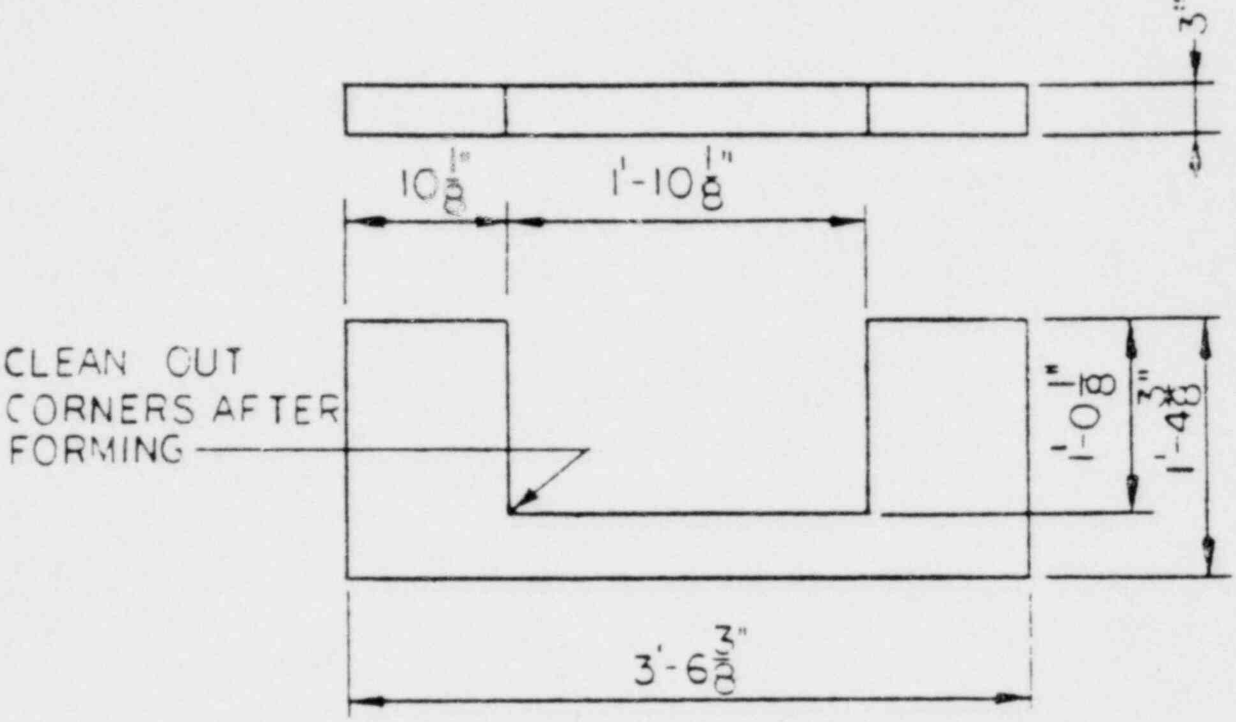
ITEM *	QTY
17-3	6
18-3	6

OK VMC.

DIM TOLERANCES			
0-6"	>6"-1'-0"	>1'-0"	ANGLES
± 1/32"	± 1/16"	± 1/8"	±0°-30'

* IDENTICAL PIECES GIVEN DIFFERENT ITEM NOS. TO FACILITATE INSTALLATION

POWER INDUSTRY GROUP	TITLE	SCALE: NONE
CHECKED R.R. Clarke	CORNER	DATE: 5-24-79
CORRECT J.T. McC[illegible]		SKETCH NUMBER SH. 4 of 10
APPROVED [illegible]		13075-MKS-13
REVISIONS ② ③ ④ ⑤		

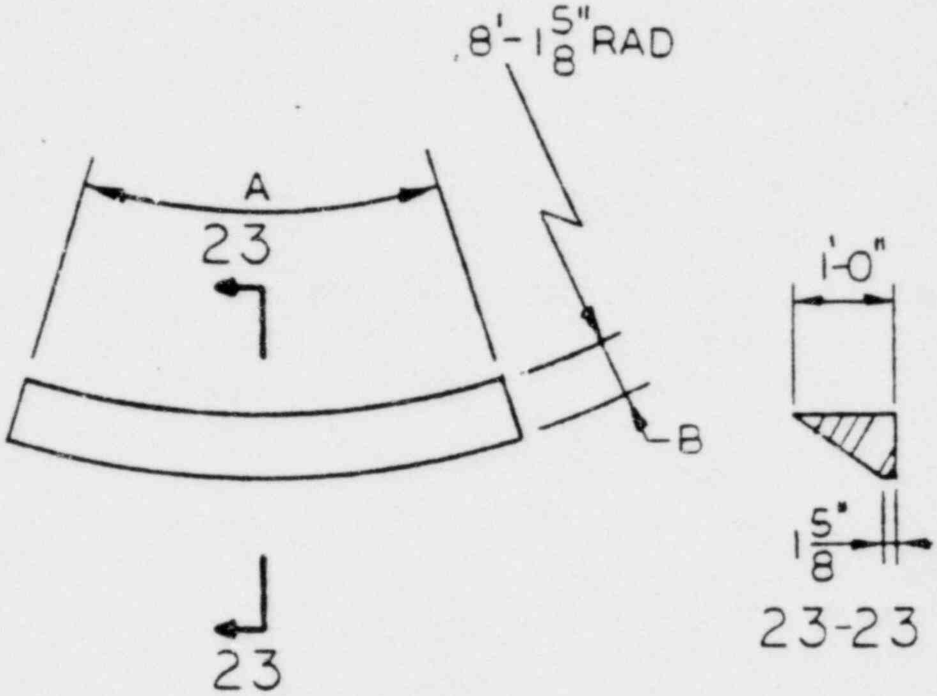


ITEM*	QTY
17-4	3
18-4	3

DIM TOLERANCES			
0-6"	>6"-1'-0"	>1'-0"	ANGLES
± 1/32"	± 1/16"	± 1/8"	±0°-30'

* IDENTICAL PIECES GIVEN DIFFERENT ITEM NOS. TO FACILITATE INSTALLATION

POWER INDUSTRY GROUP		TITLE	SCALE: NONE
CHECKED	[signature]	TOP	DATE: 5-24-79
CORRECT	[signature]		SKETCH NUMBER SH 5 of 10
APPROVED	[signature]		13075-MKS-13
REVISIONS	②	③ ④ ⑤	

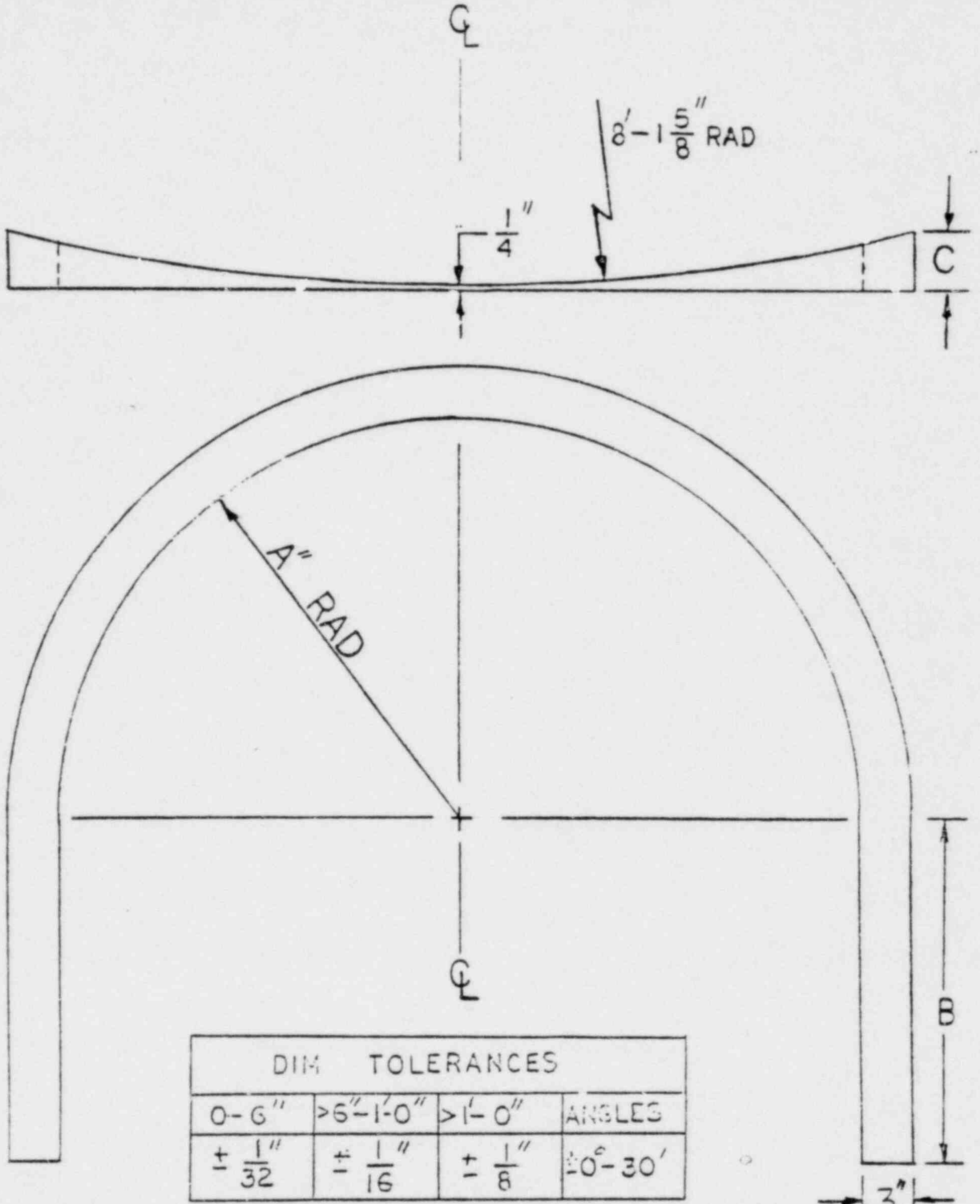


ITEM	A	B	QTY
11	35°-2'	7 3/4"	2
12	15°-2'	7 3/4"	3
13	35°-2'	6 3/4"	1

DIM TOLERANCES			
0-6"	>6"-1'-0"	>1'-0"	ANGLES
± 1/32"	± 1/16"	± 1/8"	±0°-30'

V.M.L.

POWER INDUSTRY GROUP	TITLE	SCALE: NONE
CHECKED A.R. Chick	FILLER	DATE: 5-24-79
CORRECT J.T. McL.		SKETCH NUMBER SH. 6 OF 10
APPROVED [signature]		13075-MKS-13
REVISIONS ② ③ ④ ⑤		

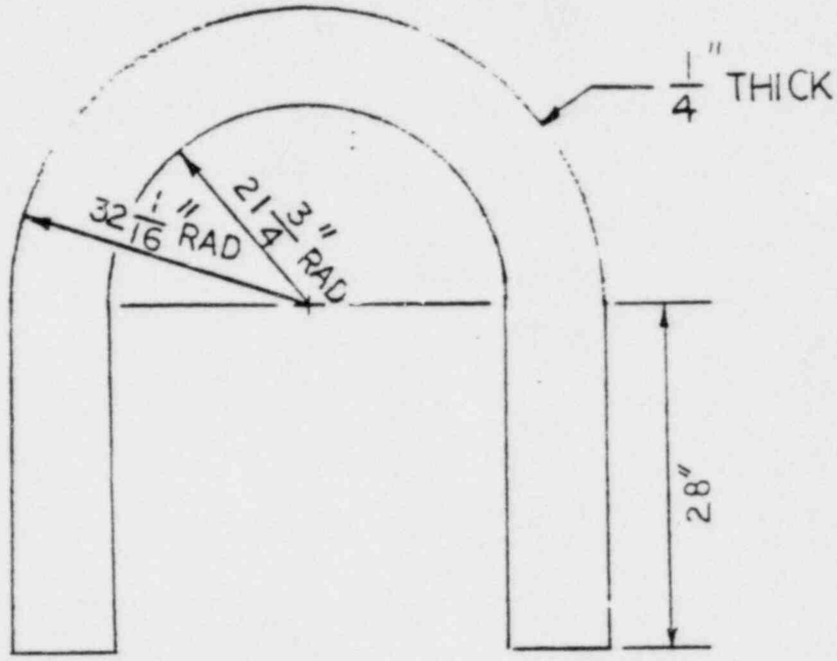


DIM TOLERANCES			
0-6"	>6"-1'-0"	>1'-0"	ANGLES
± 1/32"	± 1/16"	± 1/8"	±0°-30'

ITEM	A	B	C	QTY
19	29 1/16"	26 13/16"	5.649"	3
24	25 1/4"	21 7/16"	4.419"	3

VMC.

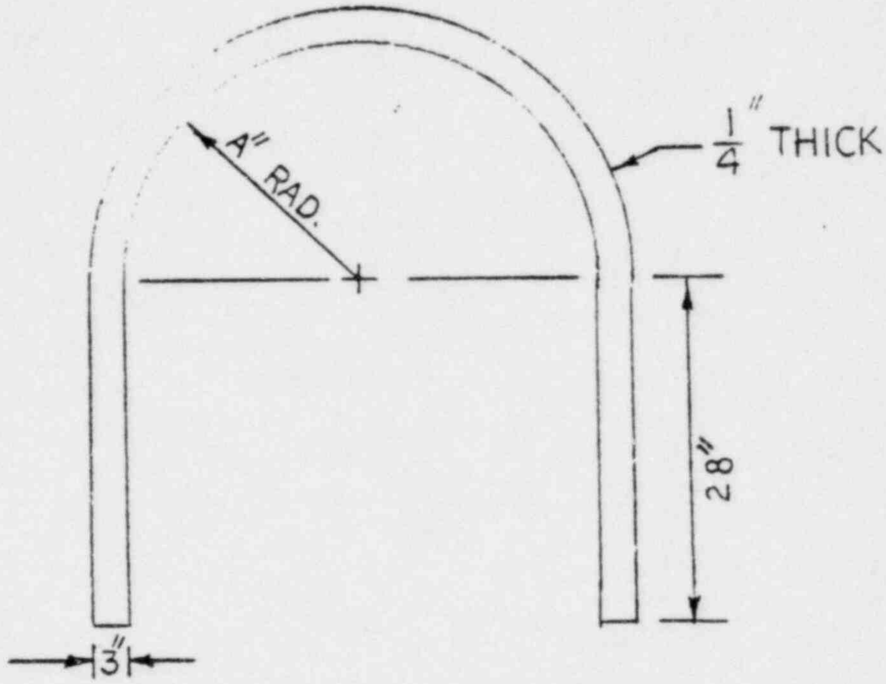
POWER INDUSTRY GROUP	TITLE	
CHECKED [signature]	SADDLE	SCALE: NONE
CORRECT [signature]		DATE: 5-24-79
APPROVED [signature]		SKETCH NUMBER SH. 7 of 10
REVISIONS ② ③ ④ ⑤		13075-MKS-13



DIM TOLERANCES			
0-6"	>6"-1'-0"	>1'-0"	ANGLES
± 1/32"	± 1/16"	± 1/8"	±0°-30'

ITEM	QTY
21	84
26	29

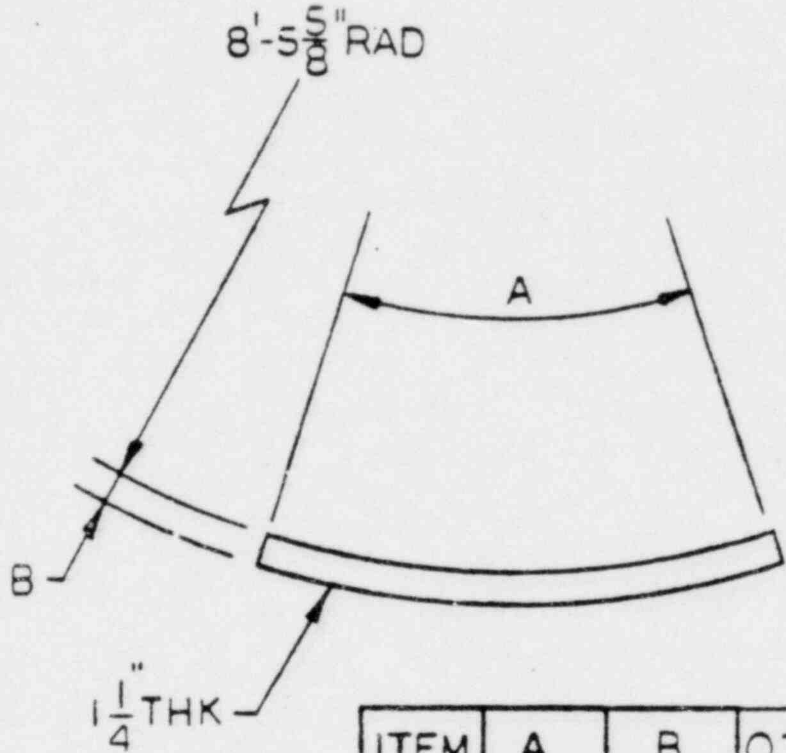
POWER INDUSTRY GROUP	TITLE	
CHECKED RR Chike	SADDLE	SCALE: NONE
CORRECT JTMcL		DATE: 5-24-79
APPROVED [signature]		SKETCH NUMBER SH. 8 of 10
REVISIONS (2) (3) (4) (5)		13075-MKS-13



DIM TOLERANCES			
0-6"	>6"-1'-0"	>1'-0"	ANGLES
± 1/32"	± 1/16"	± 1/8"	±0°-30'

ITEM	A	QTY
20	29 1/16"	136
22	23 3/4"	140
23	21 3/4"	69
25	25 1/4"	140
27	23 7/16"	202
28	21 7/16"	41

POWER INDUSTRY GROUP	TITLE	
CHECKED RR Cliche	SADDLE	SCALE: NONE
CORRECT JTMcClu		DATE: 5-24-79
APPROVED [signature]		SKETCH NUMBER SH. 9 of 10 13075-MKS-13
REVISIONS ② ③ ④ ⑤		



ITEM	A	B	QTY
14	35°2'	4"	2
15	15°2'	4'	3
16	35°2'	3"	1

DIM TOLERANCES			
0-6"	>6"-1'-0"	>1'-0"	ANGLES
± 1/32"	± 1/16"	± 1/8"	±0°-30'

VMC

POWER INDUSTRY GROUP	TITLE	SCALE: NONE
CHECKED RRChicke	SUPPORT	DATE: 5-24-79
CORRECT JTMcLel		SKETCH NUMBER SH. 10 of 10
APPROVED [signature]		13075-MKS-13
REVISIONS ② ③ ④ ⑤		

VIRGINIA ELECTRIC AND POWER COMPANY

CERTIFICATE OF CONFORMANCE

Project Name ____

Seller ______________________________ Address ______________

Item or Service _____________________ Mark No. _____________

Specification No. and Title ________________________________

____

Purchase Order No. __________________ J.O.No. ______________

Seller Identifying No. ______________ Drawing No. ___________

Deviations from Specification Requirements: (If none, so state) attach

Copies of Deviation Approval Documents

1. ______________________ 4. ______________________

2. ______________________ 5. ______________________

3. ______________________ 6. ______________________

The Seller, including his subsuppliers, hereby certifies that the item or service, supplied on this order, complies with the above-listed specifications, drawings, applicable codes, standards, and procedures. The Seller certifies that all deviations from specification requirements are listed above and that deviation approval documents are attached.

Signature ______________________________
Quality Assurance Manager
or Equivalent

INSTRUCTIONS FOR COMPLETING VEPCO'S
CERTIFICATE OF CONFORMANCE

The vendor shall complete the lines numbered below, as applicable, and return one copy with the shipment, and another copy mailed to the project location - ATTN: Resident QC Engineer:

LINE NO.	INSTRUCTIONS
1.	PROJECT NAME (Surry, North Anna)
2.	VENDORS NAME
3.	VENDORS ADDRESS
4.	NAME OF COMPONENT OR SERVICE PERFORMED
5.	MARK OR PART NUMBER OF COMPONENT
6.	THE SPECIFICATION TITLE, NUMBER, REVISION AND DATE, SPECIFIC INDUSTRY STANDARDS OR CODES ATTESTED TO AS REQUIRED BY THE PURCHASE ORDER.
7.	VEPCO PURCHASE ORDER NUMBER PLUS ANY CHANGE ORDERS
8.	JOB ORDER NUMBER
9.	VENDORS JOB NUMBER OR SHOP NUMBER
10.	APPROVED FABRICATION OR ENGINEERING DRAWINGS AND LATEST REVISION
11.	ALL VENDOR DEVIATIONS FROM THE PURCHASE ORDER OR SPECIFICATION WITH APPROVAL LETTERS ETC. TO VERIFY ACCEPTANCE OF DEVIATION
12.	Q.A. MANAGER OR EQUIVALENT RESPONSIBLE VENDOR REPRESENTATIVE

ATTACHMENT B

THE UNIVERSITY OF MICHIGAN
PHOENIX MEMORIAL LABORATORY
FORD NUCLEAR REACTOR
ANN ARBOR, MICHIGAN 48109
(313) 764-6220

September 17, 1979

Mr. Vincent Cataldo
Chemtrol Corporation
8805 Solon
Building G5
Houston, Texas 77064

Dear Mr. Cataldo:

Enclosed are tabulations of the total gamma and neutron doses administered to samples of Chemtrol material CT-40-NS Type B. Samples were irradiated at 380 ± 20°F for 110 hours and 545.6 hours at two megawatts. The specific gravities of three separate pieces from the 110 hour samples are also enclosed.

Pieces of the 110 hour samples have been sent to Southwest Research for analysis. The 545.6 hour samples are still too radioactive to be handled. Present plans are to prepare them for analysis on September 24, 1979.

Sincerely,

Reed R. Burn
Reactor Manager

enclosure

RRB/sv

CHEMTROL MATERIAL CT-40-NS TYPE B

Short Term Irradiation

Irradiation Temperature: $380 \pm 20^{\circ}F$

Irradiation	2 MW Time	Measured Dose Rate	Dose Rate -10%	Total Dose Actual	Total Dose Desired
Gamma	110 hr	8.4×10^{7} rad/hr	7.6×10^{7}	8.4×10^{9}	8.25×10^{9}
n< .11 MeV	110 hr	5.6×10^{12} n/cm 2/5	5.0×10^{12}	2.0×10^{18}	1.50×10^{18}
.11 MeV< n< 1.1 MeV	110 hr	2.4×10^{12}	2.2×10^{12}	8.7×10^{17}	7.5×10^{17}
n> 1.1 MeV	110 hr	2.0×10^{12}	1.8×10^{12}	7.1×10^{17}	3.5×10^{16}

Long Term Irradiation

Irradiation	2 MW Time	Measured Dose Rate	Dose Rate -10%	Total Dose Actual	Total Dose Desired
Gamma	545.6 hr	8.4×10^{7} rad/hr	7.6×10^{7}	4.1×10^{10}	3.3×10^{10}
n< .11 MeV	545.6 hr	5.6×10^{12} n/cm 2/5	5.0×10^{12}	9.8×10^{18}	6.0×10^{18}
.11 MeV< n< 1.1 MeV	545.6 hr	2.4×10^{12}	2.2×10^{12}	4.3×10^{18}	3.0×10^{18}
n> 1.1 MeV	545.6 hr	2.0×10^{12}	1.8×10^{12}	3.5×10^{18}	1.4×10^{17}

FORD NUCLEAR REACTOR
UNIVERSITY OF MICHIGAN

SPECIFIC GRAVITY

Sample Number	Dry Weight			Net Weight			Volume	Specific Gravity
	Net	Tare	Sample	Net	Tare	Sample		
	A	B	C = A - B	D	E	F = D - E	H = C - F G	C/H
	(gm)	(gm)	(gm)	(gm)	(gm)	(gm)	(cm³)	(gm/cm³)
	CHEMTROL MAT[illegible]AL CT-40-NS TYPE B							
POST-IRRADIATION (110 hr)	11.42021	9.20000	2.22021	1.84024	1.00000	.84024	1.37745	1.61183
	11.42077	9.20000	2.22077	1.85148	1.00000	.85148	1.36674	1.62487
	12.49373	9.20000	3.29373	2.25730	1.00000	1.25730	2.03266	1.62041

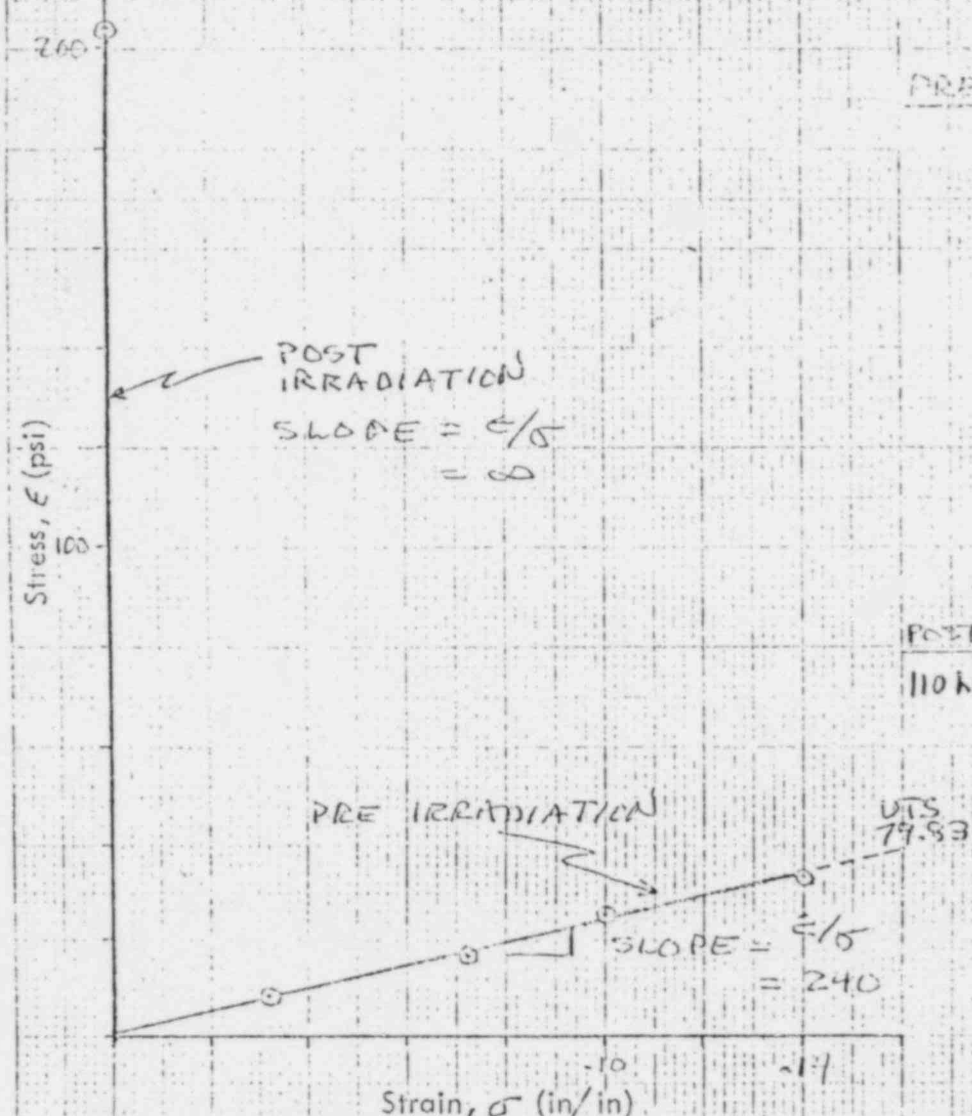
Water Temperature	
°C	
25	
G = 1.0030	
Correction	
T	Value
°C	G
20	1.0018
.2	1.0018
.4	1.0019
.6	1.0019
.8	1.0020
21	1.0020
.2	1.0021
.4	1.0021
.6	1.0022
.8	1.0022
22	1.0023
.2	1.0023
.4	1.0024
.6	1.0024
.8	1.0025
23	1.0025
.2	1.0026

FORD NUCLEAR REACTOR
UNIVERSITY OF MICHIGAN

TENSILE TEST

Sample Identification CHEMTRAL CT-4[illegible]-NS TYPE B

D. Cross Sectional Area PRE .119 | POST .098 in^2



	Tensile Force	Sample Length	Sample Elongation	Stress ϵ	Strain σ
	A	B	$C = B - L_o$	A/D	C/L_o
	(lb)	(in)	(in)	(psi)	(in/in)
PRE	0	L_o = 2.50	.0	0	0
	1	2.58	.08	8.40	.032
	2	2.68	.18	16.81	.072
	3	2.75	.25	25.21	.100
	4	2.85	.35	33.61	.140
	9.5	UTS		79.83	.250
POST	0	1.80	0	0	0
110 hr.	20	1.80 UTS	0	204.08	0

THE UNIVERSITY OF MICHIGAN
PHOENIX MEMORIAL LABORATORY
FORD NUCLEAR REACTOR
ANN ARBOR, MICHIGAN 48105

August 13, 1979

Mr. Vince Cataldo
Chemtrol Corporation
8805 Solon
Building G5
Houston, TE 77064

Dear Vince:

Enclosed is sample B6 of your CT-40NS, Type B material which has been irradiated as follows:

Gamma		8.4×10^{9} rad
Neutron	$E < .11$ MeV	2.0×10^{18} n/cm^2
	$.11$ MeV $< E < 1.1$ MeV	8.7×10^{17}
	$E > 1.1$ MeV	7.1×10^{17}

The gamma dose rate on contact from this sample was approximately 50 mrem/hr. 16 days after removal from the reactor core.

Sincerely,

Bob Burn

Reed R. Burn
Reactor Manager
Ford Nuclear Reactor

Enclosure

THE UNIVERSITY OF MICHIGAN
PHOENIX MEMORIAL LABORATORY
FORD NUCLEAR REACTOR
ANN ARBOR, MICHIGAN 48109
(313) 764-6220

July 29, 1979

Dear Vince;

Enclosed are the residual radioactivity results from the short term sample which was irradiated at 350–400 degrees.

The long term sample completed its first cycle at temperature and is doing well.

Sincerely,

Bob Burn

DISTRIBUTION LIST:

- ☐ Young
- ☐ Alford
- ☐ Block
- ☐ Chute
- ☐ Faressa
- ☐ Ferris
- ☐ Spriggs
- ☐ Russell
- ☐ Q/A
- ☐ Insurance
- ☐ Accounting
- ☐ Catalao
- ☐ Welch
- ☐ Fleming
- ☐ Yeldell
- ☐ Bell ☐ Peck
- ☐ West Coast Of.
- ☐ Shop
- ☐ Subject
- ☐ Reading
- ☐ ______
- ☐ ______

```
****************************************************************
***************   20 JUL 1979   2:39:28 PM    ***************
****************************************************************

CHEMTROL EXPERIMENT

SAMPLE DATE:  19JUL79 1446:00
SAMPLE IDENTIFICATION:  110
TYPE OF SAMPLE:  SOLID
SAMPLE QUANTITY:  0.1510000          UNITS:  GRAMS
SAMPLE GEOMETRY:  SAMPLE GEOMETRY
EFFICIENCY FILE NAME:  EFF.TABM
****************************************************************
                                      *
ACQUISITION DATE: 19JUL79 1446:00 * FWHM(1332)            2.719
PRESET TIME(LIVE):       1800. SEC  * SENSITIVITY:         16.000
ELAPSED REAL TIME:       1840. SEC  * SHAPE PARAMETER :  10.0 %
ELAPSED LIVE TIME:       1800. SEC  * NBR ITERATIONS:        5.
                                      *
****************************************************************
                                      *
DETECTOR: ADC DETECTOR               * LIBRARY:NUCL.LIBM
DATE CALIBRATED:  19JUL79  744:23 * ENERGY TOLERANCE:  2.500KV
KEV/CHNL:        1.0012299           * HALF LIFE RATIO:   8.00
OFFSET:          -0.7146839 KEV      * ABUNDANCE LIMIT:  50.00%
Q. COEFF. :    -2.733E-07 KEV/C**2 *
                                      *
****************************************************************
```

ENERGY WINDOW   99.406 TO   2000.652

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	FIT
1	1	510.85	20633.	13157.	3.20	511.01	504	14	1.146E 01	1.1	4.51E
2	1	602.67	1422.	8638.	2.73	602.74	599	9	7.903E-01	9.6	1.39E
3	1	889.01	3427.	16571.	2.52	888.84	885	9	1.904E 00	5.6	4.13E
4	1	1115.21	182305.	4137.	2.58	1114.89	1107	19	1.013E 02	0.2	1.79E
5	1	1172.93	361.	236.	3.35	1172.59	1167	16	2.006E-01	8.0	3.87E
6	1	1291.44	436.	257.	3.09	1291.02	1284	19	2.424E-01	7.1	1.78E
7	1	1332.17	312.	117.	2.63	1331.73	1326	13	1.772E-01	7.5	1.09E
8	1	1407.23	141.	153.	3.31	1406.86	1401	18	7.819E-02	15.0	2.40E
9	1	1460.48	137.	75.	3.04	1459.98	1456	10	7.626E-02	12.3	1.71E
10	1	1690.46	239.	56.	2.63	1689.88	1683	16	1.326E-01	7.8	2.13E

PEAK SEARCH COMPLETED

TOTAL LINES IN SPECTRUM	10	
LINES NOT LISTED IN LIBRARY	0	
IDENTIFIED IN SUMMARY REPORT	10	100.00%

ACTIVATION GAS

NUCLIDE	HLIFE	HLSEC	DECAY	UC/UT	ERROR	%ERR
AR-41	1.83E 00H	6.588E 03	6.111E -4	7.646E -3	5.400E -4	7.06

ACTIVATION PRODUCT

uCi/gm

NUCLIDE	HLIFE	HLSEC	DECAY	UC/UT	ERROR	%ERR
CO-60	5.26E 00Y	1.660E 08	5.556E -4	5.062E -3	3.793E -4	7.49
ZN-65	2.44E 02D	2.108E 07	5.556E -4	4.971E 0	1.190E -2	0.24
SB-124	6.02E 01D	5.201E 06	5.556E -4	1.061E -2	8.329E -4	7.85
SC-46	8.39E 01D	7.249E 06	5.556E -4	3.858E -2	2.153E -3	5.58
CS-134	2.05Y	6.457E 07	5.556E -4	**KEY LINE NOT PRESENT**		

NATURAL PRODUCT

NUCLIDE	HLIFE	HLSEC	DECAY	UC/UT	ERROR	%ERR
K-40	1.00E 03Y	3.156E 10	5.556E -4	2.210E -2	2.728E -3	12.35

THE UNIVERSITY OF MICHIGAN
PHOENIX MEMORIAL LABORATORY
FORD NUCLEAR REACTOR
ANN ARBOR, MICHIGAN 48109
(313) 764-6220

RECEIVED
OCT 10 1979
Chemtrol

October 5, 1979

Mr. Vincent Cataldo
Chemtrol Corporation
8805 Solon
Building G5
Houston, Texas 77064

Dear Vince:

I sent both short term and long term samples of CT-40-NS-Type B to Ron Estaphan, Southwest Research Institute and G.L. Elam, Wyle Laboratories. G.L. Elam is Wyle's Radiation Control Officer. You might contact the actual user of the material to warn him to expect it. Enclosed are letters sent preceding the packages.

Sincerely,

Bob Burn

Reed R. Burn
Reactor Manager

Enclosures

RRB/sv

THE UNIVERSITY OF MICHIGAN
PHOENIX MEMORIAL LABORATORY
FORD NUCLEAR REACTOR
ANN ARBOR, MICHIGAN 48109
(313) 764-6220

October 5, 1979

Mr. G. L. Elam
Radiation Control Officer
Wyle Laboratories
7800 Governor's Drive, West
Huntsville, Alabama 35807

Dear Mr. Elam:

I have packaged and sent to you two irradiated samples of Chemtrol silicone polymer base neutron shielding material CT-40-NS-Type B. The samples are in lead pigs within the box. Each sample is labeled on its lead pig. An irradiation data sheet is enclosed which provides irradiation details.

The samples are radioactive. Dose rates are provided on each lead pig.

Sincerely,

Reed R. Burn
Reactor Manager

Enclosure

RRB/sv

xc: Vincent Cataldo
Chemtrol Corporation

ATTACHMENT C

DOW CORNING

April 16, 1980

Mr. Vincent M. Cataldo
Chemtrol Corporation
P.O. Box 38556
Houston, TX 77088

Dear Mr. Cataldo:

In response to your recent telephone inquiry about the labeling of Sample No. 16705 (CT-40NS Type B), designated as irradiated with 110 hours exposure per R. G. Niemi's letter of March 3, 1980, I have talked further with Mr. R. R. Burn at the University of Michigan and also rechecked our records. Mr. Burn sent us two samples on December 7, 1979; one irradiated 110 hours, the other 545.6 hours. In recording these samples, our sample clerk assigned both of them the same sample number (16705). Thus, we do not know which of these two samples was actually analyzed. Since the identification of the material labeled 16705 is ambiguous, I suggest that you simply delete that data from your consideration. The sequence of samples is therefore as follows:

Sample 12751 - Non-irradiated
12750 - Irradiated 110 hours
17296 - Irradiated 545.6 hours

I regret the inconvenience that this confusion has caused, and hope the data will now be useful to you.

Yours very truly,

A. Lee Smith

A. Lee Smith
Manager
Analytical Services Dept.

ALS/jlm

xc: Mr. Reed R. Burn, Reactor Mngr.
Ford Nuclear Reactor
Phoenix Memorial Laboratory
Ann Arbor, MI 48109

R. G. Niemi (Dow Corning Corp.)

DOW CORNING

RECEIVED
OCT 15 1979
Chemtrol

October 8, 1979

Mr. Vincent M. Cataldo
Chemtrol Corporation
P.O. Box 38556
Houston, TX 77088

Dear Mr. Cataldo:

We received the two cured samples of SYLGARD® 170 Elastomer which you submitted specially formulated with boron carbide filler and designed for neutron shielding applications. As per your communication and designation, sample B-7 has undergone neutron and gamma irradiated exposure at the University of Michigan. For comparison, your sample designated B-12 represents a non-irradiation control. Both samples were submitted to our Analytical Department (Dr. A. L. Smith) for specific element and specific gravity analysis. These results, along with our Analytical Department reference numbers, and Corporate Test Methods (CTM) are listed below:

CTM	Element/Property	B-7 (12750) Irradiated	B-12 (12751) Non-Irradiated
0030	Carbon (C)	14.22 ± .14	17.77 ± .17
0030	Hydrogen (H)	3.00 ± .09	4.38 ± .12
0522	Silicon (Si)	41.2 ± 0.2	40.5 ± 0.2
0540	Specific Gravity	1.571 ± .005	1.359 ± .005

I hope that this analytical data will satisfy your requirements. Let me know if you have any questions.

Very truly yours,

R. G. Niemi

R. G. Niemi
Sr. Specialist
Elastomers, Technical Service
and Development
Phone: (517)-496-5380

sdk

DOW CORNING

March 3, 1980

RECEIVED
MAR 7 1980
Chemtrol

Mr. Vincent M. Cataldo
Chemtrol Corporation
P. O. Box 38556
Houston, TX 77088

Dear Mr. Cataldo:

We received the two additional samples of cured SYLGARD® 170 Elastomer that was specially formulated with boron carbide by Chemtrol (earlier samples were designated B-7 and B-12). These latest samples were designated by Chemtrol as CT-40 NS Type B and were respectively subjected to 110 hours and 545.6 hours of neutron and gamma irradiation exposure at the University of Michigan. These samples were submitted to our Analytical Department (Dr. A. L. Smith) for specific elemental and specific gravity analysis. These results, along with our Analytical Department reference numbers and Corporate Test Methods (CTM) are listed below:

CTM	Element/Property	(17296) CT-40 NS Type B 545.6 Hours Exposure	(16705) CT-40 NS Type B 110 Hours Exposure
0030	Carbon (C)	5.96 ± 0.06%	4.97 ± 0.05%
0030	Hydrogen (H)	1.07 ± 0.03%	0.83 ± 0.02%
0522	Silicon (Si)	40.2 ± 0.5%	38.0 ± 1.0%
0540	Specific Gravity	1.681 ± 0.005	Insufficient Sample

Again, I hope that this analytical data will satisfy your requirements. Let me know if you have any questions.

Very truly yours,

R. G. Niemi

R. G. Niemi
Sr. Technical Specialist
Elastomers, Technical Service
and Development
Phone: (517)-496-5380

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ATTACHMENT D