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March 18, 1994

Mr. Cass R. Chappell, Section Leader
Cask Certification Section
Storage and Transportation Systems Branch
Division of Industrial and Medical
Nuclear Safety, NMSS
United States Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Response to Letter Dated February 17, 1994

Reference: Docket 71-9019

Dear Mr. Chappell:

This responds to your letter dated February 17, 1994, which requested additional information regarding GE's Consolidated Application dated December 3, 1993, seeking a revision to Certificate of Compliance USA/9019/AF for the Model No. BU-7 shipping container.

The letter also requested additional information concerning two subsequent submittals dated December 14 and 22, 1993, provided by GE at the NRC's request. In this regard, GE emphasizes that the additional submittals dated December 14 and 22, 1993, were not provided to satisfy any applicable regulatory requirement. Rather, GE voluntarily submitted that information solely to assist the NRC in its review of the Consolidated Application.

We have also noted that certain questions, including requests for justification, ask for information beyond that required in the NRC regulations. Nevertheless, GE has sought to cooperate by providing responses to each question. Although, in some cases, the information provided may not be in the level of detail requested, GE believes sufficient information has been submitted to demonstrate compliance with applicable NRC requirements.

Attachment 1 to this letter contains responses to the questions contained in the NRC letter dated February 17, 1994. Attachment 2 to this letter contains page changes to the December 3, 1993, Consolidated

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Application reflecting any revisions needed on the basis of additional information contained in Attachment 1.

As we have previously indicated, GE strongly believes that the BU-7 package meets all applicable NRC regulatory requirements, and that the design and test data contained in the December 3, 1993, Consolidated Application clearly support this conclusion. Indeed, based upon substantially the same information as in the December 3, 1993, Consolidated Application, and as recent as 1988, the NRC concluded, in its Safety Evaluation Report, that the BU-7 package "meets the performance requirements of 10 CFR Part 71", and issued an approval.

Given this recent prior approval, GE's submittal of additional, detailed and sound engineering analyses, results of tests performed on the Model BU-7 and Model BU-J shipping containers to satisfy Japanese registration requirements, and the fact that the packaging design has remained essentially unchanged since 1974, GE knows of no reason why similar approval of the pending application should not be given for the BU-7 container at this time. The imposition during the current review of any requirements beyond those set forth in the regulations would improperly deprive GE of the ability to use shipping containers that have repeatedly been found to comply with the safety requirements of the NRC and foreign authorities.

As you know, the NRC first restricted the use of moderation exclusion and pail integrity for materials enriched above 4% U-235 in June, 1992. Because of the need to continue shipping, GE agreed to these highly conservative restrictive limitations as a temporary and expedient solution. Subsequently, the NRC also required GE to apply these same restrictive limitations to all enrichments 4% U-235 and below in the then upcoming certificate renewal. GE again complied with these restrictive limitations and was forced to purchase and lease hundreds of BU-J containers. These actions have cost, and continue to cost GE over a million dollars and severely affect our ability to participate in the international market.

Approval of the Consolidated Application would remove restrictions that are unwarranted under applicable regulatory requirements, and would be consistent with prior NRC approvals that were based on the same such requirements. In light of the substantial economic hardship imposed on GE by the current restrictions on transport in the BU-7 package, GE requests that the NRC complete the review of this current Consolidated Application as soon as possible.

Ten copies of this response are being provided for use during the review. Should the NRC have any questions regarding this matter, please contact me at (910) 675-5656.

Sincerely,

GE NUCLEAR ENERGY

C. M. Vaughan

C. M. Vaughan, Manager
Regulatory and EHS

Enclosures

cc: Mr. Charles J. Haughney (w/enclosure)
Mr. Carl J. Paperiello (w/o enclsoure)

ATTACHMENT 1

Structural

1. **The buckling analysis of the inner container (supplement dated December 14, 1993) shows a margin of only 15% against buckling under 21 psi external pressure. Section VIII of the ASME Code would require a thicker shell to resist 21 psi external pressure, and Section III of the Code would require a safety margin greater than 15% against buckling. The ASME Code applies to quality vessels, whereas the BU-7 inner container is not designed, fabricated, or inspected to the same standards as vessels which meet the ASME Code. Further, the buckling analysis does not account for possible deterioration of the container during service (note that most of the packages in use are at least 10 years old). Justify that the BU-7 containment system has an adequate margin of safety against buckling. Specify the code or standard used for design of the containment vessel of the BU-7 package. Show that this code or standard allows a margin of safety as small as 15% against buckling, and justify that this code or standard is appropriate to use for the containment system in the Model BU-7 package. Note that the integrity of the containment system is relied upon to ensure criticality safety under accident conditions.**

Section 71.31 requires that an application contain (1) a package description as required by § 71.33; (2) a package evaluation as required by § 71.35; (3) a Quality Assurance (QA) program description as required by § 71.37; and (4) an identification of the proposed fissile class.

The package description required by § 71.33 is provided in Section 2 of the BU-7 Shipping Package Consolidated Application (December 3, 1993).

With respect to package evaluation, § 71.35(a) requires a demonstration that the package satisfies the standards specified in Subparts E and F. Nothing in those regulations requires that an applicant provide structural design calculations. Instead, it is clear that the applicant is simply required to show that his package satisfies the tests specified in the regulations. For example, § 71.43(f) requires that a package "be designed, constructed and prepared for shipment so that under the tests specified in § 71.71 (Normal Conditions of Transport) there would be no loss or dispersion of radioactive contents, no significant increase in external radiation levels, and no substantial reduction in the effectiveness of the packaging." The key regulatory requirement is § 71.41, "Demonstration of Compliance," which specifically states "(a) The effects on a package of the tests specified in § 71.71 (Normal Conditions of Transport) and the tests specified in § 71.73 (Hypothetical Accident Conditions) must be evaluated by subjecting a sample package or scale model to test...." (emphasis added). This is precisely the package evaluation contained in Section 3 of the Consolidated Application.

With regard to § 71.73, GE maintains a quality assurance program for radioactive material shipping packages as approved under Docket 71-0254 dated October 5, 1989.

Thus, the Consolidated Application contains all of the information regarding structural adequacy of the BU-7 package needed to satisfy NRC regulatory requirements. Similar information was found fully acceptable by the NRC in its initial approval of the BU-7 package on August 6, 1974, and in subsequent approvals, including the Safety Evaluation Report issued on March 23, 1988.

The buckling analysis submitted by GE on December 14, 1993, was not provided to satisfy any applicable regulatory requirement. NRC reviewers had questioned whether the package was sufficiently robust to be leak tight so that moderation exclusion could be assumed in the criticality analysis. For regulatory purposes demonstration of such robustness was conclusively made through compliance with the tests specified in 10 CFR Part 71. However, since GE had performed a buckling analysis that was supportive of the acceptable test results and observed performance to date, GE was pleased to volunteer that information to the NRC, as we also volunteered the test data on 424 BU-7 18-gauge inner containers tested in 1982/83.

It should be further emphasized that the regulations do not require that a transportation package be designed or fabricated to ASME Code standards for vessels or to any other specified code or standard. Nor do they require that a buckling analysis be performed in accordance with the ASME Code standards for vessels or to any other code or standard. The ASME Code is intended for pressure retaining components and does not apply to transportation packages. It is thus inappropriate to evaluate the results of the buckling analysis against ASME Code standards or any other code or standard.

The buckling analysis for the 18-gauge inner container provided in Attachment A of our December 14, 1993, letter was performed using ANSYS which is a nuclear industry code used in nuclear power plant structural buckling evaluation. The ANSYS finite element analysis is accepted by the NRC for reactor related calculations and by ASME. Our calculations were based on Newton-Raphson techniques and employed the STIF63 shell elements for the 18-gauge inner container buckling model. The calculations are rigorous, yet conservative, and well base-lined in the nuclear industry.

The regulations require the package to withstand a water pressure equivalent to immersion under a head of water of at least 50 feet (21 psig) for not less than 8 hours. The buckling analysis demonstrates that there is a minimum margin of safety of 15% against buckling of the 18-gauge inner container over and above the regulatory requirement. In view of the regulatory requirements and of the rigorous and conservative nature of the analysis, as shown above, these results provide additional support for the evaluation in the application (based on the required tests) that the package satisfies the requirements of the regulations.

With particular regard to leak-tightness of the inner containers of the BU-7 package, as shown in Table 3-2(5) of the Consolidated Application, GE satisfied the NRC regulatory requirements of an immersion test of a single container [10 CFR 71.73(c)(5)]. Not only did the buckling analysis demonstrate that the inner container would satisfy such test, but additional supporting data is available in the information submitted in Attachment C to our December 14, 1993, letter. This documents that in 1982/83, 424 18-gauge inner containers for BU-7 packages satisfactorily passed a hydrostatic test at 21.4 psig as part of GE's program to register the BU-7 packages in Japan. Such additional data, although not required by NRC regulations, provides additional confidence in the leak-tightness of the BU-7 packages.

Question 1 includes a comment that the buckling analysis does not account for possible deterioration of the container during service. Just as the structural adequacy tests required under 10 CFR Part 71 are performed with new containers, the buckling analysis was performed using characteristics of a new container. The regulations do not require that the structural adequacy tests be performed again during the service life of the containers. It is apparent that the regulations rely upon the conservative structural adequacy demonstrated by satisfying the required tests before initial use, together with appropriate maintenance procedures and visual inspection before each use, to assure that the package will remain structurally adequate throughout its service life. Since the buckling analysis was intended to support the fact that the necessary structural adequacy existed before initial use, attempting to account for theoretical deterioration during service life would not be warranted or appropriate.

Structural

2. **For the 30-foot drop test, the BU-7 package was dropped on its top closure ring at approximately 45°. The closure ring was deformed on impact, and there was a slight opening of the drum lid. The subsequent puncture test was performed such that the package lid impacted the pin at a location away from the damaged area. The puncture test does not appear to have been performed in the orientation which would cause maximum damage to the package closure. The performance of the containment system (i.e., the ability of the inner container to exclude water) depends on the condition of the gasket after the fire test. The condition of the gasket after the fire test depends on the drum remaining closed. (Note that the insulating foam is charred all the way to the gasket after the fire test, as shown in Figures 35 and 36 of Appendix B of the application.) Justify that the 30-foot drop and puncture tests were performed in the most damaging orientation with respect to maximizing damage to the closure from the puncture test, and subsequently to the gasket from the fire test. Alternatively, perform additional 30-foot drop, puncture, and fire tests of the BU-7 package. The 30-foot drop and puncture tests should be performed in the orientation which produces maximum cumulative damage to the package closure.**

With regard to the Hypothetical Accident Condition tests in the BU-7 Test Report dated April 25, 1980, and submitted as required by regulation, two containers were subjected to the free drop and puncture tests (K-1878 and K-0174). The GE testing engineer decided to perform tests on two BU-7 packages (rather than testing a single package, as permitted by the regulations) in order to be able to perform the drop-test at differing orientations, thus providing additional assurance of testing package performance with maximum damage.

GE has re-evaluated the test information and interviewed the engineer who conducted the tests, and continues to believe that the tests were performed properly and to the requirements of § 71.32(a) and (c)(1) & (2) including the concept of cumulative damage.

Question 2 seems to be focused on whether the puncture test on package No. K-1878 was performed in the most damaging orientation, taking into account the damage to that package resulting from the 30-foot drop test. The following explanation for the selected orientation was developed using information obtained from the test report, test notes and engineers including the test engineer.

As the NRC is aware, the puncture test consists of a 40-inch (1 meter) drop onto a steel bar which does not produce a large amount of energy (1,233 ft-lbs versus 11,098 ft-lbs in the 30-foot drop). Therefore, given the design of the container, virtually all of the energy must be absorbed by the container to produce the maximum damage. The orientation, therefore, must provide for a direct impact rather than a glancing blow which dissipates the energy. Most of the surfaces and features of the BU-7 package are such that impacts on them would produce glancing types of collisions and the energy would not be transferred in any appreciable quantity to the container.

The test engineer was consulted to determine the decision process used to select the location for the penetration test. The engineer recalled and produced notes from preliminary testing work done March 10-13, 1980, describing four BU-7 containers which were challenged by several tests including the puncture test using both a sharp cornered and a rounded corner impact spike. Strikes from several different angles and to several different surfaces, including the closure ring and bolt, were completed. Based on all this information, the only type of strike which produced increased damage to the package were those strikes to the thin flat surfaces.

The preliminary test data as well as the damage to package No. K-1878 from the 30-foot drop test (Figures 11-14, Appendix B, Consolidated Application dated December 3, 1993) was considered in selecting the orientation and location of the puncture test on that package. While there was a slight opening of the cover where the closure ring of No. K-1878 was deformed, it should be noted that the closure and closure ring showed no sign of near failure. Thus, orienting the puncture test for No. K-1878 so that the deformed portion of the closure ring would hit the steel bar at an angle would not have absorbed as much energy and thus would not have been expected to cause as much damage to the container as was the case observed in preliminary tests.

In selecting a flat surface location for performance of the puncture test, it should be noted that, at the location of the deformed closure ring, the flat drum top surface is gently warped in such a manner that it would serve as an impact limiter in the collision, thereby reducing the ultimate damage. There was no crimping or metal tear or stretching that would indicate a special weakness in the already damaged location. Accordingly, the engineer selected a location away from this region because data from the preliminary tests indicated that the maximum damage would be produced by a strike on the flat thin surface and that such maximum damage was appropriate in evaluating the cumulative effect.

In evaluating the effects of the puncture tests (Figures 18 and 19, Appendix B, Consolidated Application dated December 3, 1993) the engineer found a slight indentation of only about 1/4" depression in both containers. This represents very minor damage and, as can be seen, there is no indication that the puncture test produced conditions that degraded the container's ability to withstand the sequence of tests. With the minor amount of energy involved, as evidenced in the photographs, it is reasonable to conclude that more serious damage would not have been done by dropping the container in other orientations or locations as suggested and the preliminary test data serve to reinforce this fact.

The NRC has not found error with the test during past reviews. In the March 23, 1988, Safety Evaluation Report, Section D, the NRC specifically addressed consideration of the cumulative effects of the hypothetical accident conditions and found the tests and results acceptable. In addition, it should be noted that, in this Safety Evaluation Report the NRC stated (at p. 5) that the "staff compared the results of similar shipping packages drop tested 30-feet in different orientations with the Model No. BU-7 package and concluded that different drop orientations would not result in the loss of structural integrity for the Model No. BU-7 package."

General Electric strongly believes that the test results that have been found adequate in the past continue to be adequate and that no further testing or justification pursuant to § 71.71 or § 71.73 is required.

Structural

3. The application (supplements dated December 14 and 22, 1993) discusses hydrostatic tests that were performed on BU-7 and BU-J packages. The application is not clear with respect to the details of the tests. Revise the application to clearly address the following:

   (a) Provide details of the hydrostatic tests performed on the BU-7 package. Include the package configuration, test setup, and package closure method.

   (b) State whether the packages were newly fabricated or were packages which had been in service. Justify that the tests are representative of packages which are at the end of their service life.

   (c) State how many specimens of each package type (BU-7 and BU-J) were tested. Note that Appendix B of the application dated December 3, 1993, states that only one BU-7 specimen was tested.

   (d) Describe how the pass/fail demonstration was made.

(e) State how many specimens of each package type failed the test.

(f) Explain how the tests conducted on the BU-J package are relevant to the BU-7 package, considering any differences in the design, the dimensions, or the materials of construction.

(a) The BU-7 hydrostatic tests discussed in GE's December 14 and 22, 1993, submittals were performed to satisfy Japanese registration needs, not NRC requirements. They were provided to the NRC as further substantial evidence of the 18-gauge inner container's leak tight design.

Figure I attached defines the test set-up showing air supply valves, pressure gauge, water supply location, vent, configuration, etc. The package component tested in each case was a newly constructed 18-gauge inner container fitted with the specified 3/16" thick, 1-1/2" wide steel flange. Closure of the 3/16" thick steel lid was accomplished using a gasket and twelve 5/16-18 carbon steel bolts as specified for the package. The tests were performed on 18-gauge inner containers at a minimum pressure of 21.4 psig for 8 hours. In passing the test, there was no visual water in-leakage.

In the same submittals GE provided information on immersion tests on BU-Js performed by the Saito Company for Japanese Nuclear Fuel (JNF) in Japan to meet Japanese registration requirements. Figure II attached summarizes the Japanese test set-up that JNF reported to GE. The tests are identical to the tests performed for the BU-7s except that the Japanese test set-up accommodates up to eight containers per test. Japan performs 100% leak tightness tests for all BU-Js.

GE does not believe that it is appropriate or necessary to incorporate data generated in satisfying Japanese registration requirements in GE's application for NRC certification since regulations do not require such data. This test data does, however, provide supplementary support for GE's claim of leak tightness for, and the NRC's approvals of, the BU-7's leak

FIGURE I

BU-7 TEST CONFIGURATION

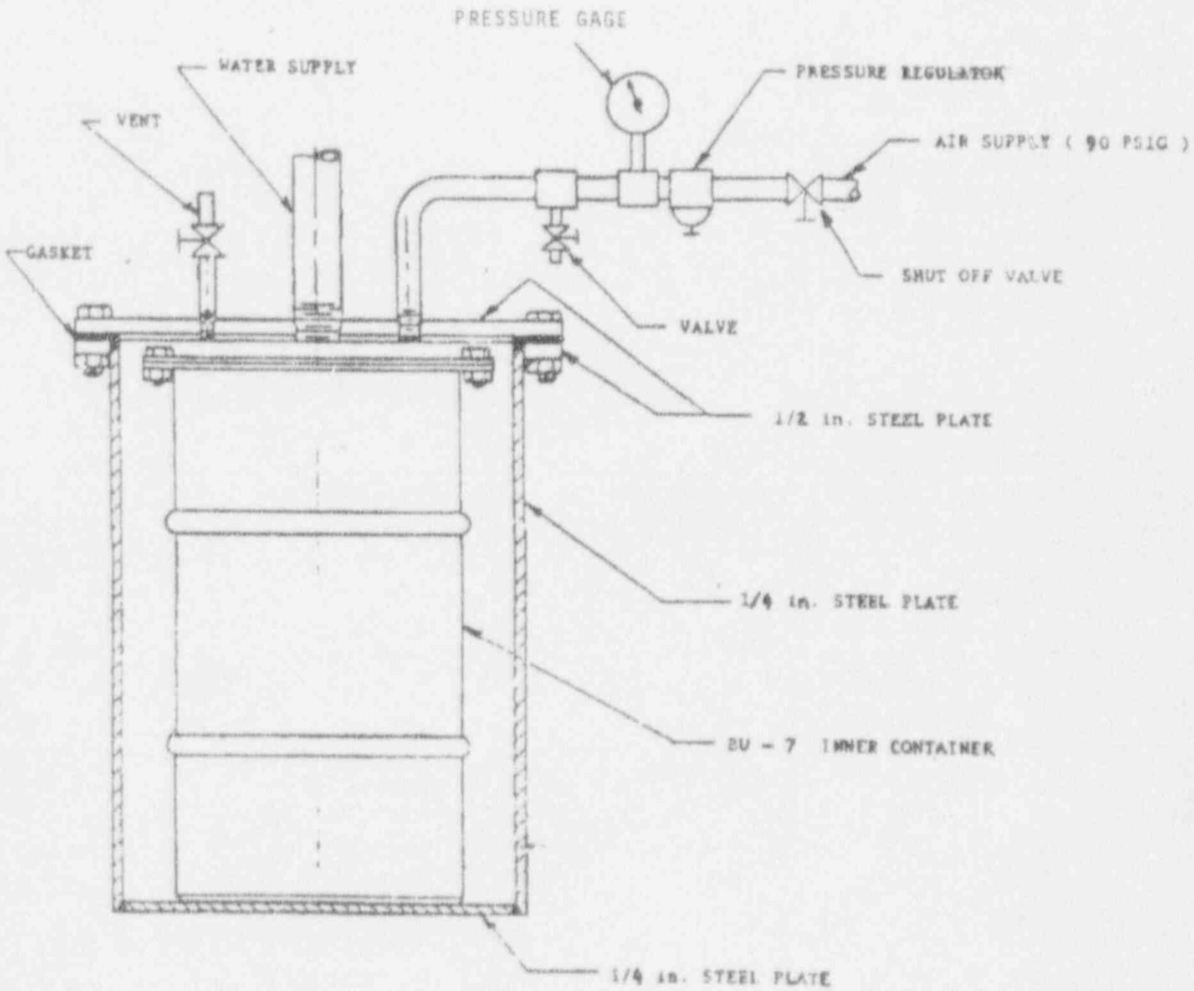
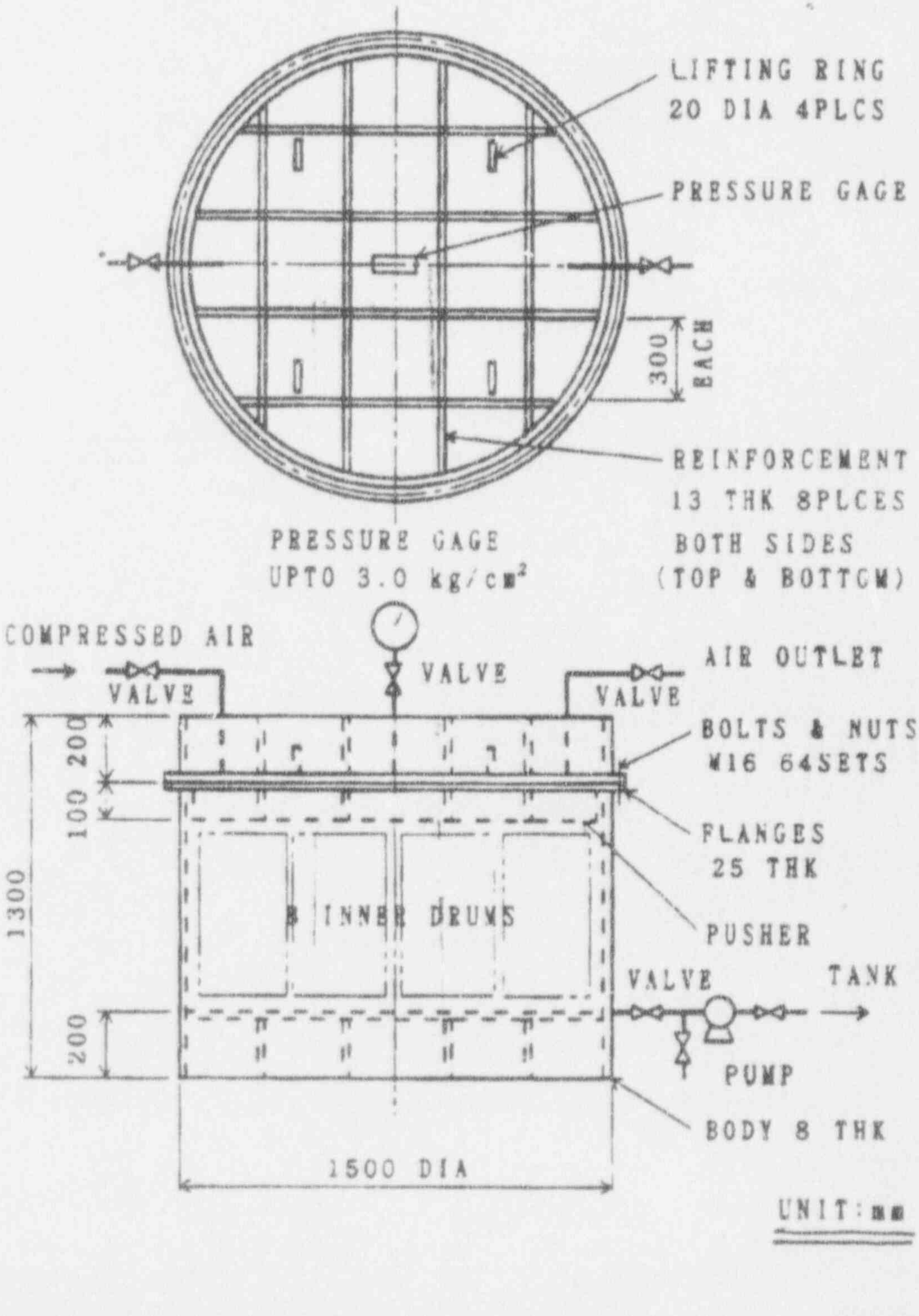


FIGURE II

BU-J TEST CONFIGURATION



TANK for BU-J Pressure Test

tightness as stated in the SERs attached to the Certificate of Compliance.

(b) The hydrostatic tests discussed in GE's December 14 and 22, 1993, submittals were performed to satisfy Japanese registration needs, not NRC requirements.

Notwithstanding the reason for the testing, all tests were performed on new 18-gauge inner containers as specified in § 71.73(c)(5).

As described in the response to Question 3(a), the hydrostatic tests performed for purposes of Japanese registration were the functional equivalent of the immersion tests performed for purposes of NRC certification under § 71.73(c)(5). That NRC regulation explicitly requires that the immersion test be performed with an undamaged container and does not require that justification be provided that the test is representative of packages which are at the end of their service life. It is apparent that the regulations rely upon the conservative leak tightness demonstrated by satisfying the required test before initial use, together with appropriate maintenance procedures and visual inspection before each use, to assure that the inner container will remain leak tight throughout its service life. Thus, the hydrostatic tests performed on new BU-7 and BU-J containers for purposes of Japanese registration requirements provide additional support for confidence in the leak tightness of BU-7 containers throughout their service life, just as the immersion test performed on new containers under § 71.73(c)(5) provide such confidence, when coupled with appropriate maintenance procedures and visual inspection. The maintenance and visual inspections for the BU-7 packages have been performed in accordance with GE programs approved by the NRC. See March 23, 1988, Safety Evaluation Report, pp. 8-9.

(c) Appendix B of the December 3, 1993, application addresses the BU-7 tests that were performed to satisfy NRC certification requirements for BU-7 packages in accordance with the applicable provisions of 10 CFR Part 71 in effect at that time. The number, identity, and tests are summarized in Section 2.1 and detailed within the report.

GE's submittals of December 14 and 22, 1993, provided BU-J test information and the BU-7 test data for registration in Japan. This information was provided over and above any NRC requirements to assist in the NRC's evaluation and general demonstration of the leak-tight nature of the container design.

424 BU-7s were satisfactorily tested as part of GE's registration of the BU-7 package in Japan. Japanese authorities accepted these test results as sufficient for registration of these BU-7 packages.

GE also has records of satisfactory hydrostatic test results for 1280 BU-J packages. GE recently purchased 431 BU-J packages that were tested as part of this group. GE does not know the total number of BU-J packages that have been satisfactorily tested in Japan, but it has been reported that every BU-J package is tested before registration can be obtained.

The results of these Japanese tests on large numbers of BU-7 and BU-J containers serve to reinforce the validity of GE's design calculations and test results.

The tests performed to meet 10 CFR Part 71 requirements for NRC certification of the BU-7 package are described in Appendix B of the December 3, 1993, application. Attached to Appendix B is Appendix 3 "Test Report BU-5 and BU-7 Container Pressure Test" dated February 10, 1978, which discusses the 50-foot immersion test. A visual examination for moisture was used.

(d) The hydrostatic tests discussed in GE's December 14 and 22, 1993, submittals were performed to satisfy Japanese registration needs, not NRC requirements. A visual examination for moisture was used and failure was defined as a visual indication that water was present in the inner container.

(e) The objective of the tests described in GE's December 14 and 22, 1993, submittals was to verify that inner containers did not leak and then pass them on to fabrication. As a result, GE did not establish a procedure to record any leaking BU-7 inner containers and does not have any documentation of leaking containers. Similarly, GE's records of tests of BU-J containers does not mention any failures. Questioning those involved with the tests of the BU-7 containers bring no recollection of failures.

(f) The BU-7 hydrostatic test results discussed in GE's December 14 and 22, 1993, submittals were performed to satisfy Japanese requirements which are similar to those found in § 71.73(c)(5) dealing with immersion to the equivalent of 50 feet in water.

The BU-7 and BU-J 18-gauge inner containers are nearly identical as can be seen in Figure III attached. Both the BU-7 and BU-J use an 18-gauge minimum steel drum with two rolling hoops. The drum dimensions are near identical. The closure flange and lid are identical except for the size of the bolt closure holes and weld nuts. The closure bolts for the BU-7 are 5/16-18 (.313") carbon steel and for the BU-J are 8 mm (.315"). The BU-7 uses a silicone gasket with detailed specifications to assure its quality. The BU-J specifies only 3mm butyl rubber. The BU-7 closure procedure specifies prescribed torque requirements whereas the BU-J is silent on this point.

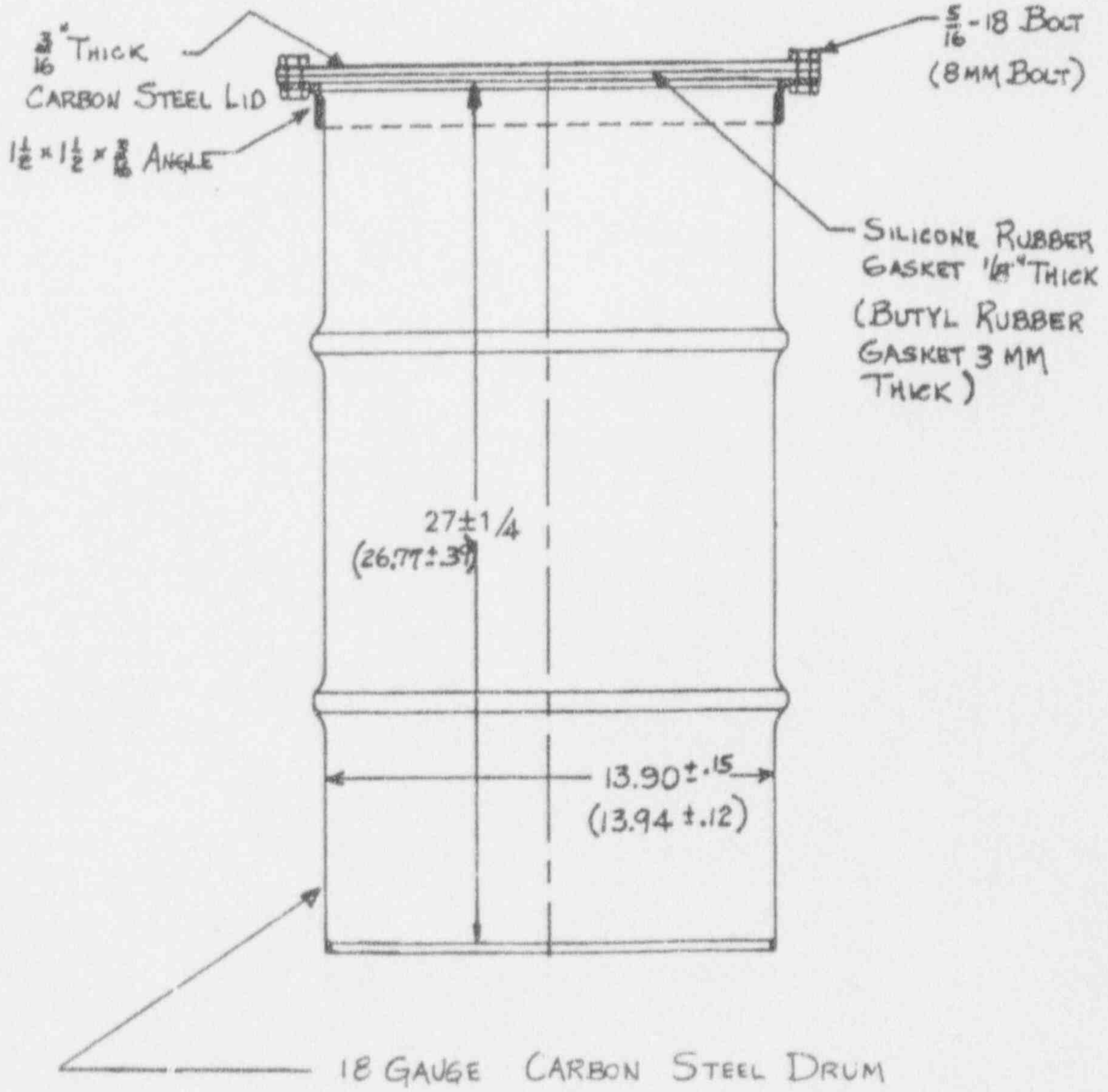
Since the BU-7's design, dimensions, and materials of construction of the 18-gauge inner container are equal, or in some cases, superior (i.e., gasket and closure torque), and the tests are performed to the same specification, it is clear that the BU-J testing is mutually supportive in the area of leak tightness of the 18-gauge inner container.

Structural

4. **Figure No. 10 in Appendix B of the application is incorrectly labelled. It does not appear that this is a photograph of drum No. K-1878 (see, for example, Figure No. 11 in the same appendix). In Figure No. 10, the bolt which secures the drum locking ring appears to be broken. Provide a description of the damage sustained by this bolt. If possible, provide an additional photograph which clearly shows that the bolt did not break due to the 30-foot drop test.**

FIGURE III

BU-7/BU-J INNER CONTAINER COMPARISON



NOTE: BU-J DIMENSIONS, IF DIFFERENT FROM BU-7, ARE SHOWN IN ( ).

GE has reviewed the report and it appears that Figure 10 is incorrectly labeled. Figure 10 more closely represents the damage done to the top of K-0174 (see Figure 18) and the report has been modified accordingly. Figures 11, 12, 13, and 14 allow easy identification as K-1878.

Figure 10 shows no breakage or damage to the closure bolt and the test engineer interviewed recalls none. The darkened area in question is a shadow as can be seen from the lighting in the photograph (cf the point of the closure ring at the nut location). In support of this position, GE has located two additional photographs from the photo sequence of the bolt on container K-0174 which more clearly show from two different perspectives that the bolt is not damaged. The photographs are enclosed and are being incorporated into the test report (Figures 10A and 10B) to avoid the ambiguity generated by Figure 10.

Criticality

1. **The structural analysis of the product pails (Attachment B of supplement dated December 14, 1993) is not sufficient to show that the pails can reliably confine uranium oxide powder. Note that Figure 37 of the application clearly shows damage to the closure and deformation of the lid of the 5-gallon product pails following the accident test sequence. Note also that there are no test results available for the 3-gallon product pails. Revise the criticality analyses to consider that the uranium oxide powder may be released from the product pails under accident conditions.**

The analysis presented in Appendix B of the supplement dated December 14, 1993, clearly demonstrates from an engineering standpoint that the product pail will contain the powder. The calculations included as Appendix B to our letter of December 14, 1993, CM Vaughan to CJ Haughney, were performed using first principles of engineering and standard formulas. GE knows of no deficiency in this analysis nor has the NRC identified any.

Notwithstanding the analysis, Figures 35, 36, 37, and 38 demonstrate the integrity of the 5-gallon product pails after the required test. There is no failure of the containment that would suggest a failure important to criticality safety under the terms of the safety analysis. Additionally, the test engineer recalls that, while there were some dents and deformation of the pails, the lids remained tight in all test cases.

The three-gallon pail is dimensionally identical to the five-gallon pail except that it is approximately 5 inches shorter than the five-gallon pail. Therefore, from a buckling standpoint, the three-gallon pail is stronger than the five-gallon pail since the maximum allowable stress is inversely proportional to pail height.

Criticality

2. Describe the method for benchmarking GEMER and identify the critical experiments used. Show that the biases presented in the application (including a bias of zero in cases where the code over-predicts k_{eff}) are proper and conservative for each of the H/U-235 ratios.

This information has already been supplied to the NRC Transportation Branch in a separate submittal dated May 23, 1990, related to the UNC-2901 package, NRC Certificate Number 6294.

With regard to bias, GE treats bias correctly. Where K_{eff} is underpredicted, the bias and the uncertainty are added to the result. Where K_{eff} is overpredicted, our current policy is not to apply a correction; which if applied, would in effect increase the maximum K_{eff} permitted in the analysis.

Operating Procedures

Specify the steps that will be taken for each shipment to verify that the product pails and inner container have been properly closed. Include a leak test to demonstrate that each inner container, as assembled for shipment, is water-tight. Specify the test method, the maximum acceptable leak rate, and the sensitivity of the leak test.

GE's program to ensure that package closure requirements are properly completed before shipment includes elements of the acceptance testing program, maintenance program, and operating procedures.

In order to assure that 18-gauge inner containers have been properly closed, the first requirement is that they satisfy NRC design, fabrication and associated acceptance testing requirements relating to leak-tightness. Under NRC regulations, this is demonstrated by subjecting a separate undamaged specimen to external water pressure of at least 21 psig for at least 8 hours in accordance with § 71.73(c)(5). As discussed in Table 3-2(5) of the Acceptance Tests portion of the Consolidated Application and as detailed in Appendix 3 to Appendix B of the application in a Test Report dated February 10, 1978, this immersion test was successfully performed. In addition, as discussed in the answer to Q-3, "Structural", GE has records showing that a substantial equivalent of the immersion test was also performed successfully with 424 BU-7 inner containers and at least 1,280 BU-J inner containers. Moreover, prior to first use of each 18-gauge inner container, GE has ascertained "that there are no cracks, pinholes, uncontrolled voids or other defects which would significantly reduce the effectiveness of the packaging..." in accordance with § 71.85(a). This included a submerged bubble pressure test at a minimum of 15 psig, as described in Section 5.2.1 of the Consolidated Application.

The product pails are not considered as a leak tight container as defined in § 71.73(c)(5) and § 71.85(a). Their function is to hold the authorized contents, UO_2 powder, etc.

The second set of requirements for proper closure is intended to assure that a properly designed and fabricated container has been appropriately maintained after initial use. This subject is covered by the Maintenance Program as described in Section 5.3 of the Consolidated Application dated December 3, 1993. The Maintenance Program for the 18-gauge inner container covers welded flange integrity, cleanliness and paint, gasket sealing surfaces, gasket inspection and replacement, bolt threads and holes. The Maintenance Program is not relevant to the product pails since they are a single trip container.

The third set of requirements for proper closure, is intended to assure that appropriate practices are used in closing the containers prior to each shipment. This subject is covered in the Operating Procedures described in Section 5.1, of our Consolidated Application dated December 3, 1993. Loading and closure is specifically addressed for the pails (5.1.1), the 18-gauge inner container (5.1.2) and final packaging and mechanical closure (5.1.5). All these elements cover configuration, container integrity, sealing surfaces, and closures, including torque and sealing requirements at key points. They fully satisfy the requirements of § 71.87(f) that prior to each shipment, the licensee determine that "the package has been loaded and closed in accordance with the written procedures."

GE believes this program to be well designed to ensure that containers are properly closed. The program has been highly effective in preventing improperly closed packages from leaving the site.

The same subject was evaluated by the NRC in the March 23, 1988, Safety Evaluation Report and found to be acceptable referencing Sections 5.1, 5.2, and 5.3, and including Condition 3 of the SER dealing with Acceptance Testing (5.2) and Maintenance Program (5.3).

There is no requirement in NRC regulations that each inner container be leak-tested for water-tightness before each shipment. As described above, the regulations require that a separate, undamaged specimen satisfy the immersion test of § 71.73(c)(5) and that all packages meet § 71.85(a) before first use. Not only is subjecting each inner container to a leak test for water tightness before each use not required, but it would be infeasible to do so for an assembled package. Subjecting such package to an immersion test would be the equivalent of destructive testing. Even though the inner container would not leak, the insulation between the inner container and the outer container would be ruined.

Acceptance Tests

1. **Describe the method used to leak test each inner container before its first use. Specify the sensitivity of the leak test and the criteria for accepting the inner container. Include a sketch of**

the test set-up. Note that the leak test should be performed on the containment system as assembled for shipment, that is, all components of the containment system (drum, lid, and gasket) should be the components actually used for shipment. Also, the leakage flow direction during testing should be the same as in operation, i.e., into the inner container. Test methods using flow in the reverse direction should be justified.

The method used to leak test the inner containers prior to first use is described in Section 5.2.1 of the Consolidated Application. This test involves submerging in water the inner container under 15 psig internal pressure for at least one minute. During this time the container is observed for visible bubbles to determine whether any leaks exist. A sketch of the test set-up is attached (Figure IV).

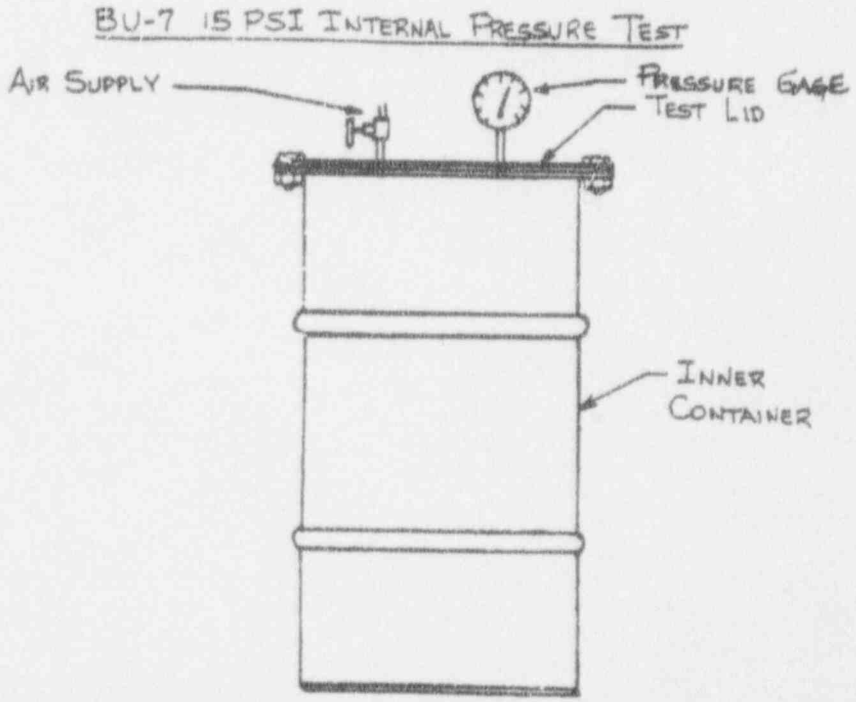
Leak testing prior to first use on each containment system as assembled for shipment (i.e., inner container, lid, gasket) is not required by the regulations. Neither do the regulations require consideration of, among other things, leakage flow direction when conducting the tests. § 71.85(a) provides that prior to first use of any packaging "[t]he licensee shall ascertain that there are no cracks, pinholes, uncontrolled voids, or other defects which could significantly reduce the effectiveness of the packaging...." The acceptance test performed by GE and set forth in Section 5.2 of the Consolidated Application clearly meets this requirement. In addition, the NRC found this testing acceptable (page 9) in its March 23, 1988, Safety Evaluation Report. Further, as noted above in GE's response to the NRC's question regarding "Operating Procedures," conducting such a leak test prior to shipment on existing "containment systems as assembled for shipment" would amount to a destructive test.

Acceptance Tests

2. **The criticality analysis considers the presence of boron in the phenolic foam insulation. Revise the acceptance tests to include verification that boron is present and evenly distributed within the foam. State the criteria for accepting the foam.**

GE has modified the acceptance criteria to include the requirement to verify the boron content in the foam. The acceptance criteria has been

FIGURE IV



TEST PROCEDURE:

1. COMPLETED INNER CONTAINER IS FITTED WITH A SILICONE RUBBER GASKET AND TEST LID BOLTED IN PLACE.
2. THE INNER CONTAINER IS PRESSURIZED TO 15 PSI WITH AIR AND THE VALVE CLOSED TO RETAIN THE PRESSURE.
3. THE INNER CONTAINER IS PLACED IN AN OPEN TANK OF WATER AND ROTATED TO EXAMINE THE GASKET AND FLANGE TO DRUM WELD, LONGITUDINAL WELD SEAM, AND BOTTOM ROLLED EDGE FOR LEAKS.
4. NO BUBBLES ARE ALLOWED FROM ANY EXTERIOR SURFACE.

established as ensuring a minimum value which exceeds the value in the criticality analysis by a minimum of 33% (i.e., this allows credit for no more than 75% of the boron verified as present in the foam). This acceptance shall only apply to packages fabricated after this approval is granted.

In 1993 the boron content of the foam was determined by destructive analysis for the current fleet of BU-7 containers. The sample plan incorporated three samples circumferentially at the top 1/3 (A1-3), mid 1/3 (B1-3), and lower 1/3 (C1-3) and a tenth sample from the bottom region. The results for the 29 BU-7s evaluated are reported in Table I (attached). The average value is 2.64 weight percent boron with a high value of 5.6% and a low value of 1.24%. This confirms that the boron content is typical of the specification used to make the foam even though it does not precisely match the value of 3.2% mentioned as nominal in specification (SP-9). The values are also far in excess of the 0.16 weight percent boron used in the criticality calculations to demonstrate safety.

Maintenance Program

1. **Revise the maintenance program to include procedures for ensuring the reliable performance of the inner container as a water-tight containment system throughout its entire service life. These procedures should be performed annually and should include:**

   a. **A leak test which verifies that the inner container remains water-tight.**

   b. **Verification that the inner container welds, inner surface, and outer surface are free of corrosion, cracks, and other damage which could compromise the water-tightness of the package.**

2. **Revise the maintenance program to include annual inspection of the phenolic foam insulation. The annual inspection should include verification that the foam has not retained moisture, that the foam has not deteriorated, and that the boron content is within acceptable limits.**

TABLE I

BU-7 Boron Sampling Results

(wt% B)

DRUM S/N	A1	A2	A3	B1	B2	B3	C1	C2	C3	4	Average	Std. Dev.	Count
258	2.83	2.37	2.30	2.29	2.48	2.79	2.45	2.69	2.55	2.53	2.53	0.19	10
361	2.66	2.63	2.57	2.79	2.58	2.67	1.80	2.37	2.39	2.47	2.49	0.28	10
374	3.20	2.81	2.76	2.89	2.73	2.79	2.66	3.12	2.45	2.59	2.80	0.23	10
484	3.41	3.41	3.11	2.29	3.46	2.76	2.19	2.36	2.21	2.55	2.78	0.53	10
553	2.53	2.45	2.45	2.73	2.39	2.16	2.32	1.66	2.73	2.81	2.42	0.34	10
672	2.78	2.03	2.21	2.55	2.86	2.03	2.46	2.69	2.07	2.08	2.38	0.33	10
1240	2.05	1.51	1.78	1.65	1.61	1.64	2.02	1.96	2.33	1.73	1.83	0.25	10
1585	1.99	1.79	2.27	1.99	2.11	4.25	1.63	1.54	1.54	2.51	2.16	0.80	10
1774	3.98	4.72	4.79	5.04	4.70	4.59	5.04	4.96	2.69	3.17	4.37	0.82	10
1951	2.28	2.04	1.98	1.75	1.97	2.15	2.82	1.83	1.79	1.52	2.01	0.36	10
1989	1.94	1.76	1.76	1.90	1.82	1.76	1.89	1.73	1.72	1.92	1.82	0.08	10
2911	2.45	2.29	2.50	2.40	2.15	2.25	2.50	2.51	2.55	2.63	2.42	0.15	10
3083	2.78	2.11	2.70	2.30	2.08	2.28	2.07	2.63	2.55	2.44	2.39	0.26	10
3151	2.76	2.32	2.25	2.67	2.72	2.69	2.68	2.51	2.60	2.20	2.54	0.21	10
3240	2.90	2.47	2.43	2.90	2.39	2.58	2.44	2.24	2.23	2.27	2.49	0.24	10
3483	1.31	2.58	2.21	1.64	2.75	2.09	2.05	2.37	2.99	3.13	2.31	0.58	10
6016	2.30	1.51	1.94	1.95	1.98	1.48	2.06	2.08	1.62	1.88	1.88	0.26	10
6190	1.38	1.38	1.33	1.54	1.41	1.24	2.15	2.22	2.13	1.91	1.67	0.39	10
6238	2.47	2.50	1.85	2.39	1.97	1.77	2.11	2.25	2.33	1.90	2.15	0.27	10
6573	2.02	2.23	1.64	3.08	3.06	3.56	2.01	2.89	1.77	2.59	2.49	0.65	10
6672	2.19	1.52	2.4	3.1	1.96	1.66	2.88	3.1	2.54	2.67	2.40	0.56	10
6733	3.55	3.65	5.6	5.36	3.67	4.29	2.23	2.57	2.76	3.57	3.73	1.11	10
6812	2.49	2.55	2.25	2.80	2.23	3.04	3.20	2.85	2.27	2.47	2.62	0.34	10
7101	3.84	3.34	3.28	3.29	3.69	4.16	3.95	3.83	3.91	1.80	3.51	0.67	10
7113	3.74	3.68	3.70	3.82	3.54	3.91	3.98	3.86	3.53	4.45	3.82	0.27	10
7334	3.31	3.31	3.44	2.28	3.25	2.96	3.2	3.1	2.90	4.10	3.19	0.46	10
7414	3.88	3.43	4.06	4.51	3.31	3.73	2.67	2.6	4.37	3.13	3.57	0.66	10
7546	1.26	2.52	3.57	3.04	1.63	2.39	3.62	2.93	3.29	3.12	2.74	0.79	10
7621	3.55	3.37	2.15	2.38	3.34	3.40	4.03	2.52	3.01	2.80	3.06	0.59	10
										Average	2.64		
										Std Dev	0.65		
										Count	29		

The applicable regulations do not require the suggested revisions to GE's existing Maintenance Program. Section 71.37(a) only requires the applicant to describe the quality assurance program for the maintenance of the proposed package. Pursuant to this requirement and as stated in Section 5.3 of the Consolidated Application, GE has implemented an effective maintenance program. Specifically, under GE's maintenance program inspections are performed before each use of the BU-7 outer drum and cover, the inner container and lid, and the boral liner, in accordance with detailed procedures to assure that the packages are in serviceable condition. The NRC approved this program in its March 23, 1988 SER and incorporated the boral liner November 19, 1993. In addition, GE submitted a quality assurance program, which the NRC similarly approved, on October 5, 1989.

GE inspects and tests BU-7 containers when new and before each use to assure that it is within the acceptable foam density bounds. If the weight of the container falls outside the accepted upper or lower density limits, that BU-7 is removed from service. This assures that the containers used do not contain excess moisture and that they do contain an adequate density of foam insulation.

In addition to the verification of the foam density, GE has verified the boron content of the foam in the current fleet after several years of service and for newly fabricated containers will verify the boron content during fabrication. Repeated boron verification is not necessary because there are no boron reduction scenarios that would not be detected by the inspection and maintenance program.

Drawings

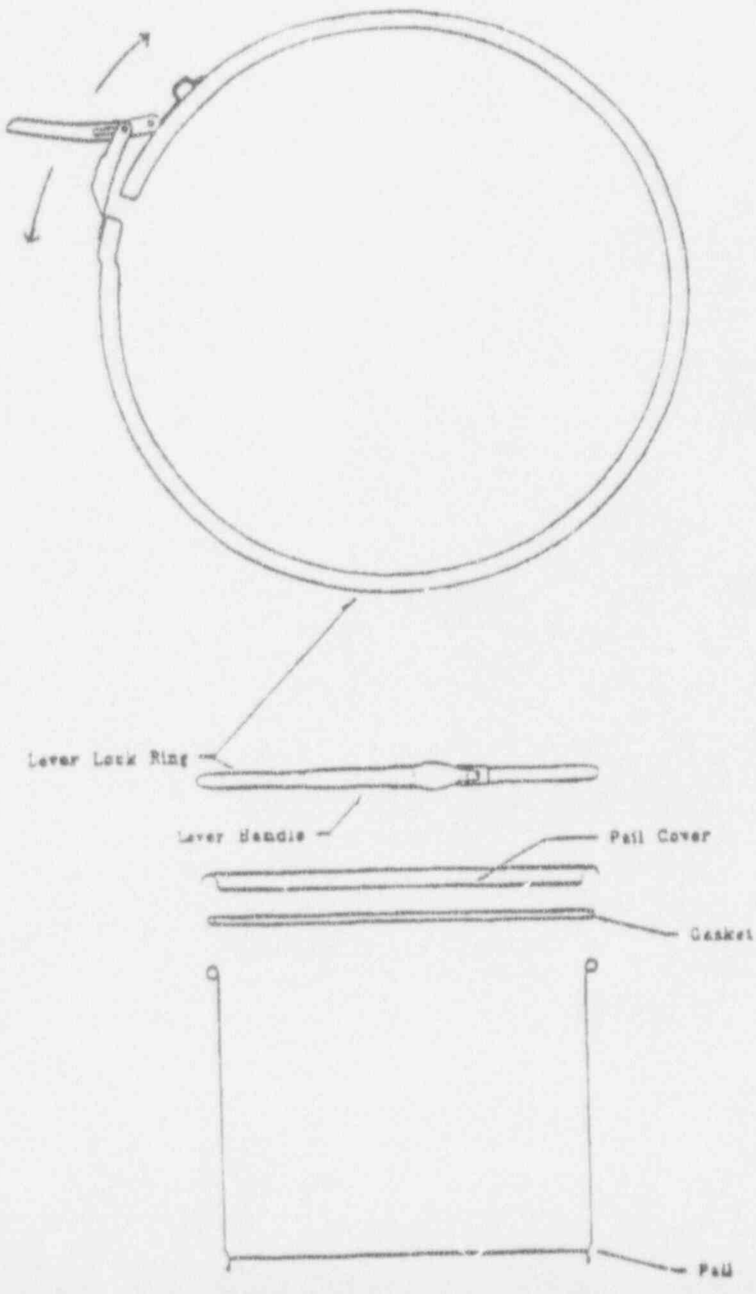
Provide drawings of the 3- and 5-gallon pails. Include the following information on the drawing: dimensions, tolerances, material specifications, applicable codes and standards for fabricating and acceptance testing the pails, and details of the pail closure.

GE purchases of the 3- and 5-gallon pails are specified to meet the ANSI MH-2-10-1979 document and in compliance with DOT regulations (pre-HM181) 49 CFR 178.131 for the DOT-37A80 container. Therefore, the drawings, dimensions, tolerances, material specifications, applicable codes and standards are contained in the above referenced ANSI standard and DOT regulation. The 24-gauge gasketed pail cover is held in place by a lever locking ring (see Figure V attached).

Acceptance testing of the pails is accomplished in accordance with 49 CFR 178.131-11 by the vendor.

FIGURE V

PRODUCT PAIL CLOSURE DEVICE



ATTACHMENT 2

The following page changes are for the BU-7 Consolidated Application dated 12/3/93.

1. Appendix B, Figure 10, has been changed to show the BU-7 serial number as K-0174 instead of K-1878. Asterisks in the right-hand margin show the location of the changes. Also added to the new Figure is the date of this transmittal (3/18/94) and that this is Revision 1 of Figure 10.

2. Figures 10A and 10B have been added. These are photos of BU-7 serial number K-0174 that have not been provided to the NRC in the past. They show that the bolt securing the outer ring was not broken. These two new figures are also identified with the drum serial number and the date of this transmittal.

3. Pages 21 through 24 of Section 5.2.1 of the 12/3/93 Consolidated Application have been modified to include the prior-to-first-use Acceptance Testing criteria for boron content in the foam. The dates on the changed pages (and those that changed as a result of pagination) have been changed to reflect the date of this transmittal. Also, the revision number has been changed on each page and asterisks are placed in the right-hand margin by the changes made to the text.

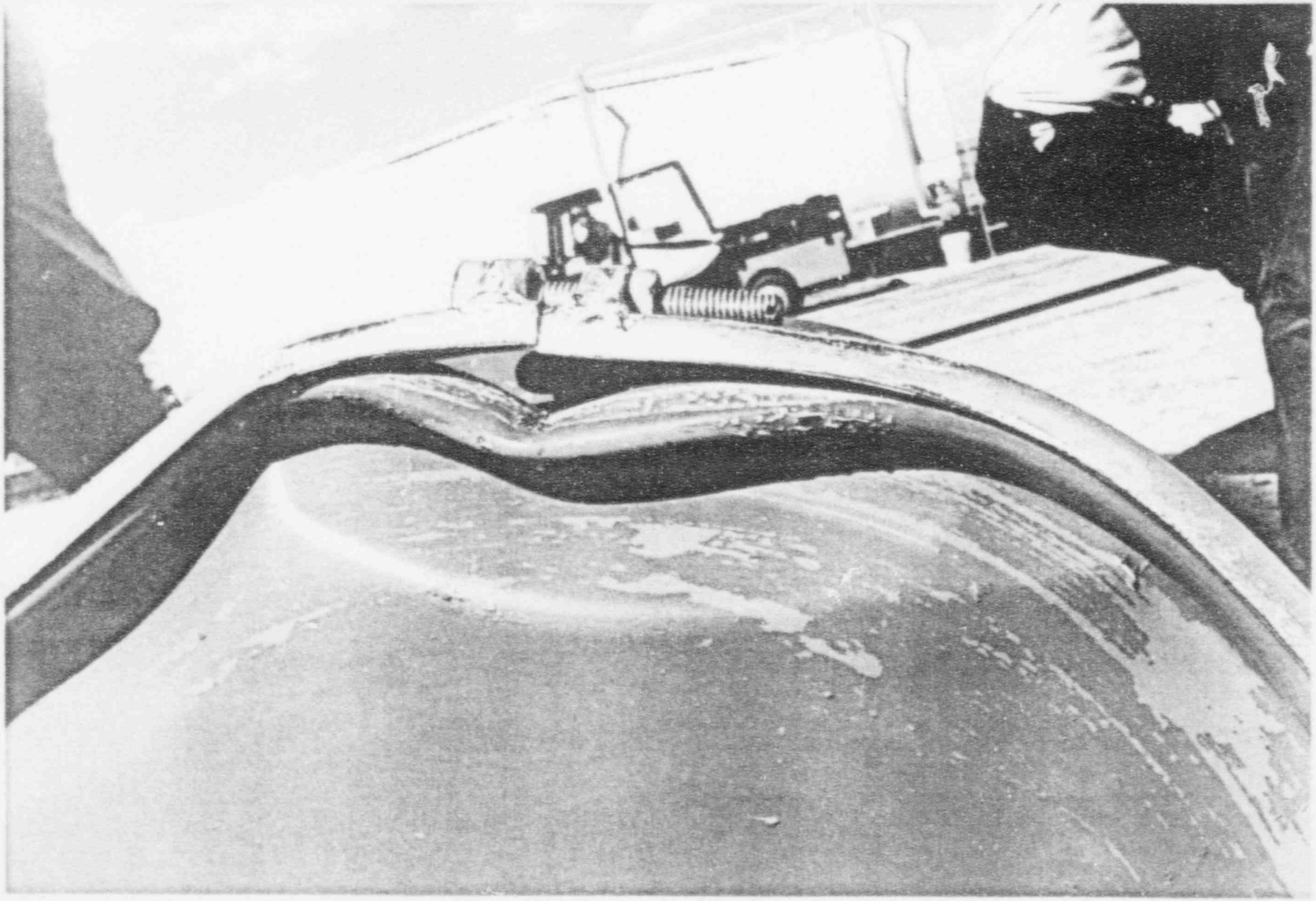


FIGURE 10 REV. 1 SUBMITTED 3/18/94

SERIAL NO. K-0174 AFTER IMPACT

* * * *

FIGURE 10A SUBMITTED 3/18/94

SERIAL NO. K-0174 AFTER IMPACT

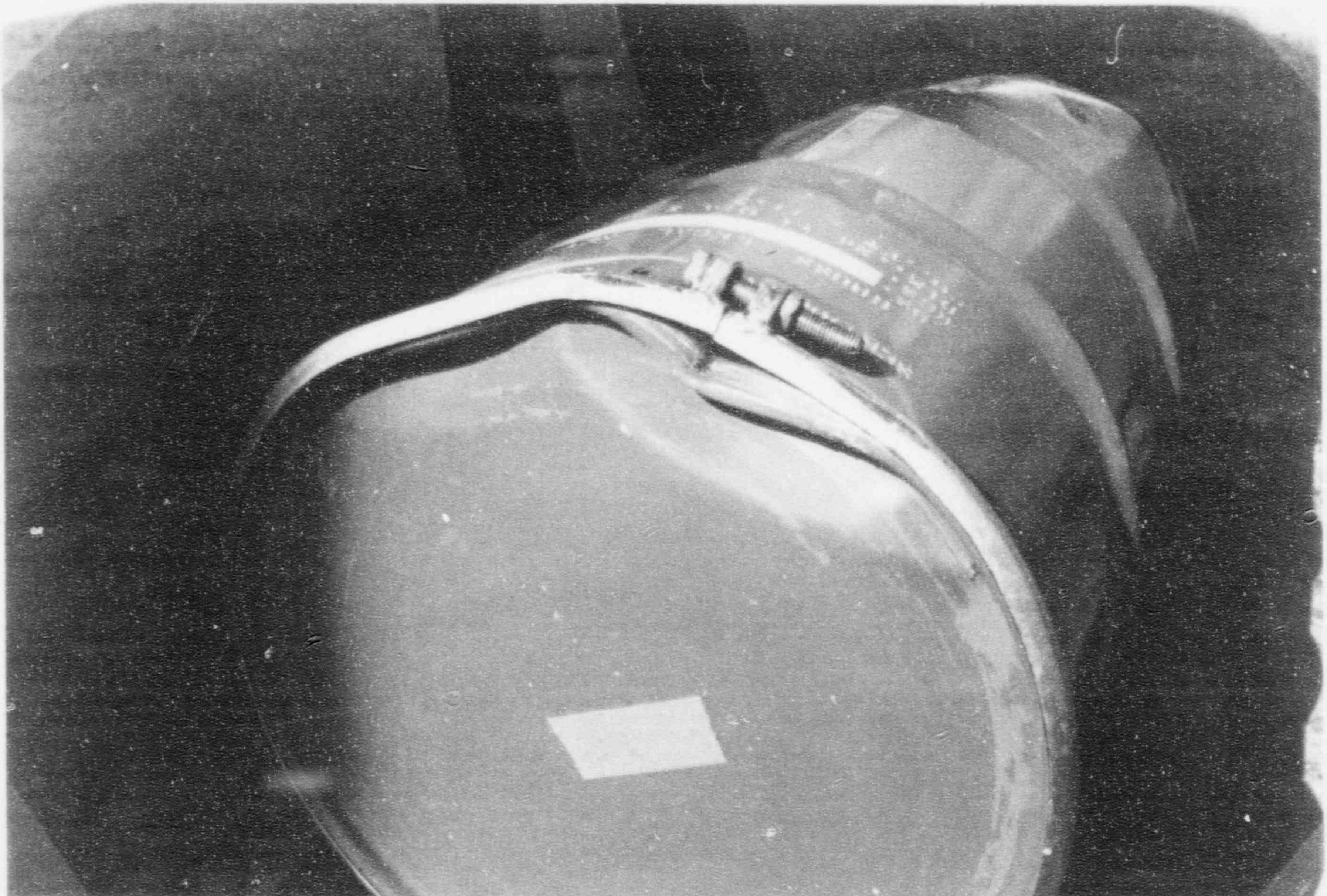


FIGURE 10B SUBMITTED 3/18/94

SERIAL NO. K-0174 AFTER IMPACT

Typical Container Characteristic	Typical Inspection Specifications
• Phenolic Plug	12.2 lbs. minimum weight of plug
• Submerged bubble pressure test for the inner container	15 PSIG minimum Prior to first use, leak tightness is verified by a submerged bubble pressure test at 15.0 PSIG, minimum. Submersion time is one minute minimum. Test is conducted using the silicone rubber container gasket as the only sealing agent between flange and cover.
• Verification of container measurements	Based on approved dimensions on licensed drawing
• Appearance integrity (Visual)	No visible holes or cracks, and no significant absence of paint.
• Boral Liner	Verification of dimensions based on licensing drawing Visual for physical integrity Visual at ends of liner for missing Boral material between stainless steel layers Review vendor test result for boron content to assure areal density Review certification for traceability of Boral to liner serial number
• Boron content in the foam	For BU-7s fabricated after 1993, assure that the minimum value of the *

Typical Container Characteristic	Typical Inspection Specifications
	boron in the foam exceeds the value used in the criticality safety analysis by at least 133% (this allows credit for no more than 75% of the boron verified as present in the foam). *

5.2.2 Failures are rejected and, where appropriate, reworked and retested.

5.3 MAINTENANCE PROGRAM

The following procedures represent the activities involved in the maintenance program for the BU-7 package.

5.3.1 The BU-7 outer drum and cover are inspected to assure:

- Good adherence of paint
- No visible holes or cracks in the metal surfaces
- No dents which affect drum integrity
- Closure rings and bolts are in good condition
- The four 1/4 inch holes in sides near top of drum are covered with weatherproof tape

- Phenolic foam insulation plug is in serviceable condition

- Container is appropriately marked

5.3.2 The BU-7 inner drum and lid are inspected to assure:

- Flange weld is intact

- Inner drum is visibly clean and painted

- Inner drum gasket sealing surface is clean, smooth and flat with no rust spots

- A new gasket is used, or the existing gasket is replaced with a new gasket if inspection shows any defects. The inner drum gasket must be changed if the gasket has been in service for more than 12 months at the time of packing

- Threads are in good condition

- There is no visible indication of holes

5.3.3 The BU-7 Boral liner is visually inspected to assure:

- The inner and outer layers of stainless steel do not have holes or punctures other than allowed by the drawing

- There is no evidence that the Boral sandwiched in between the stainless steel is missing

- Weld integrity

5.4 Criteria for Repair or Replacement of Container Components

When components parts of the BU-7 packaging do not meet the maintenance program inspection criteria, they are either reworked or replaced.

6.0 BU-7 TRANSPORT PACKAGE SPECIFICATIONS

Specifications for the BU-7 transport package are shown on General Electric Drawing 112D1592 in Appendix A.