Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690 - 0767

June 1, 1988

Mr. Thomas E. Murley
Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Mail Station P1-137
Washington, DC. 20555

Subject: Byron Station Units 1 and 2
Application for Amendment to Facility
Operating Licenses NPF-37 and NPF-66,
Appendix A, Technical Specifications
NRC Docket Nos. 50-454 and 50-455

References (a): September 3, 1986 letter from K.A. Ainger to H.R. Denton

(b): June 22, 1987 letter from L.N. Olshan to D.L. Farrar

Dear Mr. Murley:

The NRC staff requested additional information concerning our application for a license amendment documented in reference (a) to increase the storage capacity of the spent fuel racks at Byron Station. Reference (b) contained three questions regarding the use of Boraflex neutron absorber in the high density spent fuel racks. Enclosed with this letter are Commonwealth Edison's responses to the NRC questions.

The design of the region I racks has been modified to address the issue concerning Boraflex shrinkage. Enclosed is revision 2 of the Licensing Report on High Density Spent Fuel Racks which has been revised to reflect the design changes.

Please direct any further questions regarding this matter to this office.

Very truly yours,

K. A. Ainger

K. A. Ainger
Nuclear Licensing Administrator

/klj

Encl.

cc: Byron Resident Inspector
NRC Region III Office
L. N. Olshan (NRR)

4624K

Aool
1/1

8806060235 880601
PDR ADOCK 05000454
P DCD

COMMONWEALTH EDISON RESPONSE TO

NRC QUESTIONS REGARDING BORAFLEX

Question 1. Based on recent experience pertaining to degradation of Boraflex in spent fuel pools at Quad Cities and Point Beach Nuclear Power Plants, provide justification to demonstrate the continued acceptability of Boraflex for application in the Byron spent fuel pool.

Response: Commonwealth Edison, through the combination of extremely conservative assumptions regarding Boraflex shrinkage for analytical purposes, a conservative design and future surveillance plans, has ensured the acceptability of Boraflex in the Byron spent fuel racks. The design of region I has been modified to preclude any possible problems from Boraflex shrinkage. Details of the new design are contained in revision 2 of the licensing report. The region II design was found to be acceptable as is. The following is the basis for Commonwealth Edison's confidence in the Byron spent fuel racks.

Models developed by Northeast Technologies Corporation and recent experiments by BISCo (the manufacturer) indicate that Boraflex shrinks with radiation exposure until an integrated dose of approximately 10^{10} rads has been accumulated. The studies indicate that the Boraflex dimensions then stabilize until approximately 10^{13} rads have accumulated at which point the Boraflex begins to powder near edges. This data was collected in a combined neutron and gamma field.

Attachment A contains a calculation of the maximum integrated dose seen by a panel versus time for a typical off load into the Byron spent fuel pool. This calculation assumes that there was no delay time in transferring the fuel assemblies from the reactor to the spent fuel pit.

In this case, the maximum predicted dose, 2.8×10^{10} rads, is far below the expected dose for powdering to begin and is directly applicable to the region II racks. Therefore, no serious degradation problems should be encountered in this region. For the upcoming outages, there will be a need to use some region II racks as temporary storage of "hot spent fuel". "Hot spent fuel" is defined in NUREG 0612. This could result in some Boraflex panels receiving a dose of up to 10^{11} rads. A region 1 panel could see a dose of up to 6.6×10^{11} rads during its lifetime. These maximum doses are far below the dose where powdering can be expected. Therefore powdering is of no concern.

The average Boraflex shrinkage reported in the studies is 2.5%. However, the maximum shrinkage reported in a sample is 4%. Commonwealth Edison used this maximum shrinkage to ensure the criticality analyses performed could be considered bounding.

The region I racks' duty cycle, i.e. many off loads of newly discharged fuel combined with the manufacturing technique used, has led Commonwealth Edison to modify the design of these racks. This modification ensures that the criticality criterion of K_{eff} less than 0.95 at 95/95 confidence level will not be violated even with an extremely conservative assumption of 4% shrinkage. A further conservatism used in the analysis was the assumption that all shrinkage appears as a 6 inch wide gap located in all panels at the midplane, thereby maximizing the neutronic width of the gap.

Racks B2 and B3 will have two sheets of Boral with a minimum B-10 loading of .020 gm/cm^2 inserted into the flux trap between each cell. The analysis to qualify this design assumed the "worst case" configuration as regards the Boral combined with the Oat uncertainty factors to produce a maximum K_{eff} of .9434 at a 95/95 confidence level, assuming 6 inch gaps in the Boraflex of all panels.

Racks A1 and B1, which have yet to be built, will have Boral sheets with a minimum B-10 loading of .025 gm/cm^2 substituted for the Boraflex. This will eliminate all concerns regarding Boraflex shrinkage in these racks.

For region II, criticality analyses have been performed for various gap configurations. A sufficient number of sensitivity studies were performed to allow us to plot gap size versus K, up to 6" gaps in 4 of 4 poison plates. The analyses showed that the racks exhibit a K_{eff} less than 0.95 for gap conditions up to and including 6" gaps at the midplane in 2 of 4 poison plates. The analyses also indicate that if all gaps occur at the mid-plane with an additional 2" of shrinkage at the top and bottom, a gap of 3 and 3/4", in 4 of 4 poison plates, will maintain K_{eff} less than 0.95 at the 95/95 confidence level. Gaps located at other positions or not aligned result in lower K_{eff}. Eliminating the shrinkage at the ends was found to have a minimal effect on K_{eff}.

The region II racks are quite similar to the Quad Cities racks in design, except the Byron racks do not use glue to position the Boraflex plates. Based on the Quad Cities data, the probability of gaps this large in all panels at the same level is not a credible event. Commonwealth Edison therefore concludes that the use of Boraflex in the region II racks poses no hazard.

Question 2. Based on recent information, provide any changes to the in-service surveillance program for Boraflex neutron absorbing material and describe the frequency of examination and acceptance criteria for continued use. Provide the procedures for testing the Boraflex material and interpretation of test data.

Response: Attachment B is a procedure proposed by the spent fuel rack supplier for inservice inspection of the Boraflex. The procedure makes use of coupons of which one is removed from each region every other year to be analyzed. Additionally, after the first refueling, a representative sample of cells which temporarily had spent fuel stored in them will have blackness testing performed to ensure acceptability for continued use.

Question 3: Describe the corrective actions to be taken if degraded Boraflex specimens or absorber is found in the spent fuel pool.

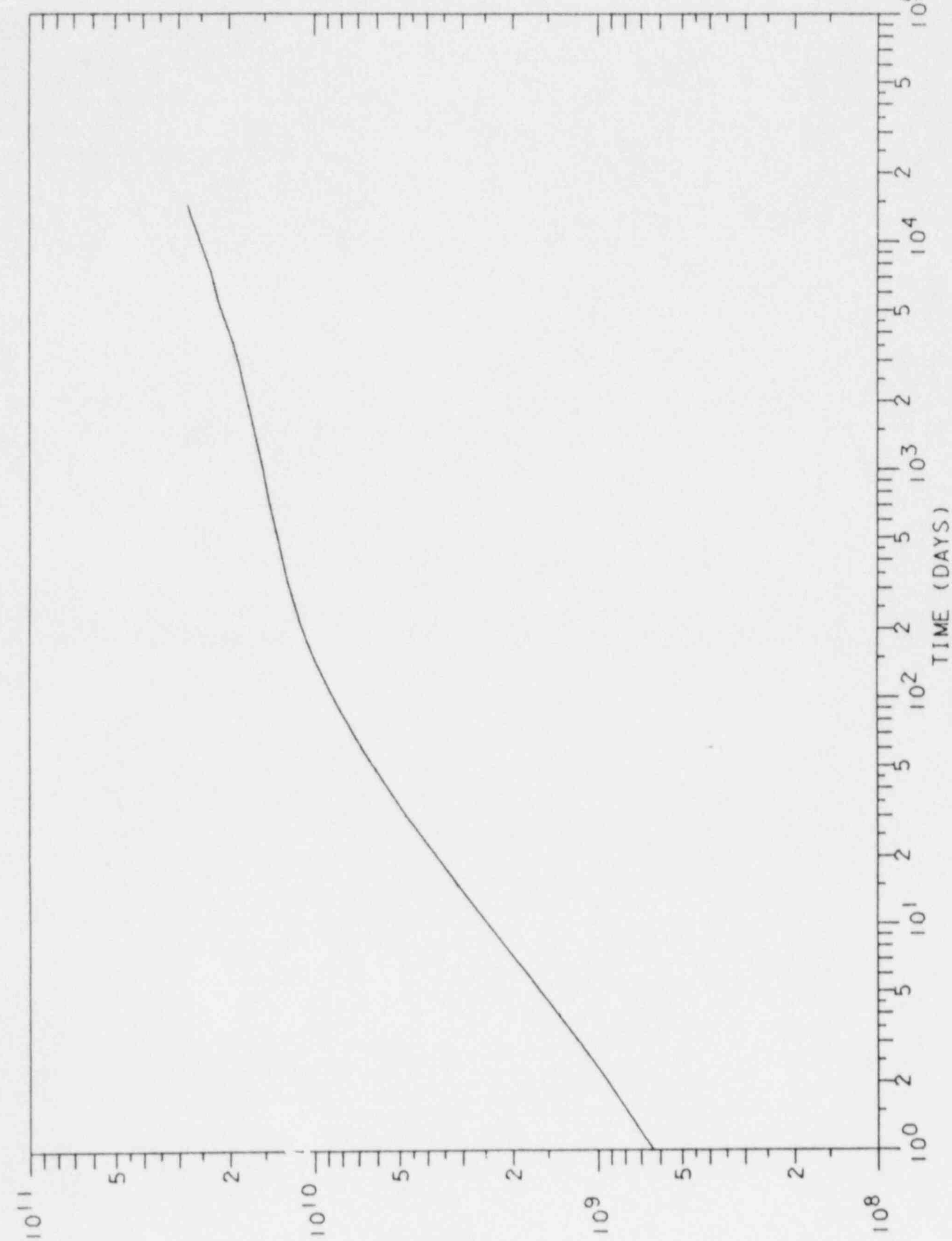
Response: The replacement of Boraflex in the A1 and B1 racks eliminates any concern over Boraflex degradation in these racks. Concerns over Boraflex gapping in the B2 and B3 racks has been eliminated by the addition of compensating Boral poison plates.

In region II racks, Commonwealth Edison does not anticipate a significant degradation of the Boraflex that would prevent it from performing its intended function. Should degradation of Boraflex be found, an evaluation will be made to ensure that the applicable safety limits are maintained.

Integrated Dose at the Center Line Between Two Spent Fuel Assemblies* in Water at the Byron/Braidwood Stations

Time After Reactor Shutdown (Days)	Dose (Rad-Carbon)
1	6.3×10^{8}
2	9.2×10^{8}
3	1.2×10^{8}
4	1.4×10^{9}
5	1.6×10^{9}
6	1.8×10^{9}
7	2.0×10^{9}
14	3.0×10^{9}
30	4.7×10^{9}
60	6.8×10^{9}
90	8.2×10^{9}
120	9.2×10^{9}
150	1.0×10^{10}
180	1.1×10^{10}
240	1.2×10^{10}
365	1.3×10^{10}
730	1.4×10^{10}
1,095	1.5×10^{10}
1,460	1.6×10^{10}
1,825	1.7×10^{10}
2,555	1.8×10^{10}
3,650	1.9×10^{10}
5,475	2.2×10^{10}
7,300	2.3×10^{10}
9,125	2.4×10^{10}
10,950	2.6×10^{10}
12,770	2.7×10^{10}
14,600	2.8×10^{10}

*The assemblies have been in an operating reactor for a period of three years.



INTEGRATED DOSE BETWEEN TWO SPENT FUEL ASSEMBLIES

ATTACHMENT B

CHEMICAL ENGINEERS & FABRICATORS
NUCLEAR POWER COMPONENTS
ESTABLISHED 1788

JOB PROCEDURE JP-2481-41
IN-USE SURVEILLANCE PROGRAM FOR
NEUTRON ABSORBING MATERIAL
FOR
PWR FUEL ASSEMBLY

REVISION					
Rev. No.	Date	Cognizant Personnel	Reviewed/Approved by Eng.	Q.C.	Approved By
0	9-30-86	[signature]	[signature]	[signature]	[signature]
1	1-13-87	[signature]	[signature]	[signature]	[signature]

* This is an Oat proprietary document. It is strictly for the use of the designated receipient. Its general publication or dissemination is strictly forbidden.

JOSEPH OAT CORPORATION
CHEMICAL ENGINEERS & FABRICATORS
NUCLEAR POWER COMPONENTS
ESTABLISHED 1788

INSERVICE SURVEILLANCE PROGRAM FOR NEUTRON ABSORBING MATERIAL

1.0 Program Intent:

A sampling program to verify the integrity of the neutron absorber material employed in the high-density fuel racks in the long-term environment is described in this section.

The program is intended to be conducted in a manner which allows access to the representative absorber material samples without disrupting the integrity of the entire fuel storage system. The program is tailored to evaluate the material in normal use mode, and to forecast future changes using the data base developed.

2.0 Description of Specimens:

A spent fuel rack is basically made out of two materials.

(a) Poison material
(b) Stainless steel material

The poison material used in the construction of a rack absorbs neutrons emitted by fuel assemblies. Boraflex is the material used as the neutron absorber material which is made out of polymer and boron powder. For Byron racks, the minimum B^{10} loading is .020 gm/cm^2, the thickness is .075" for Region I and .010 gm/cm^2 B10 loading and .041" thk for Region II. Boraflex is manufactured by Bisco (a division of Brand, Inc.).

The absorber material, henceforth referred to as "poison", used in the surveillance program must be representative of the material used within the storage system. It must be of the same composition, produced by the same method, and certified to the same criteria as the production lot poison. The sample poison must be of similar thickness as the poison used within the storage system and not less than 4" x 2" on a side. Figure #1 shows a typical coupon. Each poison specimen must be encased in a stainless steel jacket of an identical alloy to that used in the storage system, formed so as to encase the poison material and fix it in a position and with tolerances similar to that design used for the storage system. The jacket has to be closed by tack welding in such a manner as to retain its form throughout the test period and still

JOSEPH OAT CORPORATION
CHEMICAL ENGINEERS & FABRICATORS
NUCLEAR POWER COMPONENTS
ESTABLISHED 1788

allow rapid and easy opening without causing mechanical damage to the poison specimen contained within. The jacket should permit wetting and venting of the specimen similar to the actual rack environment.

3.0 Test:

In the case of Byron, twenty test samples per region are to be fabricated in accordance with Figure #1 and installed in the pool prior to storing spent fuel in or near the Region I and the Region II racks. 1

The procedure for fabrication and testing of poison samples is given below:

Note: All tests are performed on poison material only.

a. The samples should be cut to size and weighed carefully in milligrams.

b. The length, width, and the thickness of each specimen is to be measured and recorded as shown in Figure #2.

c. The samples should be fabricated in accordance with Figure #1 and installed in the pool.

d. The following method is recommended to study the effect of integrated gamma dose on boraflex.

The coupons should be on a hanging fixture that maintains the coupons within the central 3' axially of the active fuel region.

Place the coupons hanging fixture in a storage cell of Region I and Region II. Place freshly discharged fuel assemblies in cells around the cell with the test coupons.

JOSEPH OAT CORPORATION
CHEMICAL ENGINEERS & FABRICATORS
NUCLEAR POWER COMPONENTS
ESTABLISHED 1788

For the first two outages only place freshly discharged fuel assemblies in the cells around the cell with test coupons for Region II racks. For Region I racks this is to be done at every outage. 1

e. A written record of the history of the coupon fixture location with nearby spent fuel assemblies should be maintained to facilitate estimating the TID received by the coupon.

4.0 Specimen Evaluation:

After the removal of the jacketed poison specimen from the fuel pool at a designated time, a careful evaluation of that specimen should be made to determine its actual condition as well as its apparent durability for continued function. Separation of the poison from the stainless steel specimen jacket must be performed carefully to avoid mechanical damage to the poison specimen. Immediately after the removal, the specimen and jacket section should visually be examined for any effects of environmental exposure. Specific attention should be directed to the visual examination of the stainless steel jacket for any evidence of physical degradation. Functional evaluation of the poison material can be accomplished by the following measurements:

Note: All post measurements shall be taken after drying of the coupons. All tests are performed on poison material only.

(1) Physical test
(a) Dimensional stability
(b) Hardness

(2) (a) Neutron Radiograph of the poison material
(b) Neutron Attentuation measurements of the poison material.

JOSEPH OAT CORPORATION
CHEMICAL ENGINEERS & FABRICATORS
NUCLEAR POWER COMPONENTS
ESTABLISHED 1788

Procedures

(a) Dimensional stability is measured by a procedure similar to ASTM D1042, standard method for measuring changes in linear dimensions of plastics.

Fig. 2 illustrates the points where width, thickness and overall length are measured. Measurements are performed with a precision micrometer. Table 1 is the data form for dimensions measurements.

Limitations: The dimensional change should not be more than 2-1/2% of the original.

(b) Hardness: Hardness is measured by a procedure similar to ASTM D2240, standard method of indentation hardness of rubber and plastics by means of a durometer. A measurement of the hardness of the poison material will establish the continuance of physical and structural durability. The actual hardness measurement should be made after the specimen has been withdrawn from the pool and allowed to air dry not less than 48 hours to allow for a meaningful direct correlation with the pre-irradiated sample.

Measurements are performed with a Shore durometer type A-2, 0-100 scale.

Limitations: The hardness value should not be less than 90% of the original value. If the hardness is more than original, it is okay.

JOSEPH OAT CORPORATION
CHEMICAL ENGINEERS & FABRICATORS
NUCLEAR POWER COMPONENTS
ESTABLISHED 1788

Neutron Radiograph of the Poison and Neutron attenuation measurement of the poison

After performing all physical tests, the coupon should be sent to the University of Michigan, Ann Arbor, Michigan or similar testing laboratory. Performance of neutron radiography and attenuation measurements shall be done using University of Michigan Standard Operating Procedures or other specific industry accepted procedures. A neutron radiograph of the poison specimen will allow a determination of the constancy and uniformity of the boron distribution. The attentuation measurement will decide the possibility of its further use. These tests can be directly converted to B_{10} loading. The value of B_{10} loading can be obtained from the laboratory.

Limitations The minimum areal density of boron in boraflex should not be less than 80% of the original requirement (i.e. 80% of .012 = .0096 gm/cm^2).

Any test results exceeding the above specified limitations will require an engineering evaluation in conjunction with the manufacturer (Bisco) to determine acceptability of the poison material.

JOSEPH OAT CORPORATION
CHEMICAL ENGINEERS & FABRICATORS
NUCLEAR POWER COMPONENTS
ESTABLISHED 1788

TABLE 1

SAMPLE	HEIGHT (cm) INITIAL/FINAL/%Δ	WIDTH (cm) INITIAL/FINAL/%δ	THICKNESS INITIAL/FINAL/%δ	HARDNESS INITIAL/FINAL/%Δ
1st Coupon				
2st Coupon				
3rd Coupon				
4th Coupon				
5th Coupon				
6th Coupon				
7th Coupon				
8th Coupon				
9th Coupon				
10th Coupon				
11th Coupon				
12th Coupon				
13th Coupon				
14th Coupon				
15th Coupon				
16th Coupon				
17th Coupon				
18th Coupon				

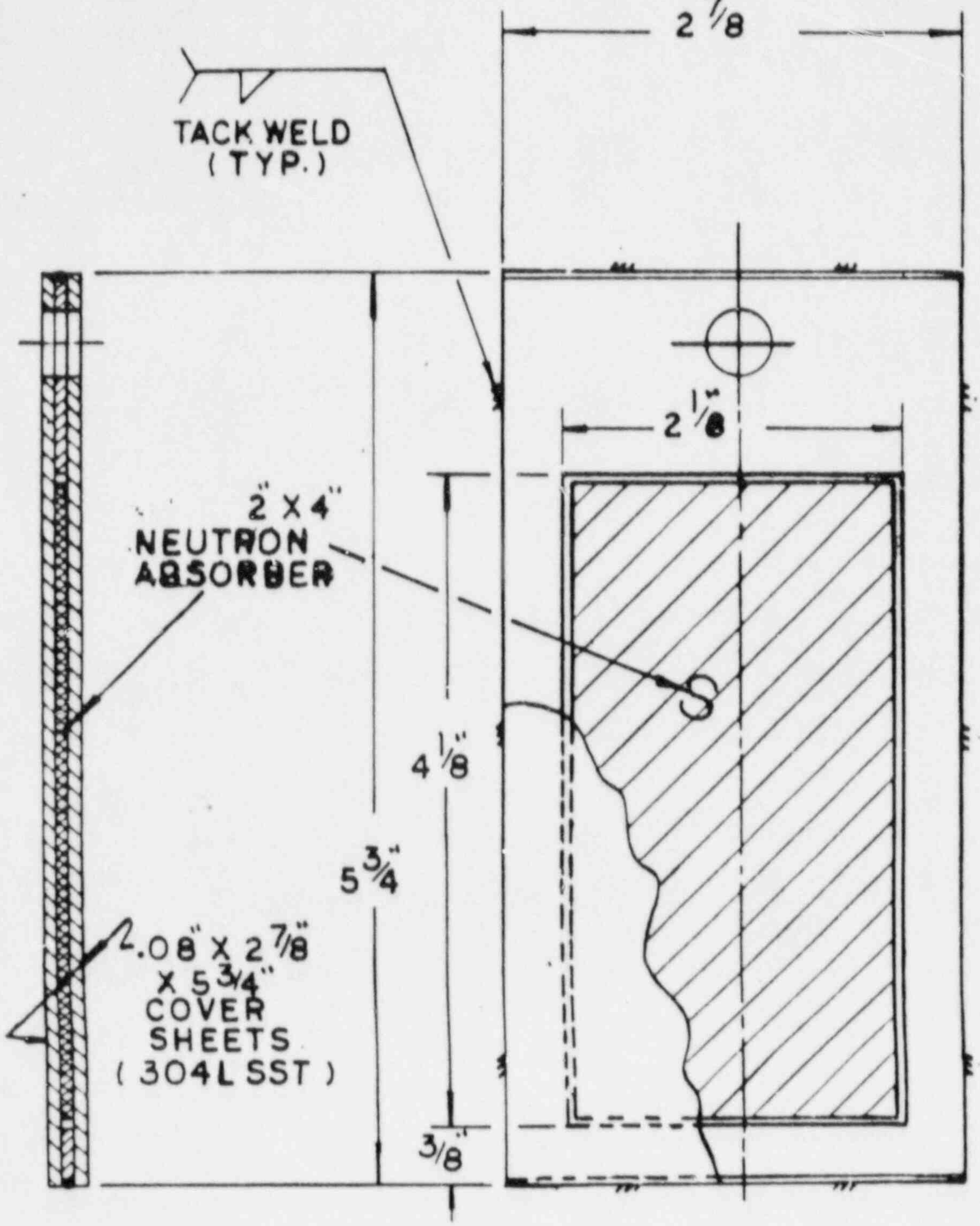

2 7/8"
TACK WELD
(TYP.)
2 1/8"
2" X 4"
NEUTRON
ABSORBER
4 1/8"
5 3/4"
.08" X 2 7/8"
X 5 3/4"
COVER
SHEETS
(304L SST)
3/8"

FIGURE 1

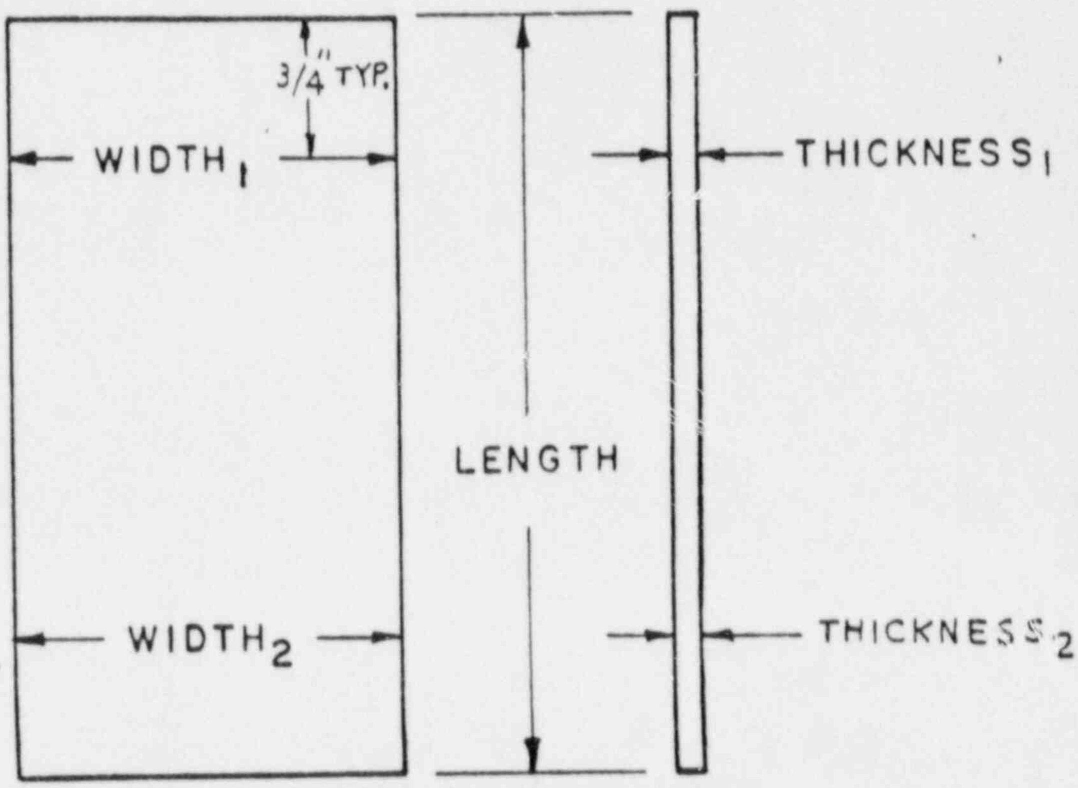


FIGURE 2

DIMENSIONAL STABILITY MEASUREMENTS