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BVT No.	N/A	D.C.P.No.	410
O.F.E.No.	13714	Issue Date	10/26/81
Q.A. Cat.	II	CO	2205

. DUQUESNE LIGHT COMPANY

BEAVER VALLEY POWER STATION 1

INSTALLATION AND REMOVAL PROCEDURE
FOR
THE SEGMENT REACTOR CAVITY SEAL RING

STONE & WEBSTER REVIEWS
(Leads & Principals)

Prepared by	[signature] 10/23/81	Power	[signature] 10/26/81
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Controls	NR [signature] 10/26	Hydraulic	NR
Nuclear	[signature] 10/26/81	Materials	[signature]
Structural	[signature] 10-26-81	Licensing	NR [signature]
Facilities	NR [signature] 10/26/81	Engr. Mech.	[signature] 10/26/81
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Assistant Project Engineer [signature] 10/26/81
(Signature & Date)

Project Engineer [signature] 10/30/81
(Signature & Date)

Note: This procedure supersedes BVPP 62-3 which was issued for DCP-216 (J.O. 12680.31), and includes revisions required by DCP-410 and by the Record Update of DCP-216 (Rev. 3). The various revisions are so identified. A general revision of paragraph numbering also occurred this revision.

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1.0 PURPOSE

This procedure covers the installation and removal of the segmented reactor cavity water seal.

2.0 RESPONSIBILITY

2.1 Duquesne Light Company is responsible for supplying all supervisory personnel, craft labor, operators, tools, and miscellaneous equipment necessary to perform all work. It is also responsible for ensuring quality control hold points identified in this procedure are adhered to and for ensuring normal personnel and equipment precautions are followed.

2.2 Stone & Webster Engineering Corporation is responsible for providing technical assistance when requested by Duquesne Light Company, providing resolution for all discrepancies and nonconformities which occur as a result of this work, and issuing approved addenda, if required, to change and/or clarify this field installation procedure.

3.0 PRECAUTIONS AND LIMITATIONS

3.1 Ensure the reactor is shut down and cooled down (Mode 6) (Ref. 1).

3.2 Ensure the coolant level inside the reactor vessel is below the vessel flange (Ref. 12).

3.3 Ensure the manipulator crane (CR-5) and reactor containment crane (CR-1) have been checked for proper operation (Ref. 1).

3.4 The seal ring segments weigh approximately 3,000 lb each. Do not exceed 5,000 lb load on the hoist rings.

3.5 Duquesne Light Company handling procedures and safety requirements shall be used on all lifts.

4.0 SPECIAL PRECAUTIONS

4.1 Lifts over the reactor vessel should be avoided.

4.2 Care should be exercised to avoid damage to the cavity liner when setting the segments in place.

4.3 To prevent personnel injury, care should be exercised in the area of the reactor cavity while the supplemental neutron shield or the reactor cavity water seal is removed.

4.4 The gasket adhesive is flammable, so extra CO_2 fire extinguishers and a fire watch should be provided until the adhesive is dry to the touch. There should be no sparks or open flames in the area of the adhesive.

5.0 EQUIPMENT

5.1 Portable Rigging Equipment

5.2 Reactor Containment Crane (CR-1)

5.3 Maniuplator Crane (CR-5)

5.4 Miscellaneous Hand Tools

5.5 Caulking Equipment (Ref. 10)

5.6 Gasket Cutting Tool (Ref. 8, Sheet 3)

5.7 Radiological Control Equipment (as determined by site Radiological Control Personnel)

5.8 4 oz of neolube

5.9 4 inch paint brush

5.10 16 oz of cleaning solvent (see step 7.1.1)

5.11 Rags

5.12 Refueling seal placement gages (Reference 8, Detail 10) 4 (4.0)

5.13 References

1. FSAR, Volume 5, Section 9.12.3
2. DLC Maintenance Manual

3. DLC Station Modification Manual

4. S&W Drawing 11700-5.11-2A

5. S&W Drawing 11700-RV-40A

6. S&W Drawing 11700-RV-40B

7. S&W Drawing 11700-RV-38D

8. S&W Drawing 11700-RV-38E

9. S&W Sketch 12690.51-SK-M83 Sh. 1 and 2 (Attachment D)

10. Scotch-Grip Adhesive Bulletin (Attachment A)

3 (216)

4 (416)

11. BVPS Operating Manual O.P.-56 Sect. 4-H.

12. BVPS Operating Manual O.P.-6 Sect. 4-G.

6.0 <u>HANDLING AND STORAGE OF THE SEAL RING</u>

6.1 The reactor cavity water seal ring segments are equipped with three safety hoist rings (part number ASD-23007) manufactured by the American Drill Bushing Company. Each safety hoist ring has a rated working load of 5,000 lb in any direction. Each ring segment weighs approximately 3,000 lb and may therefore be picked up by any one of the lifting devices.

6.2 When handling the ring segments, special care should be taken to avoid damaging the gasket surfaces of the ring segments or the gaskets themselves if installed. These surfaces are the underside of the spacer ring on the outside diameter, a 4 in wide area at the underside of the ring segments on the inside diameter, and a 5 in wide area along the top of the ring segments at the ends of the segments. The gasket surfaces should be covered with tape or some protective covering. The gaskets which are to be replaced are an acceptable protective covering.

6.3 The ring segments should be handled in a horizontal position while suspended from the three safety hoist rings, whenever possible. Time spent in any position other than horizontal should be minimized.

6.4 Whenever it is necessary to handle the ring segments in any configuration other than that described in step 6.3 above, the following precautions shall be observed:

1. When a ring segment is suspended in an other than horizontal position by one or more safety hoist rings, changes in the velocity of the ring should be done slowly and smoothly. Abrupt starts, stops, and changes in direction are to be avoided.

2. If a ring segment must be moved while supported by any device other than the safety hoist rings, the support shall be spread over the largest area possible. Interfaces between the support and the ring should be wood, rubber, or some substance that will not mechanically damage the ring. There is to be no contact between the gasket surfaces outlined in step 6.2 and any device which supports the segment. The gasket surfaces are to be cribbed to protect them from damage.

6.5 Whenever the ring is set down, it should be placed horizontally with the safety hoist rings up. It should be placed on cribbing which is located so as to prevent any contact with the gasket surfaces.

6.6 Materials which could contaminate the stainless steel parts of the reactor cavity water seal ring with chlorides, fluorides, sulfur, mercury, or lead should not contact any of the parts of the seal.

6.7 The entire underside of the radial seal is a gasket surface and should be protected from damage during handling and storage.

6.8 Whenever any threaded part is exposed, it should be protected by a thick, relatively soft material to prevent thread damage.

6.9 The ring segments should be stored in a horizontal position supported by cribbing as in step 6.5. The gaskets should be accessible for inspection, removal, and installation. The supports should be near the ends of the segments, near the center of each segment, and at least one support in between each end support and the center support. This configuration should be used both near the inside diameter and outside diameter (requires a minimum of 10 supports). The supports should be no smaller than 4 in x 4 in where they contact the segment. Segment may be stacked vertically in an area clear of safety related equipment following the above support guidelines for cribbing between segments.

6.10 If the gaskets sustain any damage during handling, they should be replaced prior to use.

7.0 INSTALLATION PROCEDURE

7.1 Gasket Installation

Note: This section shall be accomplished at least 24 hours (preferably 72 hours) prior to installing the ring in the refueling cavity. (i.e. 24 hours minimum of adhesive curing is required prior to seal ring installation.)

1. Visually inspect the neoprene washers under the perimeter spacer bar retaining bolts. If there is no indication of tears, cracks, or degradation of the washers, omit steps 7.1.2 through 7.1.6.

   Note: Washers on neutron detector hole cover do not have to be changed.

2. Remove every other perimeter spacer bar bolt and washer on each segment.

3. Clean the bolts and the surface of the seal ring where it came in contact with the washers thoroughly using a solvent such as Isopropyl Alcohol, Acetone, or Toluene (Reference 12 and Attachment C). 4 (41C

   Note: RTV was used in past to seal these mating surfaces. Ensure removal of old RTV prior to continuing.

4. Install one neoprene washer (Reference 8, Detail 9) on each of the removed perimeter spacer bar bolts.

5. Reinstall perimeter spacer bar bolts. Torque to 24±4 ft lbs.

6 Repeat steps 7.1.2 through 7.1.5 for the remaining perimeter spacer bar bolts.

7. Clean the gasket surfaces of the segmented seal ring thoroughly using a solvent such as Isopropyl Alcohol, Acetone, or Toluene (Ref. 11 and Attachment C).

8. Apply a 1/16 in coat of 3M Company Scotch-Grip adhesive No. 1711 to one segment of gasket material on the exposed hard rubber mating surfaces of the circumferential seals and the proper side of the radial seal splice gasket. A 4 inch paint brush should be used to apply the adhesive.

Caution: Ensure the adhesive is applied to the hard rubber surfaces of the circumferential seals and the side of radial splice seals to be mated with the radial seal retainer.

9. Install the gasket on the segments, and the radial seals. I.D. and O.D. seals should overlap the seal ring by 3/4 in minimum at the ends. Radial seal gaskets should overlap the radial seal at each end by 1/4 in. minimum. (Ref. 7 and 10).

Note: Retaining devices such as "C" clamps should be used to hold the gaskets in place until the adhesive cures. Use wood blocks to obtain a uniform clamping force over as much of the gasket surfaces as possible.

10. Repeat steps 7.1.7 through 7.1.9 for the remaining six seal ring gaskets and the three radial seal gaskets.

Note: The radial seal gaskets will be installed as one prefabricated gasket along the length of the radial seal as shown on Ref. 8. Detail 8.

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11. When the adhesive has dried, trim the ends of the ring segment O.D. and I.D. gaskets (Ref. 9, pg 2).

12. Caulk the 1/4 in ledge between the seal ring segments and spacer bars with RTV-732 if existing caulk requires replacement (Ref. 9, pg. 1 and Ref. 11).

13. Caulk the gap between the ring segment and spacer bar at the beveled edge for the radial seal. Smooth surface of caulk such that the beveled surface remains as smooth as possible.

14. Neolube and install the retainer studs if they have been removed. Torque to 10 ft-lbs.

7.2 Reactor Cavity Water Seal Installation

Note: The reactor cavity water seal ring is segmented into four sections: Each section is to be sealed by a prefabricated gasket of closed cell neoprene foam. This facilitates the sealing effectiveness over the entire range of operating pressures without the use of bolts for precompression of the gaskets.

1. All cable, air ducts, and insulation must be removed from the vessel head (Ref. 1).

2. The supplemental (Benelex) neutron shielding must be removed (Refs. 5 and 6).

3. Align the first segment with the neutron detector hole.

4. Set down the segment with the O.D. on the refueling cavity liner embedded ring and the I.D. on the reactor flange. The segment should extend equal distances (2 1/2" ±) over both the embedded ring and reactor vessel flange.

Note: To aid in placement of each segment, the refueling seal placement gages (Ref. 8, Detail 10) should be used. Simultaneous use of two gages, one near either end of each segment along the outer diameter, will ensure proper spacing. (See Attachment E, Figure 1 for proper placement of gage.) Remove gage blocks after seal placement. 4 (410)

5. Subsequent segments shall be installed in accordance with steps 7.2.4. The gap between the ends of the metal portions of the segments will be approximately 2 in.

   Note: Care should be exercised in placing the last ring to avoid pinching the gaskets or damaging the seal. DO NOT SLIDE SEGMENTS. (-) 4 (410)

6. Test fit the radial seals and the retainer clamping bars. When all pieces are properly aligned, remove the radial seals.

7. Measure the gap in the gaskets and, using the tool illustrated in Ref. 8, Detail 11, cut wedges to fit the gap. Use Ref. 9, Sheet 2 and Attachment F for guidance.

8. Coat the sides of the wedges with adhesive and install (See Ref. 9, Sheet 2). Adhesive to be 3M-No. 1711.

9. Install the radial seals and retainer bars. Install the washers and nuts for the retainer bars and thread the nuts to a loose fit.

10. Tighten the retainer bar nuts to achieve 1/4 in gasket compression, but no more than 25 ft-lb per nut.

    Note: Ensure the overlapping gasket on the radial seal contacts the top of the main gasket. Caulk this line of contact with adhesive.

7.3 Post Installation and Testing

1. Ensure all tools and materials are removed from the refueling cavity prior to removing the reactor vessel head and that the area meets all DLC cleanliness requirements.

2. Fill the refueling cavity until the seal ring is barely covered and monitor leakage.

3. If leakage is less than the maximum flow rate that a temporary recirculation system has the ability to overcome; or if leakage is less than 3 gpm (based on use of permanently installed equipment instead of the temporary recirculation system, and 50 percent capacity of the liquid waste evaporator, LW-EV-1), continue to fill the cavity.

4. Monitor leakage during the fill. If leakage exceeds the maximum for whichever mode of operation is in service from Step 3 above; or if the leak rate does not begin to subside noticeably as refueling cavity water level is increased over Step 2 above: Stop the filling operation, drain the cavity, repair the leaks using the adhesive as a caulk, and repeat Steps 2 and 3 when the adhesive has dried.

   Caution: If sump pump DA-P-5 remains on for 2 minutes or more, the leakage is in excess of 3 gpm. Indicating lights for DA-P-5 located on main control board.

   Note: As the cavity is filled, leakage should decrease due to the weight of the water improving the seal.

7.4 Reactor Cavity Water Seal Removal

1. Drain the refueling cavity.

2. Remove the radial seals and retainer bars.

3. Using a knife or scissors to prevent tearing the main gasket, cut through the wedges installed in step 7.2.8.

4. Lift the segments out.

5. Place thread protectors on the retainer studs.

6. Move the segments to their storage area and support them on cribbing to prevent gasket damage.

7. Cut the wedges out while removing as little of the main gasket as possible.

8. One of the solvents listed in step 7.1.1 (with the exception of the Isopropyl Alcohol) should be used to remove any adhesive remaining on the embedded ring and reactor flange.

J.O. No. 13387.70
BVPP No. 62- 4

ATTACHMENT A

Scotch-Grip
RUBBER ADHESIVE

PRODUCT SPECIFICATION

NO. 1711

DATED:
OCTOBER 1, 1966

DESCRIPTION:

- A light colored, high strength adhesive with a long tack range. Dries quickly; has excellent water, oil and grease resistance.
- Bonds Neoprene, natural, reclaim, SB-R and Butyl rubber to most substrates.

PHYSICAL PROPERTIES

BASE Polychloroprene	NET WEIGHT 7.4 lbs./gal.	CONSISTENCY Medium Syrup
SOLVENT Aromatic, Aliphatic	FLASH POINT −14°F.	VISCOSITY (APPROX.) 2600 cps
COLOR Tan	SOLIDS CONTENT (APPROX.) 36%	BROOKFIELD VISCOSIMETER RVF #3 sp. @ 20 rpm

APPLICATION CHARACTERISTICS

METHOD Brush or Flow	COVERAGE (1 MIL DRY FILM) 438 sq. ft./gal.	BONDING RANGE (10 Mil Wet Film, 2 Surfaces) Up to 20 Minutes

EQUIPMENT SUGGESTIONS

5 gallon pail dispensing system:

1. Pump—5:1 ratio double acting ball check type pump 8.0 cubic inches/cycle, 3" air motor
2. Primer—Single wiper follow plate
3. Equipment—Graco Model 225-654 system which includes:
   Monark Pump Model #204-392—Pyles Industries, Lincoln Engineering and Aro Corporation make similar equipment.

55 gallon drum dispensing system:

1. Pump—5:1 ratio
2. Primer—inductor plate
3. Equipment—Graco 5:1 Monark, Model #204-227 with a #204-490 inductor—Pyles Industries, Lincoln Engineering and Aro Corporation make similar equipment.

Accessories:

1. Hose—Samuel Moore Synflex hose or equivalent, 1000 psi working pressure minimum.
2. Flow gun—Graco Model #203-420 with a ¼" tip or equivalent.

Chemical resistance requirements:

1. Synthetic materials in contact with this adhesive must be resistant to ketones and aromatic solvents. Comper, nylon and Teflon are suggested.

Adhesives, Coatings and Sealers Division 3M COMPANY
2501 HUDSON ROAD, ST. PAUL, MINN. 55119 PHONE: 733-1110 AREA CODE 612

PRODUCT SPECIFICATION

Scotch-Grip RUBBER ADHESIVE NO. 1711

PERFORMANCE CHARACTERISTICS

180° PEEL STRENGTH Canvas/Steel			OVERLAP SHEAR STRENGTH ⅛" Birch/Birch		
Time @ 75°F.	Test Temp.	Value (lbs./in. width)	Time @ 75°F.	Test Temp.	Value (lbs./sq. in.)
1 day	75°F.	10.5	2 wk.	75°F.	238
3 days	75°F.	16.5	3 wk.	75°F.	328
5 days	75°F.	25	after 3 wk.	−30°F.	648
7 days	75°F.	31	after 3 wk.	180°F.	34
2 wk.	75°F.	32	after 3 wk.	225°F.	16
3 wk.	75°F.	36			
after 3 wk.	−30°F.	15			
after 3 wk.	150°F.	18			
after 3 wk.	180°F.	16			

STORAGE AND HANDLING

Store product at 60-80°F. for maximum storage life. Higher temperatures reduce normal storage life. Lower temperatures cause increased viscosity of a temporary nature. Rotate stock on a "first in-first out" basis. Upon request, your 3M Adhesives, Coatings and Sealers Sales Representative will be pleased to advise you of the anticipated shelf life of this product under the storage conditions in your plant.

Clean-up can be accomplished with Scotch-Grip Brand Solvent No. 2. When using solvents for clean-up, it is essential that proper precautionary measures for handling such materials be observed.

ICC SHIPPING CLASSIFICATION: Adhesive Cements, NOI. Red label required.

DANGER! EXTREMELY FLAMMABLE

Before using, extinguish all flames and pilot lights. Use only in well ventilated areas. During application and until vapors are gone, keep product and its vapors away from heat, sparks and flame. Avoid using spark producing electrical equipment such as switches, appliances, etc. Keep container closed when not in use.

IMPORTANT NOTICE TO PURCHASER

All statements, technical information and recommendations contained herein are based on tests we believe to be reliable, but the accuracy or completeness thereof is not guaranteed, and the following is made in lieu of all warranties, express or implied:

Seller's and manufacturer's only obligation shall be to replace such quantity of the product proved to be defective. Neither seller nor manufacturer shall be liable for any injury, loss or damage, direct or consequential, arising out of the use of or the inability to use the product. Before using, user shall determine the suitability of the product for his intended use, and user assumes all risk and liability whatsoever in connection therewith.

No statement or recommendation not contained herein shall have any force or effect unless in an agreement signed by officers of seller and manufacturer.

ECN-410-1-DEG
pg 3 of 6

Information about Silicone Elastomers

DOW CORNING

DESCRIPTION

SILASTIC® 732 RTV adhesive/sealant is a paste-like, one-component material which cures to a tough, rubbery solid when exposed to moisture in the air. Since it will not flow of its own weight, this sealant can be applied overhead or on sidewall joints and surfaces without sagging, slumping, or running off. It will adhere to clean metal, glass, most types of wood, silicone resin, vulcanized silicone rubber, ceramic, natural and synthetic fiber, as well as painted and many plastic surfaces.

SILASTIC 732 RTV adhesive/sealant has good resistance to weathering, vibration, moisture, ozone, and extreme temperatures. It may be applied in sub-zero weather without loss of extrusion or physical property characteristics. Fully cured SILASTIC 732 RTV adhesive/sealant can be used for extended periods at temperatures up to 450 F (232 C), and for shorter periods, as high as 500 F (260 C). Tests have shown that even after two months at 450 F (232 C) or up to one week at 500 F (260 C), the sealant remains rubbery. Graphs I and II illustrate the effects of heating upon the peel strength (180 degree peel on primed Alclad 2024 aluminum panels) and upon the ultimate elongation (measured according to ASTM D 412).

SILASTIC 732 RTV adhesive/sealant is available in a variety of colors including aluminum, black, clear, and white.

SILASTIC® 732 RTV ADHESIVE/SEALANT

Type	One-part, vulcanizing silicone rubber
Physical Form	Nonslumping paste
Cure	Cures at room temperature, on exposure to water vapor in the air, giving off a small amount of acetic acid
Special Properties	May be applied overhead or on sidewall joints and surfaces; will not sag or run off
Primary Uses	General purpose sealing and bonding as a space-filling rubber adhesive or a formed-in-place gasket

USES

SILASTIC 732 RTV adhesive/sealant is primarily used for:

- Adhering auto and appliance trim, including metal, fabric, and fabric-backed plastics
- Bonding gaskets in heating and refrigeration units
- Attaching screwless brackets or nameplates, and tacking plastic materials to metal
- Sealing windows in oven doors and flues on gas appliances, flanged pipe joints, access doors
- Formed-in-place gasket for gear boxes, compressors, pumps
- Sealing trailers, truck cabs
- Bonding and sealing appliance parts
- Bonding signs and sign letters
- Antiabrasion coating
- Sealing of marine cabins and windows
- Filleting and caulking joints in sheetmetal stacks, ductwork, and equipment housings

HOW TO USE

Applying the Material: Tack-Free Time

SILASTIC 732 RTV adhesive/sealant is supplied ready-to-use. Under pressure, it flows readily from its container. The paste-like consistency makes it easy to work; a spatula or wooden paddle can be used for tooling the surface.

The cure progresses inward from the surface. At conditions of at least 75 F (24 C) and 50 percent relative humidity, the sealant forms a tack-free skin within 20 minutes. Tooling is not practical after this skin begins forming, and should be completed within 5 to 10 minutes of application, even though this may require alternate periods of applying and tooling. Likewise, if masking tape has been used to mark off an area, it should be removed before the tack-free skin forms.

Cure Time

Cure time is affected by relative humidity, degree of confinement, and cross-sectional thickness of the sealant. Sections up to 1/8-inch thick become rubbery solids in about 24 hours at room temperature at 20 percent relative humidity. Less moisture content reduces it slightly. In 24 hours, sections up to 1/8-inch thick cure to a rubber with a Shore A

ATTACHMENT "B" B1-1

TYPICAL PROPERTIES

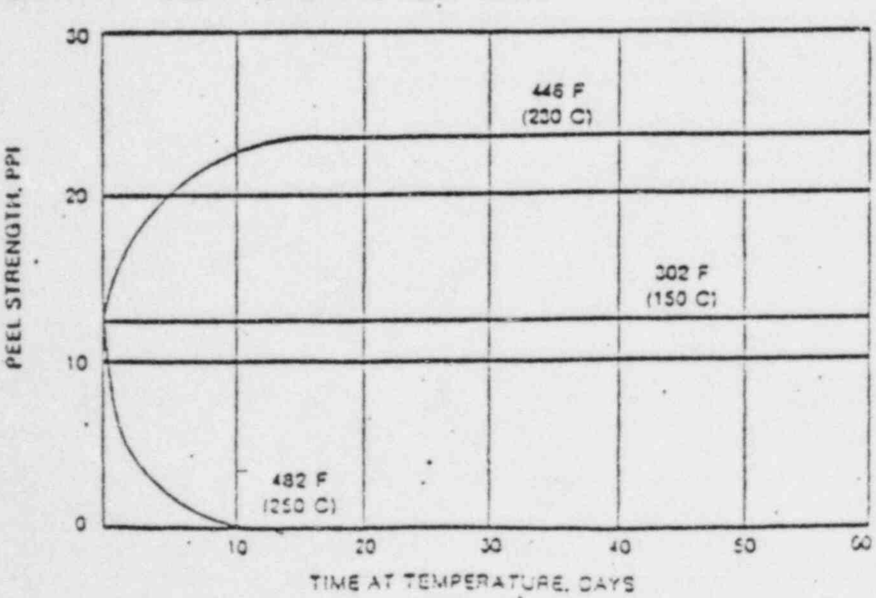
These values are not intended for use in preparing specifications.

As Supplied		
	Colors	Aluminum, black, clear, and white
	Specific Gravity at 77 F (25 C)	1.04
	Extrusion Rate (⅛-inch orifice, 90 psi air pressure), gms/min	350
	Flow Rate (sag or slump on ⅛ x 4-in bead), in	Nil
	Tack-Free Time at 77 F (25 C) and 50% RH, min	10 - 20
	Cure Time at 77 F (25 C) and 50% RH (⅛-in thickness), hrs	24
As Cured* — Physical		
ASTM D 676	Durometer Hardness, Shore A, points	30
ASTM D 412	Tensile Strength, psi (MPa)	350
ASTM D 412	Elongation, percent	500
ASTM D 746	Brittle Point, degrees	-100 F (-73 C)
ASTM D 2137A	Volume Coefficient of Thermal Expansion, 32 to 212 F (0 to 100 C)	9.3×10^{-4}
	Thermal Conductivity, cal/(cm) (degrees C) (sec)	0.45×10^{-3}
	BTU per (ft) (degrees F) (hr)	0.11
As Cured† — Electrical		
ASTM D 257	Volume Resistivity, ohm-cm	1.5×10^{15}
ASTM D 149	Dielectric Strength,** volts/mil	550
ASTM D 150	Dielectric Constant,	
	at 60 Hz	2.8
	at 100 Hz	2.8
	at 100 KHz	2.8
ASTM D 150	Dissipation Factor,	
	at 60 Hz	0.0015
	at 100 Hz	0.0015
	at 100 KHz	0.0015

*Measured on 0.125-in-thick slabs after 72 hrs/77 F (25 C) and 50% RH.
†After vulcanizing 72 hrs/77 F (25 C) and 50% RH in 1/8-in-thick cross section.
**65-mil thickness, 1/4-in ASTM electrodes in oil, rapid rise.

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

GRAPH I — PEEL STRENGTH VS HEAT AGING



durometer hardness rating of about 25 points. After 3 days at room temperature, this durometer hardness levels off to about 30 points.

In applications where SILASTIC 732 RTV adhesive/sealant may be partly or totally confined during cure, the time required for proper cure is generally lengthened by the degree of confinement. It is possible, with absolute confinement, that cure will not be completed. The result is the softening of the sealant at elevated temperatures. Metal-to-metal bonds should not overlap more than one inch. Every application involving confinement during cure should be thoroughly tested before commercialization.

Curing time increases with the thickness of the sealant. A 1/2-inch cross section, for example, may require 3 or 4 days for complete solidification. However, the cure will have penetrated the outer 1/8-inch in about 24 hours.

Adhered to glass, metal, or most woods, SILASTIC 732 RTV adhesive/sealant has a typical peel strength of 20 pounds per inch, after 72 hours at room temperature.

The odor given off during cure is due to the liberation of acetic acid. This odor disappears as the cure progresses, and is not detectable after the cure is complete.

CAUTION

On contact, uncured sealant causes irritation. Avoid contact with eyes and skin. Contact lens wearers take appropriate precautions. IN CASE OF CONTACT, flush eyes with water. Call a physician. Remove from skin with dry cloth or paper towel. Sealant releases acetic acid (vinegar-like odor) during cure. KEEP OUT OF REACH OF CHILDREN.

Bonding

1. Thoroughly clean and degrease metal and plastic surfaces, then rinse all surfaces, except plastic, with acetone. Rubber surfaces should be roughened with sandpaper, then wiped with acetone. Follow the precautions given on solvent container label.

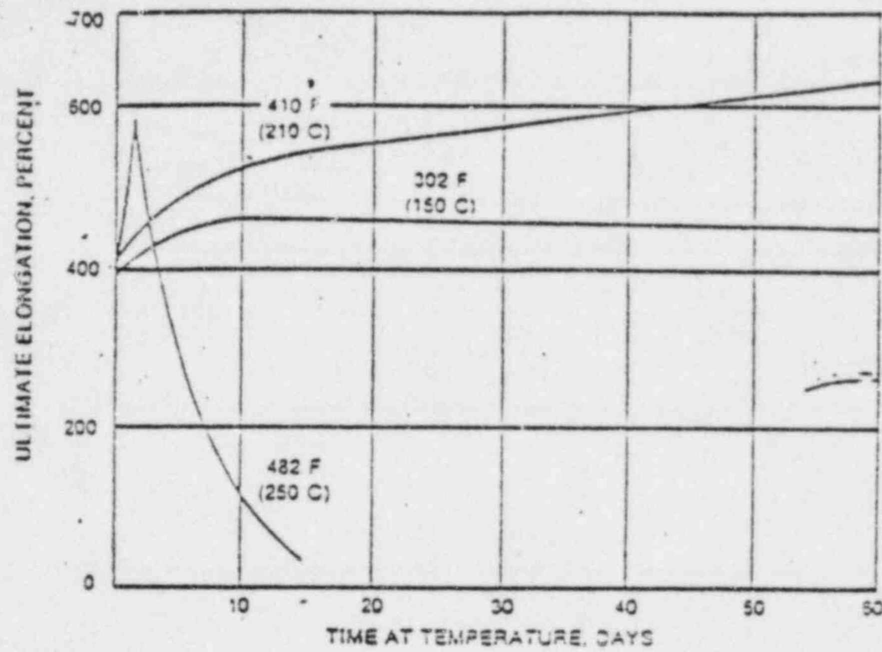
2. For stronger, more uniform bonds, apply a thin film of

DOW CORNING® 1200 prime coat to all surfaces except rubber and silicone rubber. Allow to air-dry for 30 to 45 minutes at room temperature. (Full instructions are provided with the prime coat.) *CAUTION:* DOW CORNING 1200 prime coat is flammable and has no FDA status. Keep away from heat and open flames. Use only with adequate ventilation.

3. Apply SILASTIC 732 RTV adhesive/sealant to the prepared surface in a uniform thickness. Best adhesion is obtained with a 15- to 30-mil glue line. In those cases where the adhesive is used between two surfaces, put the second surface in place, using enough pressure to displace the air but not the adhesive.

4. Let the unit stand undisturbed at room temperature to cure.

GRAPH II — ELONGATION VS HEAT AGING



Sealing

Using SILASTIC 732 RTV adhesive/sealant in sealing applications follows approximately the same step-by-step procedures as outlined for bonding applications. After preparing the surfaces and priming where required, the sealant is applied by forcing it into the joint or seam to obtain full contact between sealant and surfaces.

Estimating

For estimating sealant requirements, multiply gallons by 128 fluid ounces and divide by the cartridge size. Example: 11 gallons required x 128 fluid ounces = 1408 ÷ 10.3-fluid ounce cartridge = 137 cartridges required.

Using the Table

Example: Find how much sealant is required for a joint 3/8 inch wide, 1/8 inch deep and about 225 feet in overall length. Reading down the width column headed "3/8" to the depth line marked "1/8," gives a value of 0.25. This is the amount of sealant, in gallons, required for a joint 3/8 inch x 1/8 inch x 100 feet in length. For the joint specified, 225 feet in length, multiply by 225 over 100, or 2.25: 0.25 x 2.25 = 0.56 gallons. To convert this to cartridges, see estimating.

FDA STATUS

When fully cured and washed, SILASTIC 732 RTV adhesive/sealant meets the requirements of FDA Regulation No. 21 CFR 177.2600 (formerly 121.2562) subject to end use compliance with any applicable total extractives limitations.

NSF STATUS

SILASTIC 732 RTV adhesive/sealant is listed by the National Sanitation Foundation under the criteria C2 for direct contact with food.

USDA STATUS

SILASTIC 732 RTV adhesive/sealant is authorized by the United States Department of Agriculture for use in Federally inspected meat and poultry plants.

UL STATUS

SILASTIC 732 RTV adhesive/sealant is recognized by Underwriters Laboratories for service to 302 F (150 C) where elongation is not essential.

SPECIFICATIONS

SILASTIC 732 RTV adhesive/sealant is designed to meet the requirements of MIL-A-46106A, Amend 2, Type 1.

SHIPPING LIMITATIONS

None.

STORAGE AND SHELF LIFE

When stored in original unopened containers at or below 90 F (32 C), SILASTIC 732 RTV adhesive/sealant has a shelf life of 12 months from date of shipment. Containers

TABLE I: ESTIMATING THE AMOUNT OF SEALANT

DEPTH, inches \ WIDTH, inches	1/32	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	1
1/32	0.04	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.10	0.12	0.16
1/16	0.01	0.02	0.04	0.06	0.08	0.10	0.12	0.14	0.16	0.20	0.25	0.33
1/8	0.02	0.04	0.08	0.12	0.16	0.20	0.25	0.29	0.33	0.41	0.49	0.65
3/16	0.03	0.06	0.12	0.18	0.25	0.31	0.37	0.43	0.49	0.61	0.73	[illegible]
1/4	0.04	0.08	0.16	0.25	0.33	0.41	0.49	0.57	0.65	0.82	0.98	1.31
5/16	0.05	0.10	0.20	0.31	0.41	0.51	0.61	0.71	0.82	1.02	1.22	1.63
3/8	0.06	0.12	0.25	0.37	0.49	0.61	0.73	0.86	0.98	1.22	1.47	1.96

ATTACHMENT "B" B1-3

should always be kept sealed when not in use. After a container has been opened, a plug of cured material may form in the nozzle or tube tip during storage. When ready to reuse, unscrew nozzle and remove cured plug. Remaining sealant is ready to use.

PACKAGING

SILASTIC 732 RTV adhesive/ sealant is available in 3- and 4.7-fl oz (90 and 139 mL) tubes, 10.3-fl oz (305 mL) cartridges, and 4.5- and 52-gal (17- and 197-l) containers, net weight.

USERS PLEASE READ

The information and data contained herein are believed to be accurate and reliable; however, it is the user's responsibility to determine suitability of use. Since Dow Corning cannot know all of the uses to which its products may be put or the conditions of use, it makes no warranties concerning the fitness or suitability of its products for a particular use or purpose.

You should thoroughly test any proposed use of our products and independently conclude satisfactory performance in your application. Likewise, if the manner in which our products are used requires governmental approval or clearance, you must obtain it.

Dow Corning warrants only that its products will meet its specifications. There is no warranty of merchantability of fitness for use, nor any other express or implied warranties. The user's exclusive remedy and Dow Corning's sole liability is limited to refund of the purchase price or replacement of any product shown to be otherwise than as warranted. Dow Corning will not be liable for incidental or consequential damages of any kind.

Suggestions of uses should not be taken as inducements to infringe any patents.

DOW CORNING CORPORATION
MIDLAND, MICHIGAN 48640

Printed in U.S.A. Form No. 61-[illegible]

ATTACHMENT C

Approved Cleaning Fluids

Approved volatile solvents: Methyl Alcohol, Ethyl Alcohol, Isopropyl Alcohol, Acetone, Toluene, Varsol 4, Dowanol EB, and Stoddard Solvent 100-110. Solvents shall be technical grade, either new or redistilled.

Toluene may be used for removal of silicone greases. Varsol 4 and Stoddard Solvent leave a petroleum film which must be removed by wiping with alcohol, acetone, or Dowanol EB.

Special care shall be taken to insure that all federal, state, and manufacturers safety precautions are observed when using volatile solvents. Recommended safety related data is attached in Table I.

TABLE I

J.O. No. 13387.70
BVPP No. 62-4

SAFETY RELATED DATA FOR APPROVED SOLVENTS

	Flash Point (°F)	Flammable Limits @77°F (Vol.%)	Ft^3 Vapor/ gal. Sol'n @80°F	Vapor Density (air=1.0)	Threshold Limit Value* (ppm)	Fresh Air Recirculation Factor** (ft^3/gal. sol'n)
Methyl Alcohol	52	6.7-36.0	81	1.1	200	405,000
Ethyl Alcohol	55	3.3-19.0	56	1.59	1000	56,000
Isopropyl Alcohol	53	2.0-12.0	43	2.07	400	107,000
Acetone	0	2.6-13.0	45	2.00	1000	45,000
Toluene	45	1.2-7.0	31	3.17	200	155,000
Varsol 4	140	0.8-6.0	17	5.24	500	34,000
Dowanol EB	141	1.1-10.6	25	3.60	50	500,000
Stoddard Solvents	100-110	0.8-5.0	20	5.0	500	40,000

*Threshold Limit Values are established by the American Conference of Governmental Industrial Hygienists and are accepted guidelines for OSHA. These values are established assuming an 8 hour/day exposure. At or below these levels, there is little likelihood of ill effects to healthy individuals.

**Fresh Air Recirculation Factor multiplied by the number of gallons of solvents used per unit time will provide the cubic feet of fresh air which must be replaced, in a closed area in that same period of time. The equation from which the factor was derived is presented below.

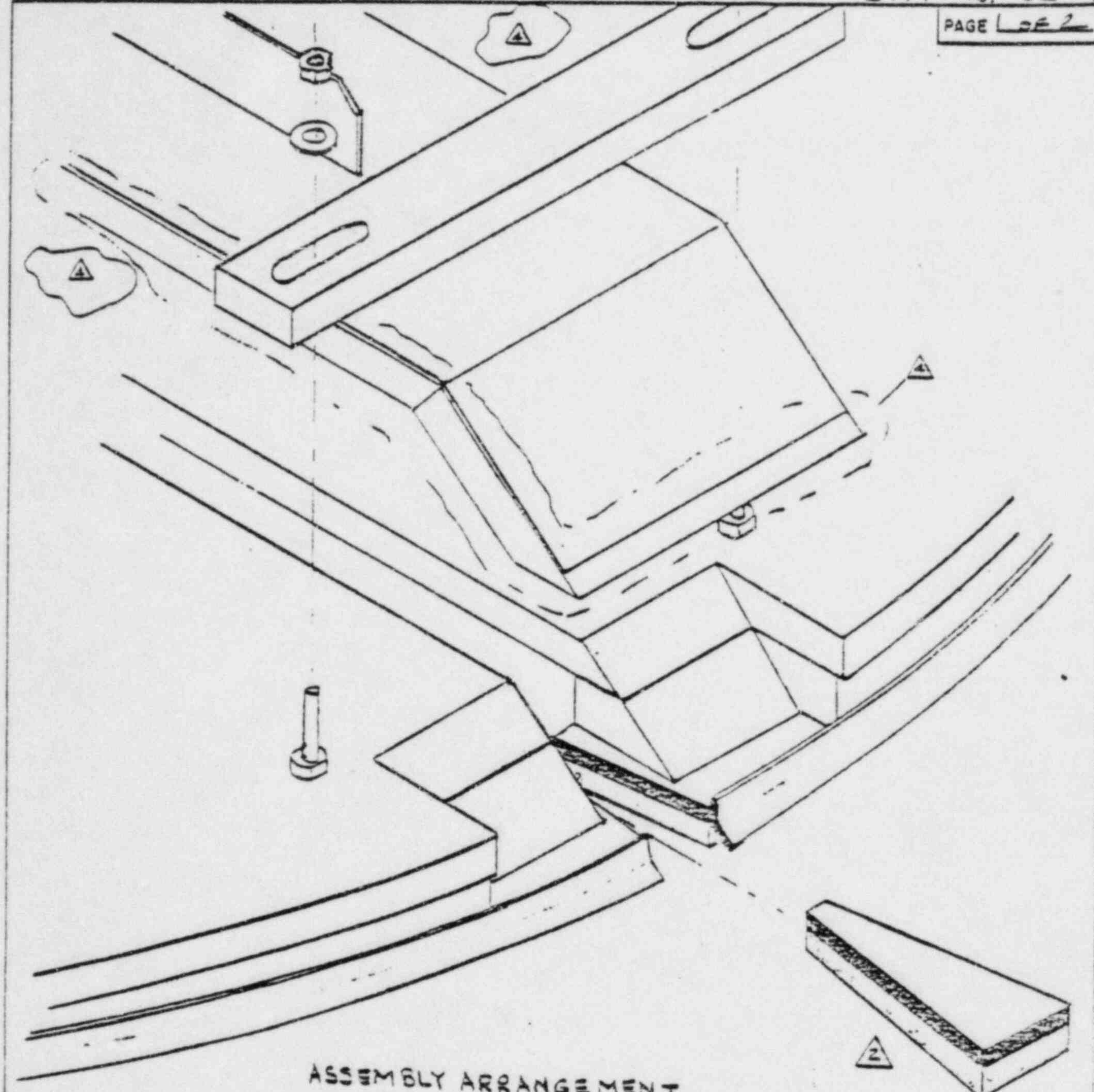
$$\frac{(ft^3\ \text{vapor/gallon solution})\ (\text{gallons used/unit time})}{\frac{\text{Threshold Limit Value}}{1{,}000{,}000}} = \text{volume } (ft^3) \text{ of fresh air required/unit time}$$

ATTACHMENT D

JO No. 13387.70
BVPP No. 62-4

STONE & WEBSTER ENGINEERING CORPORATION

PAGE 1 OF 2



ASSEMBLY ARRANGEMENT

NOTES: 1. INSIDE DIAMETER SIMILAR BUT HAS NO SPACER BETWEEN THE RING SEGMENT AND GASKET

2. WEDGE FABRICATED BY CUTTING LENGTHWISE FROM ONE OF THE EXTRA RADIAL SEAL GASKETS

NOT TO SCALE

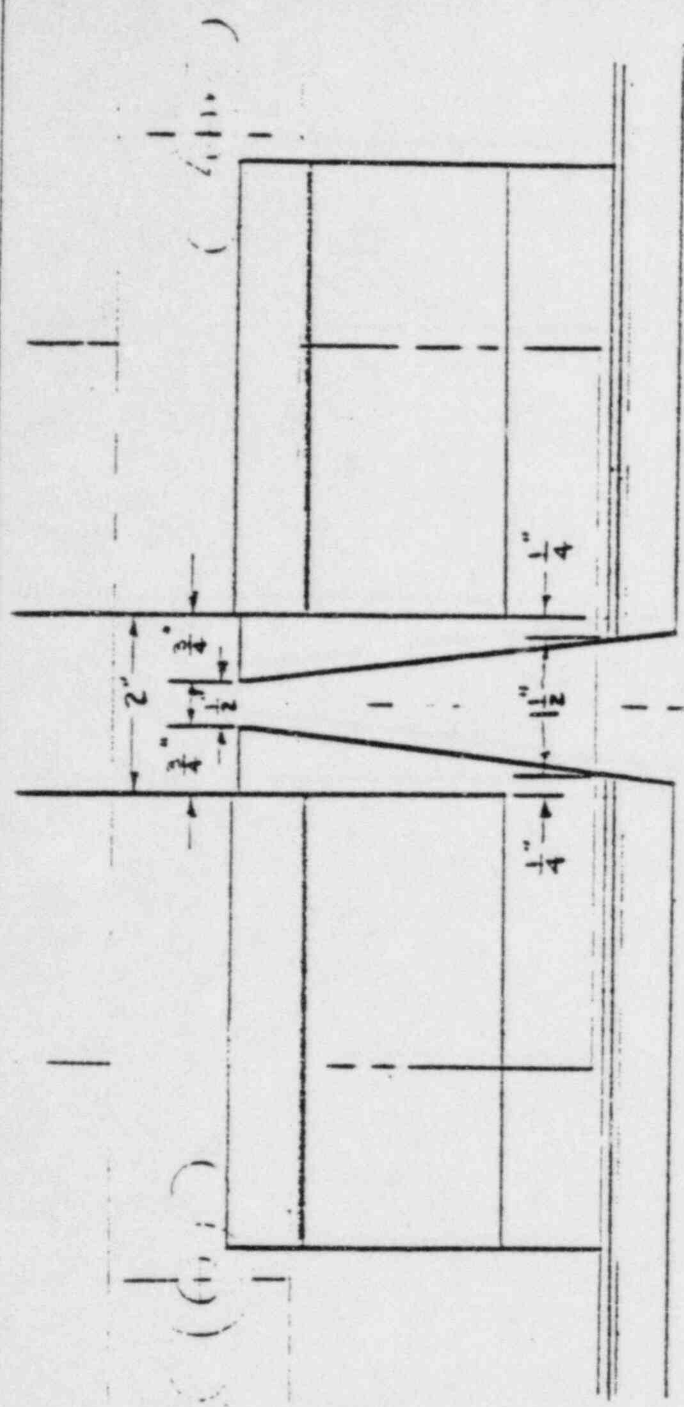
POWER INDUSTRY GROUP	BY	DATE	TITLE			CLIENT DLC
			REACTOR CAVITY WATER SEAL SPLICE ARRANGEMENT			PROJECT BVPS UNIT #1
PREPARED	REG	1/11/79				J.O. NO. 12690.51
CHECKED	CSA	1/15/79				① ISSUED BY REGRABIA
APPROVED	[illegible]	1-16-79	REF: 12690.51-SK-N-75			DATE JANUARY 16 1979
REVISIONS BY	② REG	③ REG	④ [illegible]	⑤	⑥	NUMBER
DATE	2-22-79	[illegible]	10-1-81			12690.51-SK-N-53

WEDGE FABRICATION

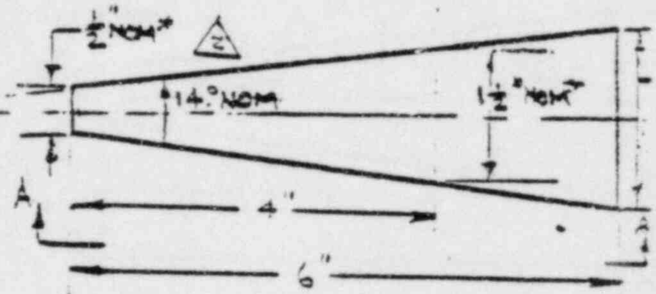
1. TRIM GASKETS ON SEGMENTS AS SHOWN
2. INSTALL SEGMENTS IN THE BOTTOM OF REFUELING CAVITY AROUND THE REACTOR VESSEL.
3. MEASURE WEDGE SHAPED OPENINGS IN THE GASKETS BETWEEN SEGMENTS
4. CUT WEDGE TO FIT
5. APPLY SCOTCH-GRIP ADHESIVE NO. 1711 TO LONG SIDES OF WEDGE AND DISTAL

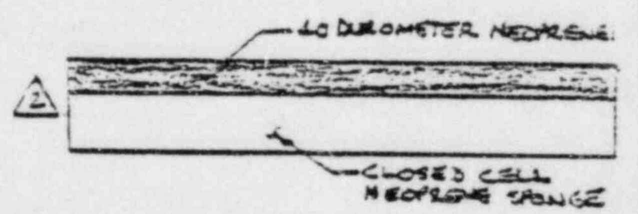
OR

6. SEVERAL WEDGES COULD BE PRECUT TO VARIOUS NOMINAL DIMENSIONS AND TRIAL FITTING THEM DURING INSTALLATION IN PLACE OF STEPS 3 & 4 ABOVE.



PLAN VIEW





VIEW A-A

NOTES: 1. NOMINAL DIMENSIONS WILL VARY WITH ACTUAL INSTALLATION ORIENTATION OF THE SEGMENTS AS INSTALLED. THE DIMENSIONS MARKED (*) SHOULD BE EQUAL TO THE CORRESPONDING DIMENSIONS ON THE GAP BETWEEN THE SEGMENT GASKETS +0"-1/8".

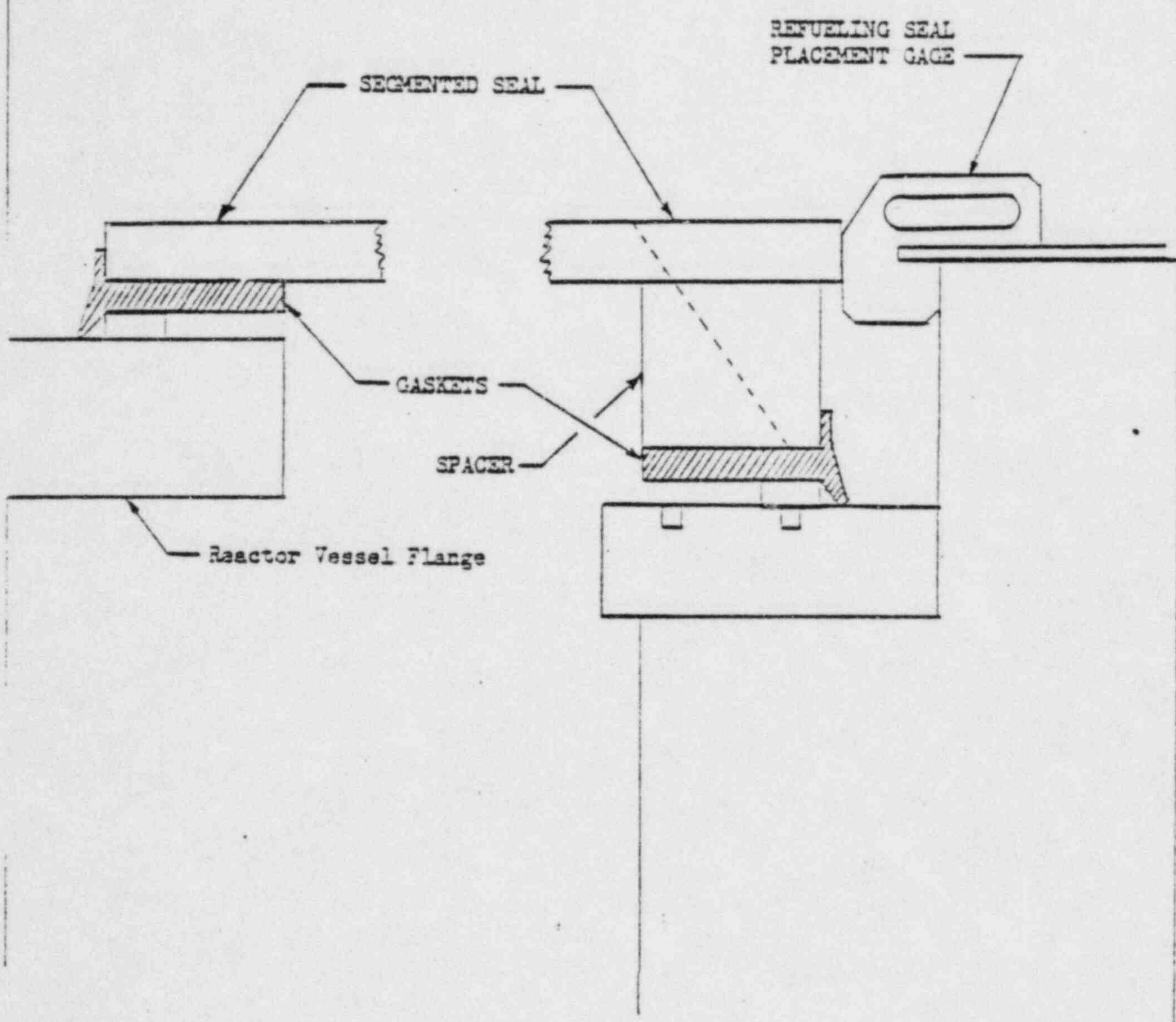
WEDGE & WEDGE CAVITY FABRICATION

HALF SCALE

POWER INDUSTRY GROUP			TITLE			CLIENT DLC
	BY	DATE	REACTOR CAVITY WATER SEAL SPLICE ARRANGEMENT			PROJECT BVPS UNIT 1
PREPARED	REG	1/11/79				J.O. NO. 12690.S1
CHECKED	CA	1/15/79				⓪ ISSUED BY RE 42210
APPROVED		1.6.79				DATE JANUARY 16, 1979
REVISIONS BY	③ REG		④	⑤	⑥	NUMBER
DATE	2-22-79					12690.S1-SK-N-83

J.O. No. 13387.70
BVPP No. 62- 4

ATTACHMENT E



DATE						TITLE: SEGMENTED SEAL ARRANGEMENT	REF:
PREP.							
CHECK	5	4	3	2	1		SKETCH Figure 1
APPR.							

▲ 5215.9

J.O. No. 13387.70
BVPP No. 62-4

ATTACHMENT F

Directions For Use Of Gasket Cutting Tool

1. The cut will be cleaner if the gasket is cut through the closed cell sponge to the neoprene.

2. Measure and mark cut line.

3. Draw cutting edge across cut line to break skin of gasket.

4. Place cutting edge along cut line.

5. Strike top of handle with a 2 lb. hammer.

Note: Wood should be placed under the gasket while cutting to preserve cutting edge.

4
(410,

3.0 DESIGN

3.1 System Requirements

3.1.1 Function

The function of the reactor cavity water seal is to prevent water which fills the reactor vessel and cavity leaving the reactor refueling cavity during refueling.

NOTE: The water is required to provide personnel radiation shielding during refueling.

3.1.2 Design Requirements

3.1.2.1 Process Requirements

Not applicable

3.1.2.2 Structural Requirements (Ref. 4)

A. Material

1. Plate - ASTM A240 Type 304
2. Bar - ASTM A479 Type 304
3. Bolts - 410 stainless steel
4. Studs and Nuts - 416 stainless steel
5. Gasket - Neoprene (40 durometer)

B. Maximum seal load 252.3 lb/in due to a 27 ft hydrostatic head.

3.1.2.3 System Configuration and Essential Features

A. Two covered openings are provided for access to the neutron detectors.

B. Three lugs are provided on each segment for lifting purposes.

C. The seal ring consists of four segments for simplified handling and for transporting into the containment via the personnel hatch.

D. Four splice plates are provided and will be located over the radial seals.

3.1.2.4 Maintenance Requirements

The gaskets for the seal ring shall be inspected prior to installing the ring. If the gaskets are worn or damaged, they shall be replaced.

3.1.2.5 Surveillance Testing and Inservice Inspection

Leakage past the seal ring should be monitored during refueling. The allowable leakage rate is one-half the capacity of the liquid water evaporator with the cavity fully flooded. (Ref. 5)

3.1.2.6 Electrical Requirements

Not applicable

3.1.2.7 Interfacing Systems

Not applicable

3.1.2.8 Quality Assurance

This modification is classified as QA Cat. III.

3.1.2.9 Codes and Standards

ASME II	7/1/77
ASME V	7/1/77
ASME VIII, Div. 1	7/1/77
ASTM	1977
SNT-TC-1A	6/75
Reg. Guide 1.13	
Reg. Guide 1.39	

3.1.2.10 Construction Phase Requirements

During shipment the sealing surfaces of the water seal will be taped and protected with cribbing.

3.1.2.11 Reliability Requirements

Not applicable

3.1.2.12 Access and Administrative Control Requirements for Plant Security

Not applicable

3.1.2.13 Fire Protection or Resistance Requirements

Scotch-Grip Adhesive No. 1711 is highly flammable. Extra fire extinguishers should be available, a fire watch should be posted, and there should be no sparks or open flame in the vicinity when the adhesive fumes are present.

3.2 System Design

3.2.1 Detailed Design Description

The segmented reactor cavity water seal has been developed to replace the existing seal which was deformed when dropped.

The segmented seal comes in four separate segments which when installed will be connected and sealed over the reactor vessel cavity. Neoprene gaskets will be used for sealing the ring. The segmented reactor cavity water seal has several advantages over the one-piece ring used in the past.

A. The segmented ring can be dissassembled and transported in and out of the containment structure.

B. Each segment is moved separately thus simplifying handling, maintenance, and storage.

C. Tolerances on the sealing surfaces can be relaxed. The segmented seal and the softer, thicker gasket material it uses will absorb larger amounts of out-of-tolerance while still obtaining a satisfactory seal.

D. No circumferential bolting is required thus reducing installation time.

E. The reactor flange and sealing surface at the shield wall do not need to be drilled.

F. All seal material is affixed to the seal plates allowing servicing of the gaskets outside the reactor cavity.

G. With minor modification, the seal ring is interchangeable with Unit 2 for use in an emergency.

3.2.2 Performance Characteristics

Not applicable

3.2.3 Arrangement

The segmented reactor cavity water seal is arranged in a circle around the reactor vessel. The inside diameter of the ring rests on top of the reactor vessel flange and the outside diameter of the ring rests on an embedded ring at the top of the shield wall.

3.2.4 Component Design

1. The seal ring is constructed of 1 in thick ASTM A240 Type 304 steel and is approximately 26 ft in diameter. Refer to Ref. 3 for details.

2. Fasteners are constructed of 400 series stainless steel to minimize galling of threads.

3.2.5 Electrical Power Systems

Not applicable

3.2.6 Construction Notes

1. The following shall not contribute lead, mercury, sulfur, arsenic, or other low melting point elements or their compounds in other than trace amounts to the working fluid:

   a. Tools used during construction and erection.

   b. Lubricants, fluids used for cleaning, and painted surfaces in contact with the working fluid.

   c. Corrosion preventatives, marking fluids, packing materials, and materials used in handling the system components.

3.2.7 System Reliability

Not applicable

REPORT ON

PROOF TESTING REACTOR CAVITY

WATER SEAL LAMINATED GASKETS

Prepared [signature] Date 3/7/80
Reviewed [signature] Date 5-13-80
Approved [signature] Date 5-17-80

TABLE OF CONTENTS

APPENDICES

REFERENCES

1. Incident Report IRI 76-9 (LER 76-6)

2. DLS-14017 dated July 19, 1978

3. Stone & Webster drawing 11700-RV-38A-9

4. Stone & Webster drawing 11700-RV-38B-4

5. Stone & Webster sketch 12690.51-SK-N-75, Rev. 2

6. Stone & Webster sketch 12690.51-SK-N-75, Rev. 5

7. Stone & Webster sketch 12690.51-SK-N-83, Rev. 3

8. Stone & Webster sketch 12690.51-SK-N-79, Rev. 2

INTRODUCTION

The segmented reactor cavity water seal ring which has been provided for Beaver Valley Power Station, Unit No. 1 under task 12690.51 is a new design. It utilizes gaskets of laminated construction consisting of a relatively soft (medium density, closed cell neoprene foam) material bonded to a relatively hard (40 durometer neoprene rubber) material in an effort to provide a leaktight seal under the full range of water level in the refueling cavity. This is accomplished without the use of any hold-down devices such as bolts to precompress the gaskets.

There had been no prior experience with backfitting a reactor cavity water seal on an operating plant. This results in the unique concepts of a segmented seal and laminated gaskets. For the purposes of ensuring a good gasket seal, arriving at a suitable configuration for sealing the ends of the gaskets where the segments join together, selecting workable adhesives and caulks, and obtaining a working experience with the physical properties of the laminated gaskets, a testing program for the laminated gaskets was devised.

The testing program consisted of leak and compression testing of the laminated gasket. A testing ring was designed that could be pressurized to simulate the water pressure of the standing head of water in the refueling cavity from the beginning of fill to full. Weights could also be added to simulate gasket loading from the weight of the reactor cavity water seal. This rig was used to leak test the gaskets and adhesives and arrive at the configuration used to seal the splices in the gaskets between the segments. A soils compression testing machine was used to test the load/ compression characteristics of the gasket and was used to refine the gasket design. Flammability was also informally compared with paper.

BACKGROUND

Task No. 12690.51 was initiated to repair or replace the BVPS Unit No. 1 reactor cavity water seal ring which was dropped inside the containment from a height greater than 25 feet (Reference 1). The damage to the ring was investigated, and it was determined that it could not be straightened with a very high level of confidence in its sealing capability. At this point, the option of repairing the damaged ring was weighed against the option of procuring a replacement ring.

At the beginning of the investigation of the feasibility of the new ring, several design criteria were set forth (Reference 2). Among these was the desirability of the ring being boltless and sealing under its own weight. This was based on the inability to accurately determine the location of the existing bolt-holes in the embedded ring which constitutes the outside diameter sealing surface (References 3 and 4). This meant that a soft gasket would be necessary to provide a leaktight seal during the initial stages of reactor cavity fill. It was also believed a soft gasket would be excessively compressed under full load and that a harder gasket laminated to the soft gasket would help absorb higher loads. The design which was selected for testing was a 5/8 in x 4 in cross section of medium density, closed cell neoprene foam laminated to a 3/8 in x 4 in cross section of 40 durometer neoprene rubber (Reference 5, page 5 of 5).

LEAK TEST SUMMARY

The initial intent of the gasket tests was to test gasket materials prior to finalizing the gasket design. However, the combined lead times for procuring materials for and building the leak test rig, testing of the gaskets, and procuring the actual gaskets exceeded the time remaining until the scheduled refueling commencement date. This resulted in the selection of a gasket design and purchase of the gaskets to be a parallel effort to testing. The testing was therefore a proof test of the basic gasket design.

There was a total of six leak tests run using various splice arrangements, adhesives, and an actual production run of gaskets. At no time did there appear to be any leakage by the gaskets themselves. This was verified by testing a specimen which was free of splices that utilized no downward preloading. The test conditions included rapid, slow, and repeated pressurization/depressurization cycles, submergence for up to 30 days, pressurization for up to 4 hours, and varying preloads with suspended weights. The final configuration of 5/8 in x 1 1/2 in cross section foam with 3/8 in x 4 in cross section neoprene rubber was also satisfactorily tested (Reference 6, page 5 of 5).

Only two types of adhesives, Dow Corning Silastic 731 RTV Silicone Rubber Adhesive and Sealant and 3M Company Scotch-Grip No. 1711 Rubber Adhesive, were tested. The 3M Company Scotch-Grip No. 1711 Rubber Adhesive was selected as the adhesive for attaching the gaskets to the ring. It maintained a better bond during compression/decompression cycles on the gasket, was much easier to remove, cheaper, and faster drying.

The Silastic 731 RTV is an air and humidity cure RTV rubber and as an adhesive it has very little exposure to air. Therefore, it never fully cures when used between the gasket and the plate or as an adhesive for the wedges used in the splices. Flooding the cavity less than 24 hours after application would result in the RTV being forced through the space it occupies followed by leakage. The Scotch-Grip Rubber Adhesive could be pressurized within three hours of application.

Several arrangements for sealing the splices in the gaskets where the segments come together were tried (Reference 7, pages 1 and 2 of 3). The initial arrangement was to fill a small gap (3/4 in to 1 in wide) with some type of elastic caulking agent. Three caulking arrangements were originally tried involving three types of RTV rubber. One gap was filled with General Electric RTV-662 Silicone Liquid Rubber. This is a two-part, catalyst cure compound which cures to a hardness of about 60 durometer. One gap was filled with Dow Corning 3-6548 Silicone RTV Foam. This is a two-part, catalyst cure compound which cures to a soft foam. The third arrangement utilized a 1/4 in layer of Silastic 731 RTV and the remainder filled in with the 3-6548 RTV foam. This was an attempt to use a caulking arrangement which would simulate the laminated gasket.

None of the caulking arrangements worked satisfactorily. The curing process of both two-part RTV compounds was inhibited by the release agent used in the 40 durometer neoprene. The release agent is added to extruded rubber to prevent sticking to the extrusion die. The RTV foam also exhibited insufficient strength when the test rig was pressurized. The one-part

RTV 731 cure time increases rapidly with thickness (i.e. 24 hours for 1/8 in thickness, 72 hours for 1/2 in thickness). When the two-part foam was laminated to the one-part RTV-731, the RTV-731 inhibited the cure of the foam.

A fourth method of sealing the gasket splices was used on the first test. A wedge-shaped splice was made in the gasket and was filled with a similarly shaped piece of the laminated gasket. The sides and mating surface with the gasket plate were coated with the one-part Silastic RTV-731. Although this splice also leaked the basic configuration seemed to offer the best solution to sealing the gasket splices. The cause of the leakage was poor cure of the RTV-731 due to a very small area exposed to atmosphere. When the test rig was pressurized, the RTV was forced through the cracks between the wedge and gasket until a leak path was established. It was believed that a suitable adhesive would facilitate a leaktight splice using this method.

The primary purpose of the second test was to pursue the concept of using a wedge in the splices and finding a better adhesive. Two types of adhesive were recommended by the 3-M Company for this type of application, Scotch-Weld Cyanoacrylate Adhesive CA-4 and Scotch-Grip Adhesive No. 1711. The Scotch-Weld CA-4 was not considered suitable due to its extremely low viscosity and rapid cure time. A high viscosity adhesive is desirable for allowing some latitude on the fit-up of the gasket splices, and a cure time of 5 to 120 seconds is too fast for applying the 18.5 ft and 13 ft lengths of gasket on the OD and the ID ring segments. The Scotch-Grip Adhesive No. 1711 was used to attach the gaskets to the test plate and used to seal wedges into wedge-shaped splices. This adhesive, the wedge arrangement, and the gaskets performed satisfactorily in all respects. There were many pressurization/depressurization cycles performed at various rates during the week. The preload was also varied from zero to an amount simulating the gasket load equivalent to about 125 percent of the weight of the reactor cavity water seal. The assembly remained submerged for eight days and was again subjected to several pressurization/depressurization cycles. At no time was there more than a slight weepage. When the gaskets were removed from the test plate, approximately 90 percent of the adhesive remained on the gasket and the residual adhesive on the stainless steel plate lifted off with relative ease. The basic layout of medium density neoprene foam laminated to 40 durometer neoprene, wedges at the gasket splices, and 3-M Company Scotch-Grip Adhesive No. 1711 was believed to be acceptable based on the test results. The final wedge arrangement is shown in Ref. 7 (Appendix D).

The remainder of the leak testing was performed for the purpose of verifying different aspects of the design and for the discovery of limitations which could affect installation (degree of craftsmanship required, minimum drying time prior to pressurization, etc.).

The third test utilized a gasket with a continuous perimeter (no splices) and no preload. This was, therefore, solely a test of the laminated gasket and Scotch-Grip adhesive under more severe than service conditions. There were no radial cuts or splices so the only leakage possible would isolate the difficulty to the gasket materials and adhesive. At no time was there any leakage during this test which included 12 pressurization/depressurization cycles and lasted for three days.

The fourth and fifth tests were performed on gaskets taken from the actual production run which was delivered to the site. The fourth test was simply a verification of previous test results using the same configuration, including the lip seal, as the gaskets used on the reactor cavity water seal. Wedges were used in the fourth test, and the test lasted for 30 days. Pressurization/depressurization cycles were satisfactorily run at the end of 30 days. The fifth test was to determine the degree of workmanship necessary in forming the wedges. Gaps between pieces of gasket were deliberately left and caulked with the Scotch-Grip adhesive. The gaps varied from about 1/32 in wide to about 1/2 in wide, and their depth was equal to the 1 in thickness of the laminated gasket. Gaps up to a width of 1/8 in could be sealed by a single application of adhesive. Gaps of up to 3/8 in wide could be sealed by from 2 to 4 applications of adhesive depending on width. For gaps larger than 3/8 in, repeated applications of adhesive would only build up to a point. After that point, the adhesive would dissolve the previous application and flow out of the crack. When the adhesive would dry it would be about the same height as the previous application. The cracks which were wider than 3/8 in were closed up to 1/8 in or less and caulked with adhesive for the fifth leak test.

There was leakage of about one drop every 5 minutes with no pressure during the fourth test. This reduced to no observed leakage in 30 minutes at 13 psig. During the fifth test, there was a stream of about 1/16 in leaking at the 3/8 in gap during initial fill. This reduced to 90 to 120 drops per minute with the test rig full and 0 psig. The leakage reduced to 0 at 6 psig, and there was no observed leakage for 30 minutes at 13 psig.

The sixth and final test was performed after the compression testing indicated that there would be insufficient gasket compression during the initial stage of fill of the refueling cavity to assure no leakage. Further compression indicated that the foam gasket had to be cut back to 1 1/2 in wide to give reasonable assurance of a good seal under the weight of just the reactor cavity seal ring. The gasket configuration for this test was as follows:

> 4 in x 3/8 in cross section, 40 durometer neoprene laminated to 1 1/2 in x 5/8 in cross section, medium density closed cell neoprene foam.

This configuration was tested through several pressurization/depressurization cycles with the preload varying between about 75 percent to 125 percent of the gasket load equivalent to the weight of the reactor cavity water seal. No leakage was expected and there was not any. The primary purpose of the test was to assure that the narrower foam gasket section would not blow out under pressure. This configuration performed satisfactorily in this regard.

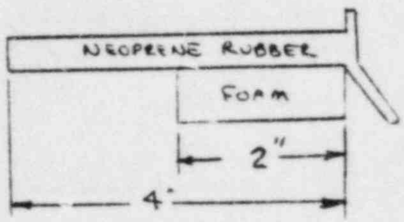
COMPRESSION TEST SUMMARY

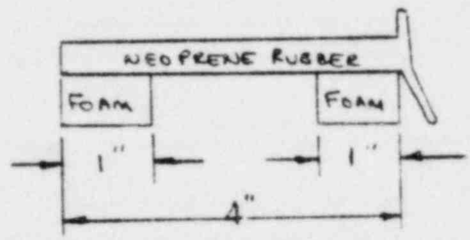
The same time problems which caused the leak test to be a proof test also meant that the compression test would be a proof test. The reactor cavity water seal had already been ordered with a specified flatness of 1/8 in/ft and 3/8 in overall. The gaskets were 4 in wide sections of 3/8 in thick, 40 durometer neoprene laminated to 5/8 in thick, medium density neoprene foam. The test piece was taken from a production run which was delivered to the jobsite. It was 12 in long and included the redundant lip seal.

The compression force was varied from zero to the equivalent gasket load of 200 percent of the maximum refueling cavity water level. Data were taken at regular intervals.

The foam gasket was found to be considerably more firm than originally anticipated. At the force equivalent to the weight of the reactor cavity water seal (approximately 97 lb) the gasket deflection was only .040 in. It was felt that a deflection of about .185 in would be necessary to assure that the reactor cavity water seal would not leak during the initial stages of fill.

Further compression tests were run with the foam gasket width reduced to 2 in and with the two 1 in wide sections of foam gasket with a 2 in gap in between. They are illustrated below.





The length of both of these test pieces was 12 in. The piece with the two 1 in foam sections was also used to simulate a 24 in long piece with a 1 in wide foam gasket. This was necessary because a 1 in section would not stay flat in the test rig without the use of a significant downward force.

These tests resulted in a change in the installation procedure for the reactor cavity water seal being changed to cut the foam part of the gaskets back to 1 1/2 in wide. This width assured a seal with less than 4 in of water on the seal and was still wide enough to seal across the existing bolt-holes and O-ring grooves in the embedded ring which is the sealing surface at the outside diameter.

CONCLUSIONS

The testing program verified the workability of the concept of using soft gasket material to seal under the weight of the reactor cavity water seal. This was especially illustrated by the third test in which the gasket had a continuous perimeter, and no preload was used to aid in initial gasket compression. As stated earlier, there was no observed leakage during the three-day duration of this test.

The arrangement for sealing the ends of the gaskets where the ring segments join was designed based on the res [illegible] of the first two tests. The original idea of using a caulking was discarded after the first test. Wedges inserted into wedge-shaped openings and held in place with a rubber adhesive were very effective. At no time was there observed leakage where the rubber adhesive formed a bond. One of the pieces of gasket, which was bonded to the plate with RTV-731, leaked slightly. The tendency of this leakage to vary inversely with respect to pressure verified the belief that the most difficult sealing conditions were during initial fill. This was also reverified during the fifth test.

The adhesive for attaching the gaskets was also specified based on test results. The RTV-731 Silastic was found to take too long to cure, be difficult to apply and remove, and leak slightly where it interfaced with neoprene. The Scotch-Grip No. 1711 adhesive performed superbly in the remaining tests and was specified for the reactor cavity water seal and for the above-mentioned wedges.

The compression testing showed that the foam section of the gasket material was considerably more rigid than originally anticipated. The final arrangement with the 1 1/2 in wide foam gasket was based on the compression test results, the flatness specification of the reactor cavity water seal plates, and the actual measured flatness of the reactor cavity water seal plates as measured in the vendor's shop. This final configuration was satisfactorily leak tested during the final test.

The design was finalized during the testing program. Problems such as configurations of the gaskets and wedges, material compatability, and material suitability were worked out in advance of reactor cavity water seal installation. The engineers who would serve in an advisory capacity gained valuable experience in handling and cutting the gaskets, adhesive application and limits, required levels of craftsmanship, and potential problem areas.

Tabulated results of the testing may be read in Appendix F of this report.

The results of the informal flammability and adhesive removal tests are also contained in Appendix F.

APPENDIX F

Initial Gasket Test of November 21, 1978

I. Purpose

A. To provide an initial "shakedown" test of the gasket test rig.

B. To provide an operational test for the "Guideline for Proof Test of Reactor Cavity Water Seal Gaskets."

C. To provide initial data for four different caulking arrangements and four different caulking agents for use in the splices in the gaskets between the segments of the reactor cavity water seal (Ref. 2.1) and to provide a check on the laminated gasket layout.

II. Equipment

Test rig in accordance with Ref 2.2

III. Caulking Arrangements

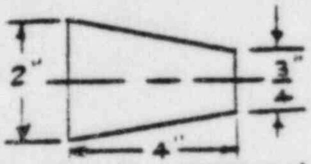
Four arrangements as follows:

1. A 3/4 in x 3/4 in x 4 in gap caulked with a 1/4 in thick layer of RTV-731 silastic rubber (one-part) followed by a 1/2 in thick layer of RTV-3-6548 RTV foam (two-part). The foam was applied after the RTV-731 silastic rubber was cured for 24 hours.

2. A 3/4 in x 3/4 in x 4 in gap caulked with a 3/4 in thick layer of RTV-3-6548 RTV foam (two-part).

3. A 3/4 in x 3/4 in x 4 in gap caulked with a 3/4 in thick layer of RTV-662 silastic rubber (two-part).

4. A wedge shaped piece 3/4 in thick of the following shape inserted into a similarly shaped opening.



The wedge is constructed of the same laminated gasket as described in Part IV. The wedge was fastened to the stainless steel gasket test plate using RTV-731 Silastic rubber (one-part). The gaps between the main gasket and the wedge shaped gasket were also caulked with RTV-731 Silastic rubber (one-part).

IV. Gasket Arrangement

A. 4 in wide x 3/8 in thick strips of 40 durometer neoprene rubber fastened to the stainless steel gasket test plate using RTV-731 silastic rubber.

B. 4 in wide x 3/8 in thick strips of medium density closed cell neoprene foam were attached to the 40 durometer neoprene rubber using RTV-731 silastic rubber.

C. Gaps were left between the strips on each side to allow for the various caulking arrangements.

D. The RTV-731 silastic rubber attaching the gaskets was allowed to cure for 60 hours before any caulking was attempted.

V. Test Results

A. Gasket Test Rig

1. The gasket test rig had one small leak in a lower corner. It was not of sufficient magnitude to stop the test. To correct this problem, that corner of the interior was recaulked.

2. There was a problem in determining exactly where the leakage in the gasket and caulking arrangement was coming from. To solve this problem, troughs were ground out at each of the caulked splices to provide a drainage path for leakage.

B. "Guideline for Proof Test of Reactor Cavity Water Seal Gaskets."

1. The test rig was pressurized by filling the test rig with water, sealing the unit, and using water pressure to pressurize the test rig. This is as opposed to using air to pressurize the test rig.

2. The weights were not varied from the minimum (224 lb) nor was the resiliency test performed, since this test was preliminary in nature to test the rig, the guideline and the basic concept being used in the reactor cavity water seal gasket arrangement.

C. Laminated Gasket Layout

The laminated gasket concept seemed to work out well. Prior to the initial leakage from one of the caulked splices, there was no gasket leakage and there seemed to be none up until there was too much leakage at the various joints to accurately evaluate where the water was coming from. Further evaluation is necessary.

D. Caulked Splices

1. 1/4 in layer of RTV-731 followed by an additional 1/2 in layer of RTV-3-6548.

   a. RTV-731 cure time was somewhat greater than 24 hours for complete cure. In 24 hours more than half of the RTV-731 was cured and RTV-3-6548 could be applied.

   b. RTV-3-6548 cure time was about 3 minutes. The material had undergone essentially all expansion and was tack free in about 2 1/2 minutes. It must be poured within about 1 1/2 minutes of mixing. While in a liquid state, retaining dams were necessary to prevent excessive spreading. The RVT-3-6548 did not completaly cure next to the RTV-731 nor did it completaly cure next to the 40 durometer neoprene.

   c. This caulked splice was the first path of leakage. This leakage occurred with about 2 in of water on the seal. This caulked splice was the only one to spray water at 12 psig in the test rig.

   d. When the splice was disassembled water could be wrung from the RTV-3-6548 foam indicating rupture in the closed cell structure.

2. 3/4 in thick layer of RTV-3-6548

   a. RTV-3-6548 cure time and application was as listed above. It did not completely cure next to the 40 durometer neoprene, but it did adhere satisfactorily to the stainless steel and the neoprene foam.

   b. This caulked splice was the second to leak. The test rig was pressurized to about 2 1/2 psig when the leakage was noticed.

   c. When the splice was disassembled, water could be wrung from the RTV-3-6548 foam as in the above configuration.

3. 3/4 in thick layer of RTV-662

   a. Cure time was approximately 24 hours. Dams were required prior to curing to prevent the RTV-662 from flowing out of the splice. The RTV-662 adhered very well to the stainless steel and neoprene foam but did not cure at all next to the 40 durometer neoprene.

   b. This caulked splice was the third to leak. Leakage occurred at about 10 psig and was very slow. Leakage did not increase appreciably at 12 psig.

4. Wedge of laminated gasket material adhered with RTV-731 and gaps between the wedge and gasket caulked with RTV-731.

   a. This arrangement was allowed to cure for about 6 hours. This allowed the outer surfaces only to cure to a depth of about 1/16 in. This was to check to see whether this amount of care coupled with the viscosity of the RTV could form a pressure boundary in a small gap.

   b. This caulked splice was the last to leak. After about 15 minutes at 12 psig sufficient RTV had been pushed out of the gaps between the wedge and gasket to allow leakage. The RTV was observed slowly squeezing out of the splice. This problem could probably be corrected by a longer cure time,but one of the objects of the test is to find a way of reducing all aspects of installation to limit the impact of the reactor cavity water seal on the critical path for refueling.

5. The following chart summarizes the results:

Caulking Agent/Type	No. of Parts	Type Cure	Cure Time	Remarks
RTV-731 Silastic Rubber	1	Air and Humidity	24 hr for 1/8 Thickness	Too long of a cure time for caulking. Acceptable for bonding gaskets to the ring.
RTV-3-6548 Closed Cell Foam	2	Catalyst	2-3 minutes	Did not cure next to neoprene. Cells ruptured under pressure.
RTV-622 Silastic Rubber	2	Catalyst	24 hours	Did not cure next to neoprene.

VI. Conclusions

A. The gasket test rig and "Guideline for Proof Test of Reactor Cavity Water Seal Gaskets" are workable concepts. Changes mentioned in paragraphs V.A. and V.B. will be incorporated for the next test.

B. The RTV-731 Silastic Rubber is acceptable as a bonding agent for the gaskets, but cure time and a 3/8 in maximum thickness limitation make it an undesirable caulking agent.

C. The RTV-3-6548 does not possess sufficient strength in the cells to withstand the required pressure. The difficulty in curing the foam next to the neoprene could be due to the release agent in the rubber or the presence of some sulfur additive, organo-metallic additive, or unsaturated hydrocarbon plasticizers in the rubber.

D. The layered application of 1/4 in of RTV-731 followed by 1/2 in of RTV-3-6548 foam was totally unacceptable.

E. The RTV-662 silastic rubber had difficulty curing next to the neoprene. This is probably due to a release agent in the rubber.

F. The wedge arrangement showed the most promise from both the installation and sealing effectiveness points of view. A caulking agent with a faster cure time and/or higher viscosity would be beneficial.

G. Whichever caulking arrangement is utilized, the caulking agent must be able to cure next to the neoprene rubber with virtually any release agent. This should be a better solution to the problem than specifying release agent in the rubber because release agents are seldom specified and this could increase the chance of an error. S&W Materials Department is investigating alternative caulking agents (i.e., natural rubber type) with a suitable curing time.

Gasket Test of December 27, 1978 through January 3, 1978

I. Purpose

A. To test two different adhesives for fastening gaskets to the plate.

B. To test the wedge arrangement similar to that illustrated in part III.A.4. of the November 21, 1978, test utilizing the above adhesives. This arrangement snowed the most promising results in initial testing.

C. To find a convenient method of field fabricating the above-mentioned wedges.

II. Equipment

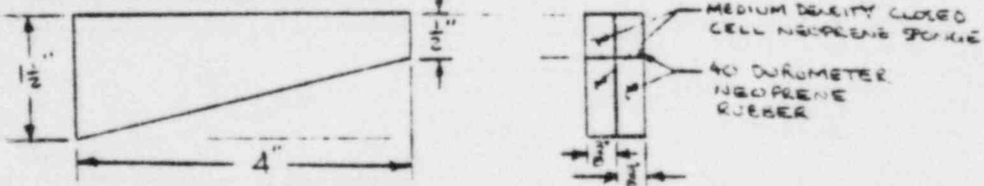
A. Test rig in accordance with Ref 2.2.

III. Gasket and splice arrangements

A. Gaskets consist of a two-layer laminated construction. The layers are made of 3/8 in x 4 in cross section of 40 durometer neoprene and 3/8 in x 4 in cross section of medium density closed cell neoprene foam. The layers are cemented together using 3M Company Scotch-Grip Rubber Adhesive No. 1711.

B. Two adhesives were tested for attaching the gaskets to the plate and for holding the wedges in place. They are 3M Company Scotch-Grip Rubber Adhesive No. 1711 and 3M Company Scotch-Weld Cyanoacrylate Adhesive No. CA-4. The adhesives were used in accordance with manufacturer's instructions.

C. Wedges constructed of the laminated gasket described above in paragraph III.A were constructed using several methods of cutting. They had the following shape and



were inserted in similarly shaped openings. They were fastened to the stainless steel plate and the gaps between the wedges and main gasket were caulked with the adhesives dercribed in paragraph III.B, above.

IV. Test Results

A. Adhesives

1. The 3M Company Scotch-Weld Cyanoacrylate Adhesive No. CA-4 was

found to be unsatisfactory for attaching the gaskets to the plate because it sets in less than 10 seconds. While this was manageable on the 14 in x 14 in test plate, this would be difficult to work with on the up to 18-ft lengths required on the reactor cavity water seal. It was unsatisfactory for the wedges because its low viscosity would not allow it to properly fill the gaps between the wedge and main gasket. This would require unreasonably close tolerances in the fabrication of the wedges and the gap into which they will be inserted. For these reasons, this adhesive was not leak tested.

2. The 3M Company Scotch-Grip Rubber Adhesive No. 1711 was found to be satisfactory. None of the connections bonded with this adhesive leaked during the entire test. The adhesive was easily applied by using either a brush or a trowel. Setup time was long enough to allow handling for large pieces and short enough to allow flooding and pressurization 3 hours after installing the wedges.

3. One of the four gasket strips was left intact from the November 21, 1978, test. The laminated layers and the gasket to plate bonds were with RTV-731 Silastic rubber. This was done to test the ability of this bonding agent to withstand handling and several cycles of pressure transients. The only leakage observed during the test was up to a maximum of 4 cc/min through this gasket to plate bond.

B. Wedges

1. Both wedge connections were made using the 3M Company Scotch-Grip Rubber Adhesive No 1711 to bond the wedge to the plate and to bond the wedge to the main gasket. Neither wedge connection leaked at any time during the test.

C. Gaskets

1. As in the November 21, 1978, test, the gaskets themselves did not leak at any time during the test. This includes the seal between the neoprene foam and the bottom of the test rig which seals without the aid of an adhesive, caulking agent, or sealant. The only sealing aid in this interface is the weight of the plate and preload weights and the water pressure in the test rig.

D. The changes to the "Guideline for Proof Test of Reactor Cavity Water Seal Gaskets" and the repair of the test rig resulting from the initial test proved to be satisfactory.

E. A complete test was run in accordance with Section 5.0 of the test guideline. Subsequent tests were run by varying pressures at several preloads. Several rapid pressurizations to maximum test pressure and back to atmospheric pressure were tried with several different preloads. This was done to test the effect of many combinations of axial vs radial loads on the gaskets, test the effect of several load cycles on the gaskets, and to test the ability of the gaskets to respond to rapidly changing conditions. The unit was left flooded for the entire 7-day duration of the test. The following charts summarize the test results:

Test No. 1 - in accordance with Section 5.0, 12-27-78

Amount of Preload (lb)	Test Rig Pressure (psi)	Gasket* Load (lb/in)	Leak Rate (cc/min)	Duration of Test Condition (min)	Remarks
160	0	5.6	∠1	15	Small weep
256	0	8.0	∠1	15	Leak decreased
352	0	10.4	∠1	15	Leak decreased
352	4	30.0	∠1	5 min	One drop
352	6	39.8	0	5 min	
352	8	49.6	0	5 min	
352	10	59.4	0	5 min	
352	13	74.1	0	30 min	
352	0	10.4	0	Overnight	

* Includes 1.6 lb/in for the 7-in column of water and weight of gasket and plate.

Test No. 2 - No preload (No weights) 12-28-78

Test Rig Pressure (psi)	Gasket* Load (lb/in)	Leak Rate (cc/min)	Duration of Test Condition (min)	Remarks
0	1.6	3	15	
13	65.3	∠1	15	
0	1.6	4	15	
4	21.2	3	5	
6	31.0	2.6	5	
8	40.8	1.5	5	
10	50.6	1	5	
13	65.3	∠1	30	

Test No 3 - 160 lb preload (5 weights) 12-28-78

Test Rig Pressure (psi)	Gasket* Load (lb/in)	Leak Rate (cc/min)	Duration of Test Condition (min)	Remarks
0	5.6	<1	15	
4	25.2	<1	5	
6	35.0	<1	5	Leak decreased
8	44.8	<1	5	One drop
10	54.6	0	5	
13	69.3	0	30	

Test No 4 - 256 lb preload (8 weights) 12-28-78 and 12-29-78

Test Rig Pressure (psi)	Gasket* Load (lb/in)	Leak Rate (cc/min)	Duration of Test Conditions (min)	Remarks
0	8.0	0	15	
13	71.7	0	15	
0	8.0	<1	5	
4	27.6	<1	5	Leak decreased
6	37.4	<1	5	
8	47.2	<1	5	
10	57.0	<1	5	
13	71.7	<1	30	Leak decreased
0	8.0	0	Overnight	
13	71.7	0	15	
0	8.0	<1	15	
4	27.6	<1	5	
6	37.4	<1	5	One drop
8	47.2	0	5	
10	57.0	0	5	
13	71.7	0	30	

Test No 5 - 352 lb preload (11 weights) 12-29-78

Test Rig Pressure (psi)	Gasket* Load (lb/in)	Leak Rate (cc/min)	Duration of Test Conditions (min)	Remarks
0	10.4	0	15	
4	30.0	<1	5	
6	39.8	<1	5	Two drops
8	49.6	0	5	
10	59.4	0	5	
13	74.1	0	30	

12-29-78 and
1-2-79

Test No. 6 - 320 lb preload (10 weights)

Test Rig Pressure (psi)	Gasket* Load (lb/in)	Leak Rate (cc/min)	Duration of Test Conditions (min)	Remarks
0	9.6	0	3-day weekend	Approximately equivalent to 2 in of water on actual seal ring
13	73.3	<1	15	
0	9.6	<1	15	Slight increase
4	29.2	<1	5	Slight increase
6	39.0	<1	5	Leak decreased
8	48.8	0	5	
10	58.6	0	5	
13	73.3	0	30	

Test No. 7 - 416 lb preload (13 weights) 1-2-79

Test Rig Pressure (psi)	Gasket* Load (lb/in)	Leak Rate (cc/min)	Duration of Test Conditions (min)	Remarks
0	12.0	<1	15	
4	31.6	0	5	
6	41.4	0	5	
8	51.2	0	5	
10	61.0	0	5	
13	75.7	0	30	
0	12.0	<1	15	
13	75.7	0	15	

Test No. 8 - 224 lb preload (7 weights) 1-2-79

Test Rig Pressure (psi)	Gasket* Load (lb/in)	Leak Rate (cc/min)	Duration of Test Conditions (min)	Remarks
0	7.2	1	15	
4	26.8	<1	5	
6	36.6	<1	5	Slight decrease
8	46.4	<1	5	Slight decrease
10	56.2	<1	5	Slight decrease
13	70.9	<1	30	No leakage after first 10 minutes

Note: Tests 7 and 8 are based on a greater than ± 2 lb/in initial gasket load from test No. 6.

Test No. 9 - 160 lb preload (5 weights) 1-3-79

Test Rig Pressure (psi)	Gasket* Load (lb/in)	Leak Rate (cc/min)	Duration of Test Conditions (min)	Remarks
0	5.6	1	15	
0	5.6	0	Overnight	
13	69.3	<1	15	
0	5.6	1.6	15	
13	69.3	<1	15	
0	5.6	1.2	15	
4	25.2	<1	5	
6	35.0	<1	5	Slight decrease
8	44.8	<1	5	Slight decrease
10	54.6	<1	5	Slight decrease
13	69.3	0	30	
0	5.6	<1	30	(No leakage after (first 20 minutes

V. Conclusions

A. The test lasted for one week during which time the test rig was constantly flooded. There were a total of 17 pressurization - depressurization cycles using seven different preloads. Seven of the pressurization transients and all of the depressurization transients covered the range between atmospheric pressure and maximum pressure (13.0 psig) in less than 3 seconds. The remaining pressurization transients were at the increments and durations indicated in the tabulated results. The preloads varied from 1.6 lb per linear inch of gasket to 12.0 lb per linear inch of gasket. This pattern of testing resulted in conditions which are more varied and more severe than the reactor cavity water seal gaskets will sustain.

B. The 3M Company Scotch-Grip Rubber Adhesive No. 1711 is thus far the most suitable adhesive tested. It is the most easily handled, inexpensive, and can also be used on the wedges with a 3 hour setup time. At no time during the the test did a joint which was formed with this adhesive leak. This adhesive also appears to be easier to remove from stainless steel than the RTV-731 Silastic rubber. It tended to stick to the neoprene upon removal of the gasket and what remained on the metal pulled up in a thin sheet without the aid of a solvent. In contrast, the RTV-731 required considerable scraping to remove which would be time consuming on the reactor cavity water seal and could compromise the gasket surface. The ease of removal of the Scotch-Grip Adhesive may have been enhanced by the fact that the gaskets were previously mounted on that surface using the RTV-731 for the

November 21, 1978, test. There is currently a slippery feeling residue on the plate from the RTV-731. A test should therefore be run by fastening neoprene to clean stainless steel and checking ease of removal.

C. The concept of the reactor cavity water seal gasket sealing under the weight of the seal ring is considered to be a valid concept. This is because the interface between the foam seal and the bottom of the test rig never leaked. The initial gasket loading was varied from 19.5 to 146 percent of the actual initial load the gasket will carry in service. This interface corresponds to the foam seal to reactor flange interface on the id and the foam seal to embedded ring interface on the od (ref 2.1).

D. The wedges were easily fabricated using a home-made cutting edge from an old power hack saw blade. The edge was made by hand grinding the back of the blade on a bench grinder for a 6-inch length. The opposite end of the blade was wrapped in masking tape for a handle. The gasket was placed on a piece of plywood and the blade was driven from the foam side with a 2-lb hammer. The space for the wedge was fabricated in the same manner. At no time did a wedge leak.

E. The leakage through the RTV-731 generally decreased as the downward loading on the gasket increased. There were a couple of exceptions during initial pressurization of the test rig (0 to 4 psi in test Nos. 5 and 6). During overnight periods, lunch breaks, and 30-minute periods at maximum pressure, there was an observed tendency of the leakage to decrease to zero with time while the test conditions remained constant. The tendency to leak seemed to increase very slowly as the number of pressure transients performed increased. Since the test transients were of greater number and were performed much more quickly than the actual gasket service conditions, the amounts of leakage were so minute that this is not considered to be a problem. The tendency of leakage to decrease with time at constant conditions supports this belief.

Gasket Test of March 5, 1979

I. Purpose

A. To test the laminated gasket only by minimizing the number of leak paths to gasket mating surfaces or the gasket itself.

II. Equipment

A. Test rig in accordance with Ref. 8.

III. Gasket Arrangement

A. The gasket was used as delivered from Presray. It consisted of a 14 in x 14 in piece of 5/8 in thick medium density closed cell neoprene foam laminated to a 14 in x 14 in piece of 3/8 in thick 40 durometer neoprene. A 6 in x 6 in hole was then cut out of the middle with the 6 in sides parallel to the 14 in sides. This resulted in a gasket with a continuous perimeter such that the only leak paths were between the layers of the laminated gasket, the gasket-to-metal interface under the foam, the adhesive attaching the gasket to the test plate, and any possible porosity in the gaskets themselves.

IV. Test Results

A. The entire test was run with no preload to assist in gasket compression. There was an initial leak rate with no pressure of 5 drops per minute which reduced to 3 drops per minute after 15 minutes. There was no leakage after the test rig was pressurized. The following summarizes the results:

Amount of Preload (lb)	Test Rig Pressure (psi)	Gasket Load (lb/in)	Leak Rate (cc/min)	Duration of Test Condition (min)
0	0	1.6	3-5 drops/min	15
0	4	21.2	0	5
0	6	31.0	0	5
0	8	40.8	0	5
0	10	50.6	0	5
0	13	65.3	0	60

V. Conclusions

A. This test confirms the feasibility of the laminated gasket concept. The initial leakage was quite small and under conditions yielding considerably less initial gasket compression than what will be seen by the gaskets in actual service. This degree of sealing was also obtained using plate with as-rolled flatness and finish, whereas the reactor cavity water seal will mate to a 125 rms surface. The laminated gasket concept is believed to be valid as a result of this test and may require only minor modifications.

Gasket Test of March 7, 1979 through April 6, 1979

I. Purpose

A. To provide a long-term test of the adhesive, gasket materials, and wedge configuration.

II. Equipment

A. Test rig in accordance with Reference 8.

III. Gasket Arrangement and Adhesives

A. A production run of gaskets extruded from the same lot as those delivered to the jobsite were used. The configuration is in accordance with Reference 5, page 5 of 5, including the redundant lip. Two wedge seals were inserted in accordance with the December 27, 1978 through January 3, 1978 test.

B. 3-M Company Scotch-Grip Adhesive No. 1711 was used to attach the gaskets to the test plate. It was also used to hold and seal the wedges.

IV. Test Results

A. A 256 lb preload was initially utilized for this test to most accurately simulate the initial fill conditions. During the first day, tests were also run using 160 and 352 lb preloads which simulate a range of greater than ± 25 percent of the initial fill conditions of the reactor cavity water seal. All remaining tests were performed with the 256 lb preload.

B. Pressurization/depressurization cycles were run at least once daily for the first week and at least twice weekly after that. The test gaskets were submerged for 30 days, and at no time did they leak.

V. Conclusions

A. The gaskets and Scotch-Grip Adhesive will withstand being submerged for the duration of a refueling with no sign of porosity or leakage. This includes the wedge arrangement which will be used to seal the ends of the id and od gaskets where the ring segments join.

Gasket Test of April 24, 1979

I. Purpose

A. To test the ability of the 3-M Company Scotch-Grip No. 1711 Adhesive to caulk gaps of various sizes. The main purpose of this is to determine the degree of craftsmanship required to fabricate the wedges and the openings into which they must fit.

II. Equipment

A. Test rig in accordance with Reference 8.

III. Gasket and Splice Arrangements

A. The gaskets are from the same production run as those used in the March 7 through April 6 test. The pieces used on each side join at the corners of the 14 in x 14 in test plate with a mitre joint.

B. Splice Arrangements

1. All of the gaps in the gasket splices were 1 in deep corresponding to the gasket thickness.

2. The mitre joints between each of the sides and three other splices were used. The width of the gaps in the splices varied between 1/32 in and 1/2 in. Some of the splices had jagged cuts which left rough edges and slightly torn foam.

IV. Test Results

A. Gaps up to about 1/8 in wide could be caulked with a single application of Scotch-Grip Adhesive.

B. Gaps up to about 3/8 in wide could be caulked with two or more applications of Scotch-Grip Adhesive. The number of applications was dependent upon the width of the gap.

C. Gaps over 3/8 in wide could not be caulked. Once the gaps were filled to a certain depth, subsequent applications of the adhesive dissolved the previous applications. Most of the new layer would then run out of the gap, and it would dry at about the same depth as the previous applicaton. The gaps which were greater than 3/8 in were filled with a narrow piece of gasket and the gap on each side caulked with adhesive.

D. Since the gasket plate was upside down when installing gaskets and caulking gaps, the top of the gaskets during this phase is the underside during the testing. This surface is the one that mates with the floor of the test rig. Since there is no adhesive used between the gaskets and the floor of the test rig, the smoothness of the caulking in the gaps will impact the ability to seal. If it is necessary to caulk the gap between wedges and gaskets in the field, the reactor cavity water seal segments and wedges will already be installed. Therefore, the top of the gap will not be a sealing surface and smoothness is unimportant. When the test rig was filled and pressurized, the smoothness of the caulked gaps showed some leakage. This leakage started as a 1/16 in stream through the bottom of the 3/8 in wide gap during the initial stages of fill. This reduced to 5.7 cc/min with the test rig full and zero leakage at 6 psi. The following summarizes the results:

Amount of Preload (lb)	Water Level (in)	Test Rig Pressure (psi)	Gasket Load (16/in)	Leak Rate (cc/min)	Duration of Test Condition (min)	Remarks
160	0	0	4	~1000	2	
160	3.5	0	4.8	12	2	
160	7	0	5.6	5.7	2	
256	7	0	8.0	1.5	2	
352	7	0	10.4	<1	15	1.5 drops/min
352	7	4	30.0	<1	5	Slight weep
352	7	6	39.8	0	5	
352	7	8	49.6	0	5	
352	7	10	59.4	0	5	
352	7	13	74.1	0	30	
352	7	0	10.4	<1	30	Slight weep

V. Conclusions

A. Gaps of up to 3/8 in in any portion of the pressure boundary can be sealed with the 3-M Company Scotch-Grip Adhesive No. 1711. This should present no wedge fabrication problems. Experience in wedge fabrication in previous tests indicates that there should seldom be a gap larger than 1/16 in and never a gap larger than 1/8 in between the wedges and gaskets.

Gasket Test of May 17, 1979

I. Purpose

A. Verify that the reduction in width from 4 in to 1 1/2 in will have no undesirable consequences under the full range of pressure.

II. Equipment

A. Test rig in accordance with Reference 8.

III. Gasket Arrangement

A. The cross section of the gasket had a 5/8 in x 1 1/2 in section of foam laminated to a 3/8 in x 4 in section of neoprene rubber. The gasket had no lip seal so that the foam could be observed. Two sides were spliced in such a manner as to allow the foam to blow out under pressure if it had a tendency to do so. The splices were cut with a razor blade and uncaulked. No preload was used. The following illustrates the gaskets:

IV. Test Results and Conclusions

A. The narrower section of foam showed no tendency to blow out under pressure. The test rig pressure was held at 4, 6, 8, and 10 psi for 15 minutes each and 13 psi for 60 minutes.

B. There was slight leakage through the razor splices up to 4 psi. From 6 psi to 13 psi there was no observed leakage.

C. The 1 1/2 in wide foam section is believed to be suitable for the service conditions of the reactor cavity water seal.

Adhesive Removal Test of January 11, 1979 through January 19, 1979

I. Background and Purpose

A. After removing the gaskets from the gasket test plate in the December 27 through January 3 test, almost no Scotch-Grip Adhesive remained on the metal, and the little bit that stayed on the metal lifted off very easily. There is, however, a silicone rubber residue left behind from the November 21 test when Silastic RTV-731 silicone rubber was used as a gasket adhesive. This residue is quite slippery to the touch and is believed to contribute to the ease of removal of the adhesive.

B. The purpose of the test is to check the ease of removal of the gaskets and adhesive from clean, bare, as-rolled stainless steel.

II. Equipment

A. Clean piece of as-rolled stainless steel, ASTM A240, Type 304. Minimum dimensions are 6 in x 14 in.

B. 4 in x 12 in long piece of 40 durometer neoprene.

C. 3-M Company Scotch-Grip Adhesive No. 1711.

III. Procedure

A. Glue neoprene to stainless steel plate using the Scotch-Grip Adhesive.

B. Let stand for at least one week.

C. Remove gasket and adhesive.

IV. Test Results and Conclusions

A. Most of the adhesive stayed on the neoprene when the gasket was removed. About one fourth of the adhesive remained on the plate, and most of that lifted off easily. About 10 percent of the adhesive was scraped off with no difficulty.

B. No solvents were tried, but manufacturer's data indicate that aromatic solvents would be effective. There should be little problem removing gaskets and adhesives in the field.

Gasket Compression Tests of May 7, 1979, and May 15, 1979

I. Purpose

A. To derive a load-deflection curve for the laminated gaskets for the purpose of:

1. Ensuring a leaktight seal during initial fill conditions when gasket compression is minimum. This is accomplished by comparing the deflection at the simulated load on the gaskets from only the reactor cavity seal segments and the flatness specification of the reactor cavity water seal.

2. Ensuring stable behavior of the gaskets under conditions simulating greater loading than a full refueling cavity against the reactor cavity water seal.

II. Equipment

A. Leonard Farnell 10-ton, constant strain, soils compression testing machine.

B. Two dial indicators with stands to measure gasket deflection at each end of the gasket.

C. Strain ring with dial indicator to measure compressive force.

III. Procedure

A. The test specimen is placed between steel plates in the compression testing machine.

B. Dial indicators are placed at each end of the gasket centered over the foam.

C. The test rig is brought into contact with the top plate without placing a compressive strain on the gasket.

D. Zero the dial indicators.

E. Turn on the compression testing machine. Monitor the dial indicator on the calibrated strain ring to monitor force. At preselected values, take strain readings from the gaskets.

IV. Test Results

A. The following tables and graphs summarizes the test results:

Test No. 1 - 12 in long 3/8 in x 4 in neoprene and 5/8 in x 4 in neoprene foam.

Ring Strain (X.0001 in.	Force (lbs)	Deflection Front (mm)	Deflection Rear (mm)	Avg. (mm)	Avg (in)	Force Per Unit Length (lb/in)	Equiv. Water Elevation (ft)
0	0	0	0	0	0	0	- 0.90
30	564	5.70	5.22	5.46	0.215	47.0	4.32
60	1140	8.68	8.20	8.44	0.332	95.0	9.66
80	1518	9.74	9.27	9.51	0.374	126.5	13.16
110	2092	10.83	10.38	10.61	0.418	174.3	18.47
130	2478	11.35	10.89	11.12	0.438	206.5	22.04
160	3054	11.95	11.53	11.74	0.462	254.5	27.38
190	3628	12.40	12.00	12.20	0.480	302.3	32.69
220	4162	12.76	12.39	12.58	0.495	346.8	37.64
240	4526	12.98	12.60	12.79	0.504	377.2	41.01
270	5084	13.26	12.89	13.08	0.515	423.7	46.17
290	5476	13.44	13.08	13.26	0.522	456.3	49.80
320	6028	13.67	13.33	13.50	0.531	502.3	54.91

Test No. 2 - 12 in long 3/8 in x 4 in neoprene and 5/8 in x 2 in neoprene foam.

Ring Strain (X.0001 in.	Force (lbs)	Deflection Front (mm)	Deflection Rear (mm)	Avg. (mm)	Avg (in)	Force Per Unit Length (lb/in)	Equiv. Water Elevation (ft)
0	0	0	0	0	0	0	- 0.90
5	95	3.35	1.97	2.66	0.105	7.9	- 0.02
10	190	5.25	3.82	4.54	0.179	15.8	0.86
20	376	7.76	6.39	7.08	0.279	31.3	2.58
30	564	9.21	7.96	8.59	0.338	47.0	4.32
60	1140	11.40	10.43	10.92	0.430	95.0	9.66
80	1518	12.22	11.36	11.79	0.464	126.5	13.16
110	2092	13.15	12.39	12.77	0.503	174.3	18.47
130	2478	13.68	12.93	13.31	0.524	206.5	22.04
160	3054	14.39	13.67	14.03	0.552	254.5	27.38
190	3628	14.98	14.25	14.62	0.575	302.3	32.69

Test No. 3 - 12 in long 3/8 in x 4 in neoprene and two 5/8 in x 1 in neoprene foam strips.

Ring Strain (X.0001 in.	Force (lbs)	Deflection Front (mm)	Deflection Rear (mm)	Avg. (mm)	Avg (in)	Force Per Unit Length (lb/in)*	Equiv. Water Elevation (ft)*
0	0	0	0	0	0	0/0	- 0.90/-0.90
10	190	5.15	4.78	4.97	0.195	15.8/7.9	0.86/-0.02
20	376	7.64	7.33	7.49	0.295	31.3/15.7	2.58/0.84
40	750	10.19	9.91	10.05	0.396	62.5/31.3	6.04/2.57
60	1140	11.54	12.25	11.90	0.468	95.0/47.5	9.66/4.38
120	2280	13.66	13.45	13.56	0.534	190.0/95.0	20.21/9.66
160	3054	14.60	14.35	14.48	0.570	254.5/127.3	27.38/13.24
220	4162	15.37	15.15	15.26	0.601	346.8/173.4	37.64/18.37
320	6028	15.95	15.79	15.87	0.625	502.3/251.2	54.91/27.01

*Deflection of 2 - 12 in strips/Equivalent deflection of 1 - 24 in strip.

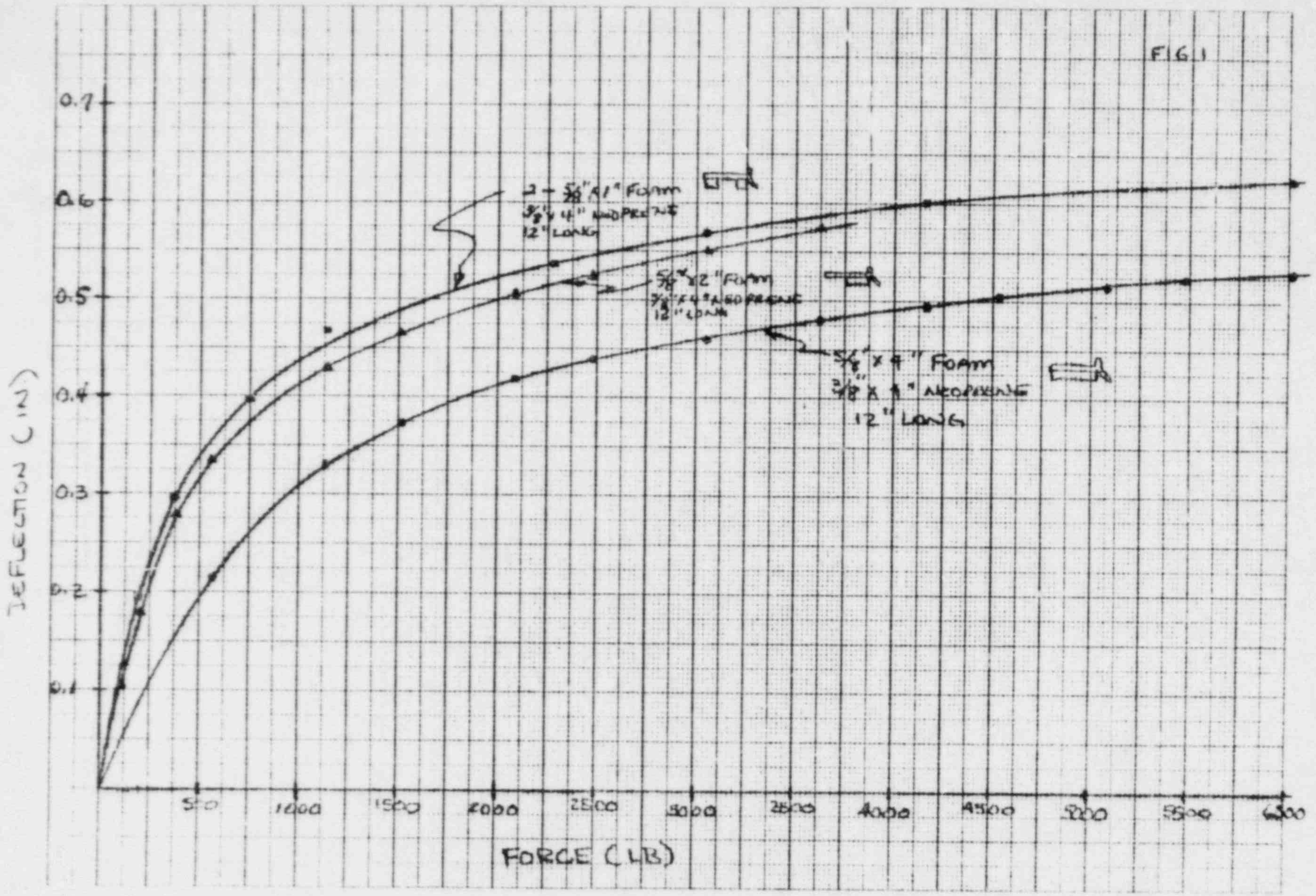
V. Conclusions

A. The 4 in wide gasket will deflect only 0.040 to 0.045 in under the weight the reactor cavity water seal. The desired 0.185 in deflection will not occur until there is about 3 1/2 ft of water in the refueling cavity.

B. A 1 1/2 in wide gasket will deflect about 0.160 in under the weight of the reactor cavity water seal. The desired 0.185 in deflection will occur with about 4 in of water in the refueling cavity. A 1 1/2 in wide gasket is the minimum width which will be considered due to the O-ring grooves and bolt holes in the embedded ring under the OD gaskets.

K+E 10 X 10 TO THE CENTIMETER
KEUFFEL & ESSER CO.

46 1510



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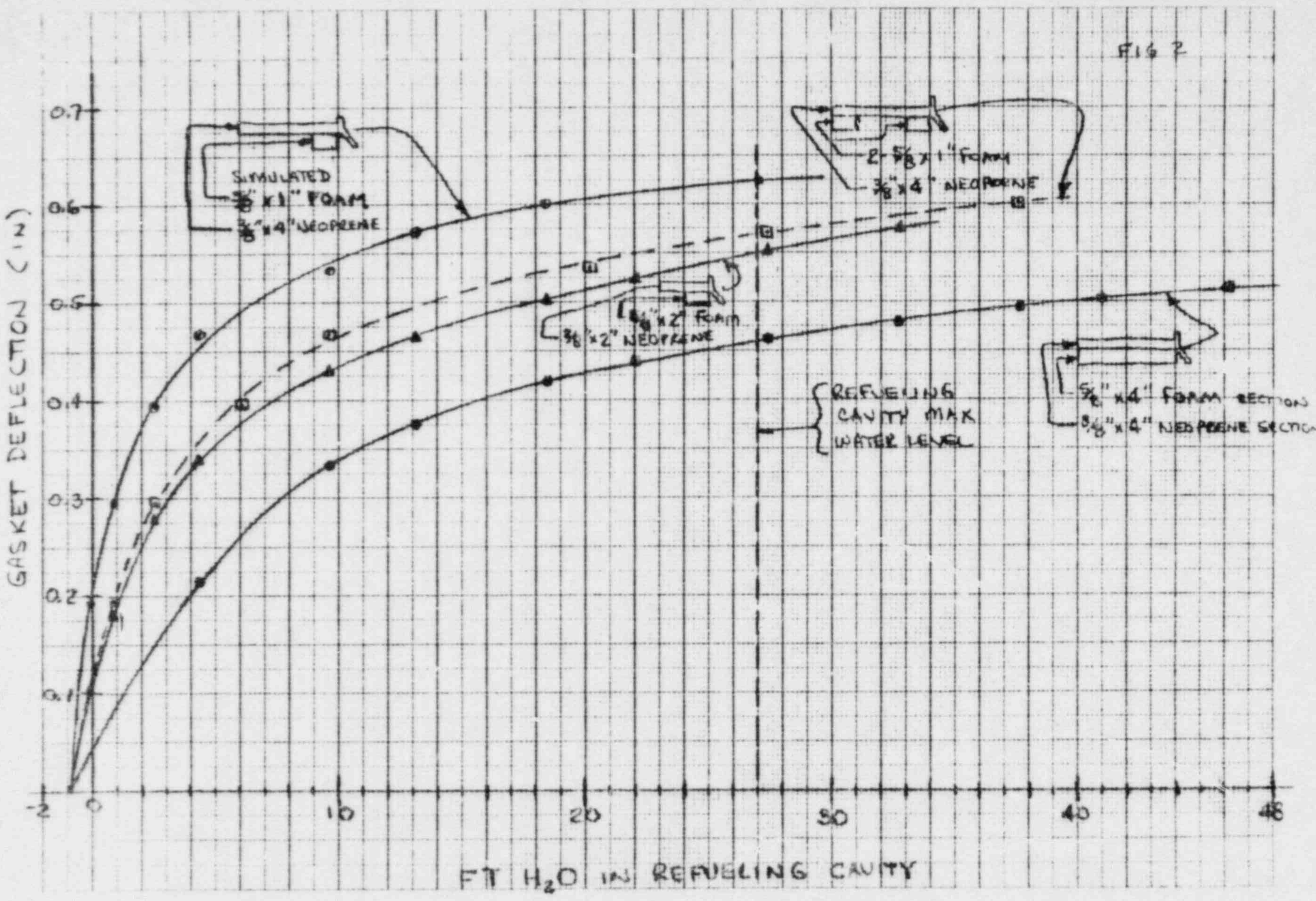

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AOP-27 REFUELING CAVITY WATER SEAL FAILURE

Scenario Assumption

Part A: Major seal failure where reactor cavity inventory loss is greater than makeup and there is no fuel movement - reduce volume of water loss to containment floor.

Part B: Major seal failure where reactor cavity inventory loss is greater than makeup and one fuel assembly is in transient in Reactor Building and one in transient in Fuel Building. This procedure assumes that any fuel assembly on the manipulator crane and/or spent fuel pool bridge crane will be placed in a safe position. Place fuel assemblies in safe position to obtain maximum heat removal and shielding.

Symptoms

1. Any of the following annunciators may be energized:

   SPENT FUEL POOL LEVEL LOW
   Annunciator Window: A6-3

   REFUELING CAVITY LEVEL HIGH-LOW
   Annunciator Window: A6-16

   CONTAINMENT SUMP LEVEL HIGH
   Annunciator Window: A1-49

   INCORE INSTRUMENT RM SUMP LEVEL HIGH
   Annunciator Window: A1-50

2. Rapid decrease in refueling cavity and spent fuel pool level.

3. Increasing radiation levels in the refueling cavity and spent fuel pool areas (RM-RM-215A or B, RM-VS-104A or B, RM-VS-103A or B, RM-RM-203, RM-RM-207).

Automatic Actions

None

Manual Actions

NOTE: If radiation levels reach alarm setpoints on RM-RM-215A or B, RM-VS-104A or B, RM-VS-103A or B anytime during the performance of this procedure, refer to EOP 22 - IRRADIATED FUEL DAMAGE WHILE REFUELING.

PART A - NO FUEL MOVEMENT

1. Verify transfer tube closed - if not, go to Part B steps 6 - 10 to shut transfer tube gate valve and install weir gate.

AOP-27 REFUELING CAVITY WATER SEAL FAILURE (continued)

2. If the transfer tube is closed or weir gate installed and inflated, conserve water inventory by pumping the contents of the refueling cavity back to the RWST in accordance with OM Chapter 20, Section 4, Procedure E, DRAINING THE REFUELING CAVITY.

PART B - FUEL MOVEMENT

1. Sound the standby alarm and evacuate all non-refueling personnel from the Rx Containment Building and the Fuel Building.

CAUTION: If purification is lined up with suction from reactor cavity per OM Chapter 20, Procedure D, REFUELING OPERATIONS, and the transfer tube gate valve is shut, stopping the fuel pool purification and cooling pumps will prevent pumping down the reactor cavity area and prevent a possible exposure of a fuel assembly laying on the transfer mechanism.

2. To prevent dry pumping the fuel pool cooling and fuel pool purification pumps [FC-P-1A, 1B] and [FC-P-4A, 4B], place their respective control switches in the STOP position, Benchboard - Section C.

CAUTION: Obtain proper rad monitoring equipment or rad worker coverage prior to proceeding to the reactor containment or fuel building areas. Verify upon arrival that rad levels are less than recommended guidelines before proceeding into the areas to perform the following job task. If the rad levels are in excess of recommended guidelines inform the NSS of the condition and request assistance and review the EPP for applicability.

NOTE: Licensed operators are required to operate conveyer car and lifting frame (upender).

3. If necessary, dispatch an operator(s) to the Rx Containment and/or Fuel Building to verify or perform steps 5 through 9.

NOTE: Two (2) licensed operators are required to return the conveyer car to containment. One will be located in containment and one in the fuel building.

4. Make-up to the reactor cavity per OM Chapter 11, Section 4, Procedure D, FILLING REACTOR REFUELING CAVITY. Monitor RWST level and discontinue this evolution when RWST level approaches ZERO or when fuel assemblies are placed in a safe position where fuel assembly(s) are in the core, or lowered in the lifting frame (upender), or lowered in a fuel rack cell.

AOP-27 REFUELING CAVITY WATER SEAL FAILURE (continued)

CAUTION: If corrective action cannot maintain at least a two (2) foot cover of water over a spent fuel assembly, evacuate all personnel and review the EPP for applicability.

5. Containment Lifting Frame Operator or Fuel Building Lifting Frame Operator - If a fuel assembly is in an upright position in the lifting frame (upender), place in a horizontal position as follows:

   a. Verify CONVEYER CONTROL SELECTOR switch OFF and depress the FRAME DOWN pushbutton. When the FRAME DOWN light comes ON the lifting frame is in the horizontal position.

6. At the containment control console, verify the conveyer car in containment by observing the CONVEYER AT REACTOR light illuminated. If not illuminated return the conveyer car to containment as follows:

   a. Containment Conveyer Car Operator and Fuel Building Conveyer Car Operator - Check MAIN POWER switch is ON at control console.

   b. Containment Conveyer Car Operator - Verify VALVE OPEN light is ON for permissive to operate conveyer. If not, notify Fuel Building Conveyer Car operator to open transfer tube gate valve until VALVE OPEN light comes ON.

   c. Fuel Building Conveyer Car Operator - Verify FRAME DOWN light is on for permissive to operate conveyer. If not, turn FRAME JOG-RUN selector switch to RUN, press FRAME DOWN pushbutton with CONVEYER CONTROL SELECTOR switch OFF and check FRAME DOWN light comes ON.

   d. Fuel Building Conveyer Car Operator - Turn CONVEYER CONTROL SELECTOR switch to ON. Notify Containment Conveyer Car operator that conveyer car is ready to be moved.

   e. Containment Conveyer Car Operator - Check that the CONVEYER CONTROL LIGHT is ON.

   f. Containment Conveyer Car Operator - Turn CONVEYER SELECTOR SWITCH to REACTOR.

AOP-27 REFUELING CAVITY WATER SEAL FAILURE (continued)

g. Containment Conveyer Car Operator - Press CONVEYER START pushbutton. CONVEYER AT PIT light will go off, check that the conveyer car moves into containment building and stops. CONVEYER AT REACTOR light should come on.

h. Notify Fuel Building Conveyer Car Operator to close transfer tube gate valve.

CAUTION: Extreme radiological care should be taken when closing the transfer tube gate valve [PH-185] or installing the weir gate, since rad levels increase as pool level decreases.

7. Close the transfer tube gate valve [PH-185] to prevent further draining of spent fuel pool.

8. Install the weir gate as follows:

   a. Connect lifting sling to the weir gate.

   b. Turn load cell off.

   c. Remove 2 manual keys (locks).

   d. Lift up off the two storage alignment pins.

   e. Place in closed position alignment pins.

9. In the fuel building, northwall-westside, inflate the weir gate seal as follows (refer to Fig. 1):

   a. Open valve 'A'.

   b. Adjust the pressure regulator until 30 psig is obtained as read on pressure regulator gage.

   c. Open valve 'B' and verify pressure at 30 psig. Adjust pressure if necessary.

   d. Inflate the seal by opening valve 'C' and verify 30 psig. Adjust pressure if necessary.

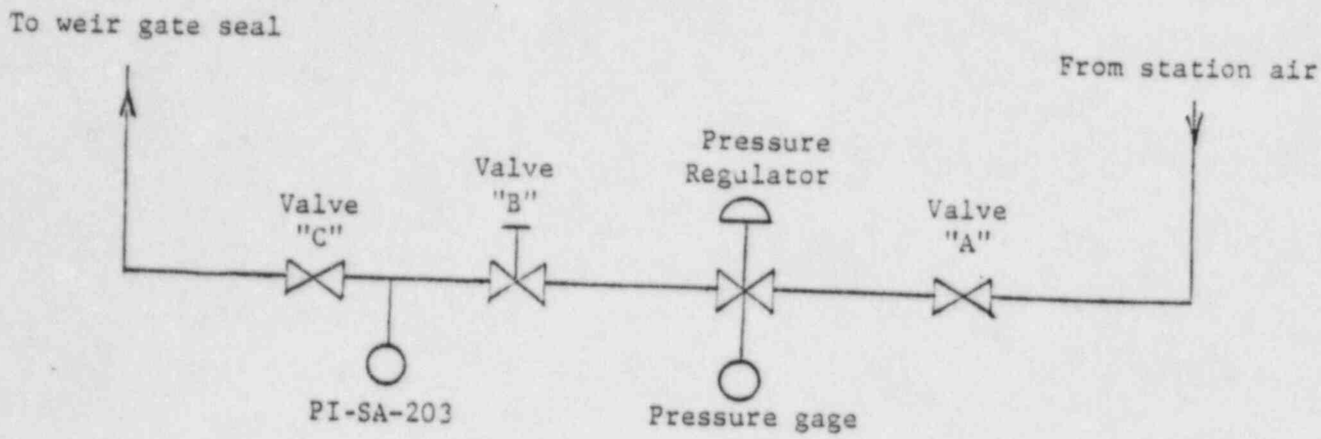


Figure 1

NOTE: If no fuel movement (Part A) was in progress, refer to Part A, step 2.

10. Once the fuel transfer tube is closed or the weir gate installed and sealed, request direction from the NSS or NSOF concerning refilling of the Spent Fuel Pool.

Follow-Up Actions

1. Initiate corrective action to repair the failed seal.
2. Begin dewatering and deconing the incore instrument pit and/or containment floor.
3. Inspect all areas for any visible water damage to plant equipment and electrical wiring.
4. If it is desired to make up to the spent fuel pool proceed as follows:
   a. Shut the RWST coolers and refrigeration units combined outlet isolation valve [QS-29], located by QS-P-1B.
   b. Open the refueling water to fuel pool isolation va ve [QS-37], located west of RWST coolers QS-E-1A and 1B.
   c. At the Benchboard - Section C, start the refueling water recirculation pump [QS-P-2A or 2B] by placing its control switch in the FAST position.
   d. Continue pumping as necessary and monitor RWST level.

TABLE OF CONTENTS

Section Index

Note:

This procedure has not been reviewed/approved for use.

ABNORMAL REFUELING PROCEDURES

I. PURPOSE

The purpose of this Procedure is to identify the appropriate actions to be taken during abnormal occurrences while refueling.

II. APPLICABILITY

This Procedure applies to BVPS Unit 1 during Mode 6 and includes actions required by personnel in Refueling and the station operating groups.

III. DEFINITIONS/DESCRIPTIONS

BVPS - Beaver Valley Power Station

FP - Fueling or Refueling Procedure

DLW - The Westinghouse three-letter code for Duquesne Light's Beaver Valley Power Station Unit 1

Refueling Mode or Mode 6 - An operational mode agreeing with Table 1.1 of the Technical Specifications.

This mode is reached when Keff of .95 or less and Tavg is below 140 degrees F, but it is applicable only when the reactor vessel head is unbolted or removed.

Suspension of Core Alteration - Tech Spec Definition 1.12

Suspension of CORE ALTERATION shall not preclude completion of movement to a safe conservative position.

Manipulator Crane - The Stea ns-Roger Crane used to remove or place fuel assemblies in the reactor core, the fuel transfer system, and the RCC change fixture. Mark Number CR-5.

It takes an average of five (5) minutes to remove a fuel assembly from the core and release it in the upender.

Spent Fuel Pit Bridge Crane or Fuel Pool Crane - This Dresser Crane is used to manipulate fuel assemblies in and out of the fuel transfer system, the spent fuel racks, and the cask area. Also it moves new fuel assemblies to the new fuel elevator. Its Mark Number is CR-27.

It takes approximately six (6) minutes to remove a fuel assembly from the upender and put it in a spent fuel rack.

III. DEFINITIONS/DESCRIPTIONS (Continued)

Fuel Cask Crane - This Dresser Crane is used for spent fuel cask movements and is kept in the Decon Building.
Its Mark Number is CR-15.

Refueling or Reactor Cavity - The refueling cavity (UFSAR Figures 9.12-1 and 5.1-5) is a reinforced concrete structure lined with stainless steel. It is the area above the reactor closure head flange that is filled with borated water to form a pool above the reactor. This pool protects the refueling operators during fuel transfer.

Transfer Canal or Fuel Transfer Canal - The transfer canal adjoins the refueling cavity, but is approximately 11½ feet lower. It contains the RCC charge fixture, the blind flange, the upender, and the transfer cart. During a flooded condition it becomes part of the total pool area and is used in the transfer of fuel assemblies into and out of containment.

Fuel Pool or Pit or Spent Fuel Pit - Consists of the fuel transfer mechanism area, the spent fuel storage rack area, and the cask area. The fuel transfer mechanism area and the cask area each have a weir gate or a gate with inflatible seals and it is separated from the transfer canal by the transfer tube, which has the blind flange on the transfer canal side and a gate valve (CPA-135) on the transfer mechanism side. It is also termed the transfer canal - fuel pool side.

Fuel Transfer System - This system is used to manipulate fuel from the transfer canal to the fuel pool. It consists of two (2) lifting frames or upenders, a conveyor car or transfer cart, and a transfer tube that has a blind flange on the containment side and a manual gate valve on the fuel pool side.

It takes two (2) minutes for the car to travel its full length and one (1) minute for the upenders to complete their movements.

III. DEFINITIONS/DESCRIPTIONS (Continued)

Incore Instrument Room or Keyway	-	The incore instrument room or pit/sump or 'keyway' is located directly below the reactor and partially under the RHR platform. Any water leaking from the reactor cavity seal and flowing past the neutron shield tank ends up in the incore instrument sump.
Reactor Cavity Water Seal	-	A seal designed to maintain water in the reactor or refueling cavity during its flooded or refueling condition. The seal covers the annulus gap between the reactor vessel and the reactor cavity.

IV. ORGANIZATION and RESPONSIBILITY

The organizations involved in this procedure are the Refueling Group, including contractors, and the normal plant operating groups such as Maintenance and Operations, plus the Radiation Control Group. See Section 4 of the Refueling Procedure for Organizational Charts and the listed responsibilities of the Refueling Group, including contractors. The station operating groups have responsibilities as per their specifiic administrative procedures.

NOTE: With any incident requiring the suspension of core alterations, all fuel handlers will attempt to complete movements that will place fuel assembly in a safe conservative position, but will not perform any actions that will endanger their health or safety.

V. REFERENCES

1. UFSAR Rev. 0 (1/82), Section 9.12 and 14.2
2. FP-DLW-R3, Refueling Procedure, Cycl. III-IV
3. Tech Manual, 2.102, Fuel Transfer System Manual
4. IE Bulletin No. 84-3: Refueling Cavity Water Seal
5. DCP No. 640 Guideline No. 6884-MD-PR30-001, Rev. 0 "Guideline for Reactor Vessel Water Seal Ring Installation, Test, Operation, and Removal"
6. ND1SCA:0095, 9/17/84, "Spent Fuel Melting"
7. LIS, Docket No. 50-213, 811299
8. ND1MNE:2290, 9/19/84, "New Reactor Cavity Seal Ring" and Interim Report on the BVPS No. 1 Reactor Cavity Seal
9. Note Pad EM No. 3859 - Subject: Reactor Vessel Upper Internals Package Radiation Levels, Response to EM No. 3816
10. BVPP No. 62-4, "Installation and Removal Proceudre for the Segment Reactor Cavity Seal Ring"
11. ND1SHP:329, 9/24/84, "Reactor Cavity and Fuel Pool Dose Rates"
12. Op. Manual, 20, Fuel Pool Cooling and Purification System
13. Op. Manual, 1.53.4, E-22, "Irradiated Fuel Damage While Refueling"
14. Op. Manual, 9, "Reactor Plant Vents and Drains"
15. ND1SCA:0097, 9/24/84, "Water Evaporated by Spent Fuel"
16. ND1SHP:334, 10/3/84, "Rx Cavity Dose Rates"

VI. INSTRUCTIONS

A. Prerequisites

The prerequisites are those required to be in a Refueling Mode and moving fuel assemblies. See Tech Specs 4.9.1 through 4.9.13 and the Refueling Procedure.

B. Precautions and Limitations

The same precautions are followed as required by the Refueling Procedure.

1. If a condition occurs that requires the evacuation of containment or the fuel building, the Refueling Shift Supervisor (Refueling SRO) shall provide direction on the placement of fuel in a conservative position.

CAUTION: At no time shall personnel stay at their posts if a spent fuel assembly has less than 4 ft. of water over top of it. Any irradiated or spent fuel assembly partially exposed to the atmosphere represents a significant potential for high exposure rates within very short periods of time. Also, the cladding may become damaged and additional exposure problems would occur.

CAUTION: Even if all the fuel assemblies are placed in a safe conservative position, the internals, upper and lower, could present exposure problems.

2. Spent fuel in the fuel pool racks will present exposure problems that depend on the amount of water shielding provided.

3. Any fuel assembly left in the horizontal position in the fuel building or containment transfer canal, will not present an exposure problem as long as they remain covered with water - approximately 9 feet of water.

4. The RCC change fixture is not to be used as a temporary storage location for spent fuel or as an RCC change fixture, until all safety concerns have been addressed. It will not be used at all in the 1984 Fourth Refueling Outage, Cycle IV-V.

VI. INSTRUCTIONS (Continued)

B. Precautions and Limitations (Continued)

5. To simplify emergency actions, the manipulator crane operator is not to move off the index used to remove a fuel assembly from the core until the upender or lifting frame has been cleared or emptied. This allows for any preliminary movements needed to prevent grid strap damage before the fuel assembly is raised out of the core.

6. A loss of the reactor cavity seal would drain the reactor cavity and, and when the gate valve is open, it would ruin part of the transfer canal and fuel pool. Approximately one (1) foot of water would remain over the fuel in the fuel pool storage racks.

C. Procedures

NOTE: All Abnormal Refueling Procedures will follow the format of Abnormal Operating Procedures.

1. ARP-1 Reactor Cavity Seal Failure

Symptoms

a. The High-Low Refueling Cavity Level alarm (ANN Window No. A6-H6) will annunciate in the control room.

b. If the gate valve (PH-185) in the transfer tube is open and the weir gate is not installed, the spent fuel pool low level alarm (ANN Window No. A6-3) will annunciate in the control room.

c. The Refueling personnel will notice the decrease of water in cavity and, if the fuel pool is connected, they will notice the level drop in the fuel pool and in either case notify the control room via direct communication line, page, or pax line.

d. The incore instrument room sump level high level alarm (ANN Window No. A1-50) will annunciate in the control room.

e. The containment sump high level alarm (ANN Window No. A1-49) will eventually annunciate in the control room.

VI. INSTRUCTIONS (Continued)

C. Proceudres (Continued)

Symptoms (Continued)

NOTE: This will occur regardless of flow from DA-P-5, because the speace between the reactor and neutron shield tank will not support a large volume flow and the remaining flow will discharge from the nozzle penetrations and drain to the containment sump.

f. Depending on the rate of water (shielding) loss, the rad monitors in containment and the fuel building, if the gate valve is open, will alarm. (Contianment Area RM219A&B and Fuel Pool Area Monitor RM207)

Automatic Actions

a. If DA-P-5 (Incore Instrument Room Pump) is not on clearance, it will start (Benchboard Section A) and pump 10 gpm to the containment sump.

b. One of the containment sump pumps (DA-P-4A or DA-P-4B) will pump 25 gpm to the north sump in the PAB.

c. A high-high rad monitor alarm in containment or the fuel building should initiate E-22.

1) This should actuate changes to the ventilation in each building or this should be done manually if the notification from the refueling personnel precedes the alarms.

2) The high-high alarm should also actuate the evacuation alarm. The evacuation alarm should be preformed if the refueling personnel notify the control room before the high-high alarm is initiated.

Immediate Manual Action

a. Notify control room through direct communicating page, or pax phone, of situations and planned planned action.

VI. INSTRUCTIONS (Continued)

C. Procedures (Continued)

Immediate Manual Action (Continued)

CAUTION: If corrective actions cannot maintain at least a two (2) foot cover of water over a suspended spend fuel assembly, evacuate all personnel. See chart provided that shows task and leak duration times. Also, the Refueling Shift Supervisor could request the control room to start a low-head safety injection pump ( ) and pump for five (5) minutes from the RWST. This would add to the volume of water in the cavity which increases the time until the cavity is drained.

b. Remove all unnecessary personnel from containment and the fuel building.

NOTE: The Refueling Shift Supervisor (DLC) is required to monitor all evolutions involving raising and lowering fuel assemblies with the manipulator crane and will initiate proper actions and have the responsibility to direct the placement of the fuel assemblies in safe conservative positions.

NOTE: Respirators will probably be issued by the Rad Con personnel at this time.

c. Suspend all core alterations.

1) Manipulator Crane (CR-5) Operator handling spent fuel assembly.

i. Place manipulator crane over the most open area of the core, unless it is already in position over the upender.

NOTE: The control room should be able to clearly identify the nearest and most open area of the core if the crane operator needs assistance.

NOTE: The Refueling Shift Supervisor will direct or operate the crane and have overall responsibility for the placement of the fuel assembly. If the transfer cart or upender is not available, take the crane to the open area of the core.

VI. INSTRUCTIONS (Continued)

C. Procedures (Continued)

Immediate Manual Action (Continued)

ii. Lower the fuel assembly into the core or the upender. It must be unlatched if it is in the upender and the mast raised.

iii. If possible, inform the control room of the final disposition of the fuel assembly.

iv. Assist any other operators, if possible, then evacuate area.

2) Spent Fuel Pit Bridge Crane (CR-27)

Operator, if handling a spent fuel assembly.

i. Position assembly over an empty fuel rack cell, unless it is already in position over the upender and the upender is ready to receive it.

NOTE: The control room should be able to clearly identify the nearest empty cell.

CAUTION: If it is impossible to place in an empty cell, place it in the larger opening east of the "failed fuel cans." Go to the spent fuel racks or the above location if the upender is not positioned correctly.

ii. Lower the fuel assembly into the rack or the upender. It must be unlatched if it is in the upender.

iii. Assist any other operators, if possible, then evacuate the area.

iv. Inform the control room of the final disposition of the fuel assembly.

3) Transfer System Operator

(Irregardless of whether fuel assembly is being hand led or not.)

VI. INSTRUCTIONS (Continued)

C. Procedures (Continued)

Immediate Manual Action (Continued)

i. If a crane is in position to lower a fuel assembly, wait until the crane has unlatched before lowering the frame; otherwise lower immediately.

ii. Try to move car to containment position.

iii. Close the gate valve (PH-185) after car has completed travel. If problems arise in valve closure or time permits, install weir gate and inflate seal.

NOTE: Immediately inform the control room of any delays or problems.

iv. Evacuate area.

v. Report final disposition of fuel and equipment to control room.

Follow-Up Actions

a. If the fuel assemblies were not placed in a safe or or conservative condition, the plant will initiate Chapter 57, the Beaver Valley Emergency Preparedness Plan, and any further actions would be beyond the scope of these procedures.

b. If the gate valve was not closed but the fuel assemblies were all placed in safe positions, refer to ARP-2.

c. Given minimal operator actions, all the fuel assemblies are in a safe conservative position and the gate valve was closed, perform the following actions:

1) Cautiously monitor exposure levels in containment and especially the fuel building.

2) Spray down internals once with D.I. water.

3) Refill fuel pool to normal water level.

4) Clean-up and decon containment lower levels.

VI. INSTRUCTIONS (Continued)

C. Procedures (Continued)

Follow-Up Actions (Continued) .

5) Remove reactor cavity seal.

CAUTION: Per information received from Kewaunee with the internals and head removed, the surveys showed 70-100 MR/HR at the edge of the pool near the internals package. Also, during the split pin program an estimated 600R/HR was used for the bottom of the guide tubes near the center of the core.

a) Install temporary shielding to protect personnel that enter cavity. (Either lead or a waterwall shield should be installed.)

b) Remove reactor cavity seal per applicable procedure, DCP No. 640, 6884-MD-PR30-001, Rev. 00 (Steps 5.41 through 5.4.2.3).

c) Repair seal per engineering direction.

d) Reinstall per 6884-MD-PR30.001, Rev. 00.

e) Follow normal refueling procedures after the removal of the temporary shielding for the cavity fill.

2. ARP-2 Gate Valve Not Shut With Fuel Pool Drained To 642'1" Level

This procedure follows ARP-1 except the gate valve is not closed and the fuel pool has drained to the 642'1" level. All fuel assemblies have been placed in safe conservative positions. The Symptoms and Automatic Actions are the same as ARP-1.

Immediate Manual Action

a. If there is no fuel assembly in the upending mechanism:

1) Transfer the carriage or cart to the containment.

a) Use manual wheel.

b) Use emergency pull-out cable.

c) Override electrical switch and move cart with the control panel in containment.

COMPANY ____

DEPT. ____

DIVISION ____

FORM G-23-112

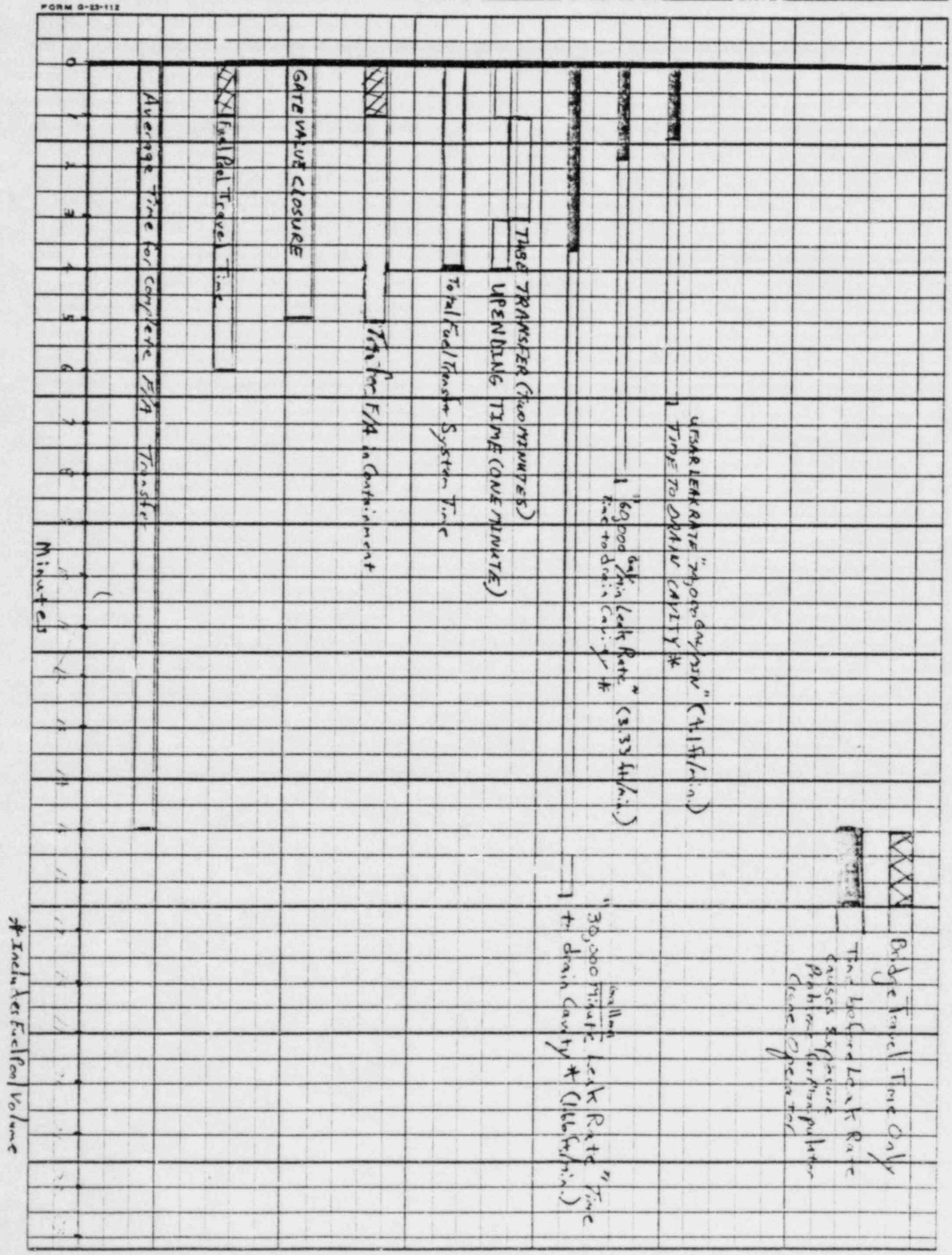
SUBJECT: TASK & TIME CHART (DRAIN DOWN TIMES INCLUDE ADDED FUEL POOL & TRANSFER CANAL(S) VOLUME)

SHEET NO. ____

COMPILED BY: JHM

CHECKED BY ____

DATE ____



COMPANY

DEPT.

DIVISION

FORM G-23-113

SUBJECT Manipulator Crane SHEET NO.

Operator Exposure As Water Level Decreases

COMPILED BY JHM CHECKED BY DATE

Operator Platform
Floor Level ≅ 772'6"

Normal
Water Level
765'10"

8 ft. above F/A - 39 MR/HR

6 ft. above F/A - 730 MR/HR

4 ft. above F/A - 16 R/HR

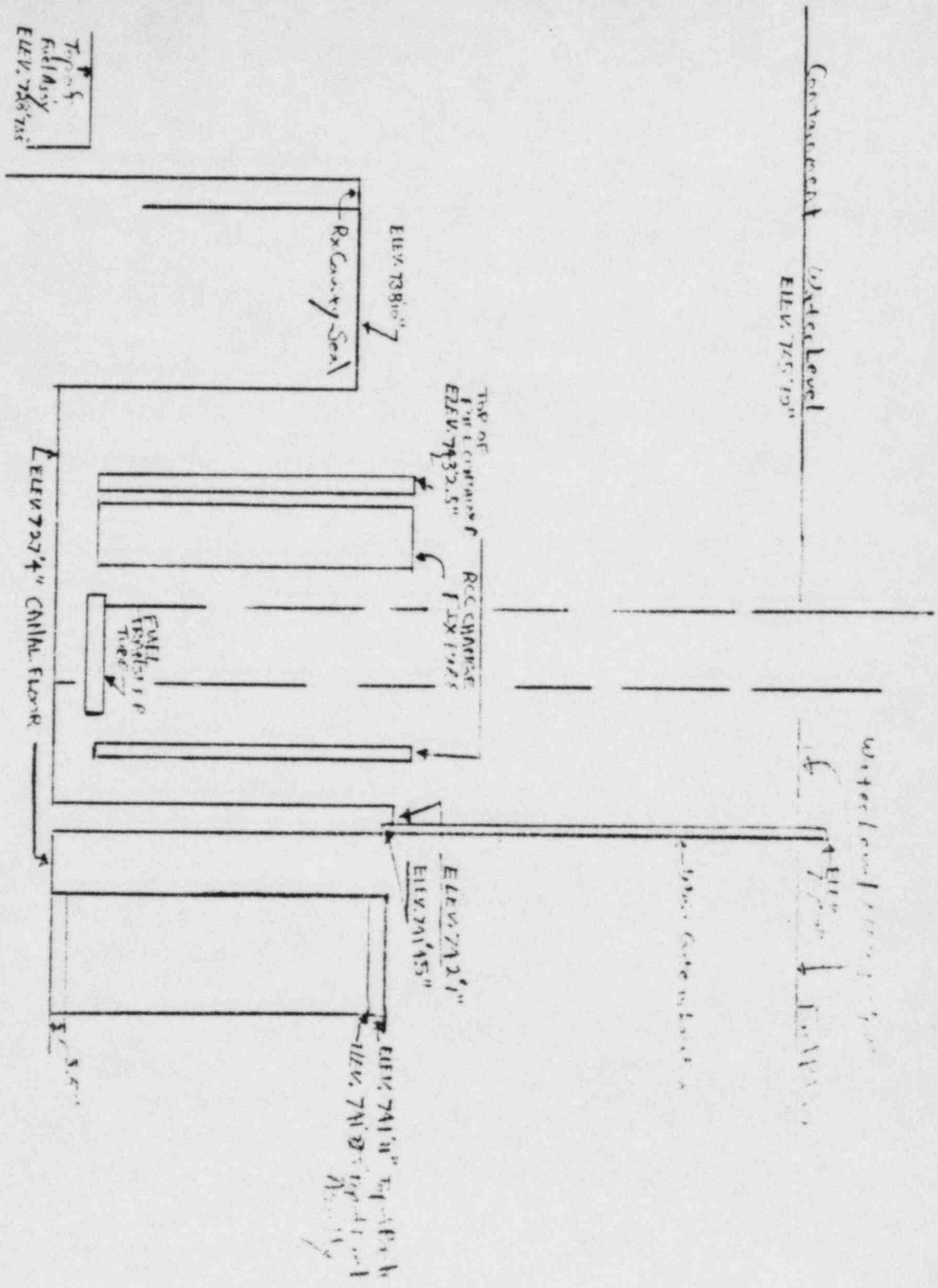
2 ft above F/A - 340 R/HR

1 ft above F/A ≅ 1400 R/HR

(F/A) Top of FUEL ASSEMBLY 757'5.5" (IN MANIPULATOR)

Top of Fuel 756'5"

NOTE: DOSES SHOWN ARE FOR MANIPULATOR CRANE OPERATOR



For ....
Dated .... Scale: ....

FACTORY MUTUAL ENGINEERING ASSOCIATION Factory Mutual System 1151 BOSTON-PROVIDENCE TURNPIKE, NORWOOD, MASS. 02062	Ind. No. .... Tr. No. A ....

VI. INSTRUCTIONS (Continued)

C. Procedures (Continued)

2. Immediate Manual Action (Continued)

2) Install blind flange by using divers.

(If flange leaks, use normal engineering corrective measures or weld closed.)

3) Refer to ARP-1 for follow-up actions, except any damage to the transfer system must be repaired.

b. If there is a fuel assembly in the transfer cart, there are two (2) possible solution paths.

1) a) Bring fuel assembly into containment using the manual, emergency, or control panel (containment side).

b) Close the gate valve in the fuel building. Possibly make a quick entry with an electric drill to turn valve, or close valve remotely from sheltered location on roof.

c) Follow directions given in ARP-1 Follow-Up Actions.

2) a) Lower diver into transfer canal and have diver cut transfer carriage at blind flange. Ensure blind flange can be installed.

b) Have diver install blind flange.

c) Refer to ARP-1 for Follow-Up Actions, except any damage to the transfer system must be repaired.

Follow-Up Action

See ARP-1.