August 04, 2004

Ms. Lori Podolak
Product Licensing Specialist
AEA Technology/QSA Inc.
40 North Avenue
Burlington, MA 01803

SUBJECT: MODEL NO. 976 TRANSPORT PACKAGE, REQUEST FOR ADDITIONAL INFORMATION

Dear Ms. Podolak:

This refers to your application dated March 9, 2004, requesting a Certificate of Compliance for the Model No. 976 package, designed to transport special form sources.

In connection with our review, we need the information identified in the enclosure to this letter. Additional information requested by this letter should be submitted in the form of revised pages. To assist us in scheduling staff review of your response, we request that you provide this information by 60 days of the date of this letter. If you are unable to provide a response by that date, our review may be delayed.

If you have any questions regarding this matter, we would be pleased to meet with you and your staff. I may be contacted at (301) 415-8512.

Sincerely,

/RA/
Julia M. Barto, Project Manager
Licensing Section
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Docket No.: 71-9314
TAC No.: L23719

Enclosure: Request for Additional Information

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ENCLOSURE

Request for Additional Information
Model No. 976 Package
Docket No. 71-9314

By application dated March 9, 2004, AEA Technology/QSA Inc., requested a Certificate of Compliance for the Model No. 976 package. This Request for Additional Information (RAI) identifies additional information needed by the U.S. Nuclear Regulatory Commission staff in connection with its review of the application. The requested information is listed by chapter number and title in the applicant's safety analysis report (SAR). NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material," was used by the staff in its review of the application.

Each individual RAI describes information needed by the staff for it to complete its review of the application and to determine whether the applicant has demonstrated compliance with the regulatory requirements.

Chapter 1 - General Information

1-1 Describe all possible configurations of the Model 3015 inner shield container.

Section 1.2.1.2.3, page 1-3, of the application states, "The insert can be modified, if desired, to provide cavities for holding individual sources or to increase the wall thickness'. However, the minimum insert design will comply with the specifications on the drawings included in Appendix 1.4." Provide adequate description and drawings (including dimensions) of each possible configuration. Describe the number of sources each configuration allows the inner shield to hold, and provide associated shield thickness dimensions with each configuration. This information is necessary to ensure compliance with 10 CFR 71.33.

1-2 Correct Section 1.2.1.2.3, page 1-3, of the application to reference Section 1.4, rather than Appendix 1.4 (editorial).

Appendix 1.4 does not exist. The intended reference appears to be Section 1.4, "Appendix: Drawings of the Model 976 Series Transport Packages." This information is necessary to ensure compliance with 10 CFR 71.7.

1-3 Specify the weights and the dimensions of the radioactive contents that may be transported by each of the inner shields used in the Model No. 976 package.

This information is necessary to ensure compliance with 10 CFR 71.33.

1-4 Clarify the maximum capacity activity for 976B and 976D, and revise the application to show the correct values.

The activity amounts in Table 1.2a, and Table 7.1.1.a, differ from the activity amounts given in Table 1.2c. This information is required to meet the requirements of 10 CFR 71.33(b)(i) to identify the package accurately.

Chapter 2 - Structural Evaluation

2-1 Revise Section 2 to indicate (in tabular form) all material specifications and mechanical properties of the components (i.e., top plate for the 855 shield container) used to fabricate the package.

This information is needed to verify that the mechanical and physical properties of the materials will provide adequate margin such that the package will function under anticipated services conditions, per the provisions of 10 CFR 71.31(c).

2-2 Revise the design drawings to include applicable codes and standards. In addition, clearly show on the drawings weld types and dimensions.

See NUREG/CR-5502, *Engineering Drawings for 10 CFR Part 71 Package Approvals*, for technical justification. This information is needed to assure compliance with 10 CFR 71.31(c).

2-3 Quantify the bases to support the use of the words “trivial” and “surmise,” as applied in Section 2 of the SAR. The following are examples of statements of this type:

- Section 2.6.1.3 states, “As can be surmised from Section 2.6.1.2, thermal differentials will have no effect on the interfaces between the outer drum, cork inserts and shield inserts.” Clearly state the reasoning for the thermal differentials to have no effect on the interfaces.

- Section 2.6.1.3 states, “Mechanical loads are trivial as the maximum weight of the series is 280 lbs. and well distributed throughout the package.” Clearly state the reasoning for deeming the mechanical loads trivial.

- Section 2.7.4.3 states, “As can be surmised from Section 2.7.4.2, thermal differentials will have no effect on the interfaces between the outer drum, cork inserts and shield inserts.” State the reasoning for the thermal differentials to have no effect on the interfaces.

This information is required to meet the requirements of 10 CFR 71.7 for completeness and accuracy of information provided to the NRC.

2-4 Clarify the acceptance criteria of the shield container under normal conditions of transport for reduced external pressure.

Section 2.6.3 states, “If the 8.7 psi were then superimposed on this pressure, the stress, if taken through a single bolt, would be 18,300 psi, still significantly below the bolt’s strength.” Specify which strength is met by this calculation–the bolt’s yield strength or tensile strength. In addition to verifying that the bolt’s material properties (i.e., strength) exceeds required pressure, specify the design codes and standards used as

acceptance criteria on the design drawings. This information is needed to assure compliance with 10 CFR 71.71(c)(3).

2-5 Analyze the transportation package and its component's resistance to buckling as a result of the numerous drop tests under various orientations.

This information is needed to assure compliance with 10 CFR 71.71 and 71.73.

2-6 Provide a technical basis for not performing a fatigue analysis due to the combined stresses of acceleration, vibration, resonance, temperature, pressure, and cyclic loads. Alternatively, analyze whether these loads will lead to degradation of the package containment, fatigue failure, or deterioration of closure devices.

The analysis should consider if closure bolts are reused and, if so, include the bolt pre-load in the fatigue evaluation and the frequency with which they are reused. Additionally, the analysis should consider the resonant vibration, which can cause rapid fatigue damage, and its potential effect on package internals. This information is required to meet the requirements of 10 CFR 71.7 for completeness and accuracy of information provided to the NRC.

2-7 Revise the wording in Section 2.6.9 of the application. Section 2.6.9 states, "This weight is also greater than 13 kPa (2 lb/in^2) multiplied by the surface area of the transport package."

The pressure value to be multiplied is the vertically projected area of the package, rather than the total surface area as the application suggests is required in 10 CFR 71.71(c)(9).

2-8 Revise Table 2.7.4.1.b, "Summary Table of Maximum Pressures," to include pressure summaries for all package configurations.

Summaries only for package configurations 976A, B, E are provided. This information is required to meet the requirements of 10 CFR 71.7 for completeness and accuracy of information provided to the NRC.

2-9 Perform differential thermal expansion calculations in Section 2.7.4.2, for hypothetical accident conditions, as was performed in Section 2.6.1.2, for the normal conditions of transport.

This information is required to ensure compliance with 10 CFR 71.71(c)(4).

2-10 Provide an evaluation of the drum base plate and the drum wall for the lifting condition evaluated in Section 2.4.1.

The evaluation performed in Section 2.4.1 considers only axial stress and not the bending stress at the junction of the base plate. This information is required to meet the requirements of 10 CFR 71.7 for completeness and accuracy of information provided to the NRC.

2-11 Describe details of the unyielding surface used for the free drops and of the steel bar used for the puncture tests.

This information is required to verify that the requirements of 10 CFR 71.41(a), 71.71(c)(7), 71.73(c)(1), and 71.73(c)(3) are met.

2-12 Provide verification that the test specimens for Test Plan Report 90 were fabricated and designed using the same materials, methods, and quality assurance as the one to be used in the transportation package.

Staff must confirm that the test specimens, subjected to the requirements of 10 CFR 71.71 and 71.73, are designed and fabricated similarly to the transportation package.

2-13 Clarify the results of the 4-foot drop test described in the Test Plan 90 Report in Section 5.1.3.

The second paragraph states, “Very little damage to drum was noted.” However, Figure 5, “Normal Conditions Drum Damage: Specimen TP90A,” clearly shows the drum clamp unbolted. If this is a result of the drop test, the staff requests that this be noted in the text so a thorough evaluation is described as required by 10 CFR 71.35(a). This information is required to meet the requirements of 10 CFR 71.7 for completeness and accuracy of information provided to the NRC.

2-14 Provide more detailed information between the shield containers in this application and those previously approved by the NRC to thoroughly satisfy the reasoning for not conducting tests or analyses for the thermal test hypothetical accident conditions.

Section 2.2.3 of Test Plan 90 provides some of the information for the previously approved containers, but is not complete. This information is needed to meet the regulatory requirements of 10 CFR 71.73(c)(4). Additionally, this information is required to meet the requirements of 10 CFR 71.7 for completeness and accuracy of information provided to the NRC.

2-15 Provide a basis for not conducting 30-foot drop tests and puncture tests on the Model 3078 shield container.

Thirty-foot drop tests and puncture tests were performed on Model 855 and 3056 shield containers (representing the group of 3056, 3015, and 3018 shield containers) but not Model 3078. Although Section 2.2.3 of Test Plan 90, attempts to explain why thermal tests were not conducted for the various shield containers, it is not apparent why drop and puncture tests for the Model 3078 shield container was not conducted. Staff need assurance that the requirements of 10 CFR 71.73(c)(1) and 71.73(c)(3) are met.

2-16 Provide justification to show that the Model 3056 shield container will remain within the drum under various drop orientations for the hypothetical accident condition tests.

This assumption by the applicant forms the basis for the shield container maintaining its structural integrity under thermal tests for hypothetical accident conditions. The Test Plan 90 Report reasons that the Model 855 and 3078 shield containers could exit the

drum, and if so, would still provide adequate shielding to the source under thermal hypothetical accident conditions. However, as stated in the last paragraph on page 8 of the Test Plan 90 Report, the Model 3056 shield container would not exit the drum, based on prior tests of similar containers.

Based on tests conducted at Lawrence Livermore National Laboratory in November 2001, shallow-angle drops of 17.5° confirmed that drum closures with a bolted ring are more susceptible to separation than much steeper angle drops, such as 45°. Test procedures and results are documented in NUREG/CR-6818, *Drop Test Results for the Combustion Engineering Model No. ABB-2901 Fuel Pellet Shipping Package*. Analyses and/or tests on the transportation packages must show the effects of free drops for which maximum damage is expected according to normal conditions of transport and hypothetical accident conditions, 10 CFR 71.71(c)(7) and 71.73(c)(1), respectively.

2-17 Verify that the package tamper proof device is not readily breakable.

This information is required to assure compliance with 10 CFR 71.49.

2-18 Provide references for all documents referenced in Section 2 of the application, so that staff can verify the accuracy of information required by 10 CFR 71.7. Examples of documents requiring complete reference information is presented below:

a. The value of the stress in one bolt is calculated in Section 2.6.1.3. To determine "A," the stress area of the bolt, a reference to the Machinery's Handbook is given. Provide more descriptive references information on this book.

b. Provide references and analyses of previous NRC-approved inner shield designs that have been used in Type B shipments that establish no vibration-induced failure of any shield fasteners, steel drums, clamp bands, and cork (used in the drum liner inserts), discussed in Section 2.6.5.

c. Section 2.7.1.2 states, "From prior drop testing and experience, we know that drops that cause significant amounts of deformation are the least onerous orientations." Provide references to these prior test and results confirming this statement.

2-19 Clarify inconsistencies and discrepancies in the text and design drawings in Appendix 1.4 of the application. Examples of inconsistencies and omissions are described below:

a. Section 1.2.1.2.1 states that the Model 855 shield container has a diameter of 10 7/8 inches, however, this dimension is not labeled on the drawings (Drawing No. R85590, Sheets 1-6).

b. Section 1.2.1.2.1 states that the Model 855 shield container incorporates a base plate at the bottom of the shell with a diameter of 11 1/4 inches. The base plate is not labeled on the drawings (Drawing No. R85590, Sheets 1-6).

c. Section 1.2.1.2.2 states that the Model 3056 shield container has a diameter of approximately 6 1/4 inches. The value is inconsistent with Drawing No. R3056, Sheet 1 of 4, which labels the diameter as 7.7 inches.

d. Section 1.2.1.2.3 states the Model 3015 shield container is approximately 6 inches in diameter and 10 inches in height. These dimensions are inconsistent with Drawing No. R3015, Sheet 2 of 4, which labels a diameter of 5.9 inches and height of 8.2 inches.

c. In Section 2.6.4, the maximum stress in the Model 855 shield container is calculated based on a pressure of 20 psi. The thickness of the top plate used in this calculation is 0.25 inches. However, Drawing No. R85590, Sheets 2 of 6 and 3 of 6, show the thickness of the top plate as 5/16 inches. The maximum stress on the container may need recalculation based on a different top plate thickness.

d. In Section 2.4.1, the maximum stress in the base plate of the drum is calculated. The thickness of the base plate used in the equation is 0.06 inches. However, that value is the thickness of the drum wall, while the thickness of the base plate is 0.75 inches according to Drawing No. R97608.

g. Table 2.2a notes a yield strength of stainless steel of 30 ksi. Section 2.4.1 states the ultimate yield strength of the stainless steel is 70000 psi (or 70 ksi). Address the discrepancy between these values. If these are two different stainless steel compositions with varying yield strengths, then all materials of this package should be labeled by a specific designation that are referenced in industry codes and standards.

This information is needed to show compliance with the requirements of 10 CFR 71.7, 71.31(c) and 71.33.

2-20 Provide an explanation for why Section 14 (Appendix G) of Test Plan 90 contains a Type A package checklist.

The application identifies the Model No. 976 as a Type B package. However, Section 14 of Test Plan 90 contains a checklist for a Type A package. This information is necessary to ensure compliance with 10 CFR 71.7.

Chapter 3 - Thermal

3-1 Provide a complete reference list for all references cited in the thermal section.

A “Reference 3.6.5" is cited on page 3-1, but is not listed in Appendix 3.6. This information is necessary to ensure compliance with 10 CFR 71.7.

3-2 Provide a heat balance of the package assuming realistic boundary conditions for the bottom surface of the package. Adiabatic conditions for the bottom surface of the package could be assumed for a conservative calculation.

The calculation that was performed in Section 3.4.1.1, and 3.4.1.2, assumed that there was free convection from the bottom surface of the package. This may not be realistic given the shipping configuration of the package. This information is required to assure compliance with the 10 CFR 71.35 requirements.

3-3 Provide a discussion of the specific similarities between the Model No. 976 package and all other packages referenced where the performance of other packages are used as justification for the acceptable performance. Clearly demonstrate how other previously tested or analyzed packages are bounding.

The staff cannot perform a confirmatory review if the informational basis for thermal conclusions is not provided. All information used to make safety findings must be provided in the application. Note that Section 3.5 of the application is incomplete because it references other package designs, but does include data. This information is required to verify compliance with the 10 CFR 71.41(a) requirements.

3-4 Provide a detailed analysis of shielding material performance in response to the hypothetical accident condition (HAC) fire exposure for any shield container that could potentially exit the drum following the drop or pin-puncture tests.

Shielding materials such as lead and/or depleted uranium can be adversely affected by high temperatures. If a shield container was to exit the drum package as a result of the drop and/or pin puncture test, the shield container would be directly exposed to the fully engulfing HAC fire test. The condition of the shield container and specifically the shielding materials used in the container must be evaluated for this type of exposure. This information is required to verify compliance with the 10 CFR 71.51.(a).(2) requirements.

Chapter 5 - Shielding

5-1 Clarify what radioactive sources were placed in each test unit listed in Figure 1 of Section 3 of Test Plan 90.

It is not clear as to which sources were used to obtain the dose measurement profile data presented in Section 6 and Section 11 (Appendix D) of Test Plan 90. Provide the following information for each source used to obtain profile data for each of the shield containers: (a) isotope, (b) activity, and (c) chemical and physical form. Provide similar information (isotope, activity, chemical and physical form) for the 424-9, ‘dummy’-style 424-9, and 969 source assemblies referred to in Section 3 of Test Plan 90. This information is required to ensure compliance with 10 CFR 71.35.

5-2 Clarify the procedure followed to obtain external radiation profile data for each of the test units.

It is unclear whether the package contained source material during the package testing, or if the source was placed in the package subsequent to testing. Specify whether the package was tested with a dummy source or an actual source, and fully describe the source characteristics (see RAI no. 5-1). Specify whether any movement of the source

or dummy source occurred during the package testing. This information is required to ensure compliance with 10 CFR 71.35.

5-3 Address the following regarding Test Plan 90, Section 6, Figure 23:

a. Clarify whether the measurements presented are in units of millirems or millirems per hour. If the units are millirems, state the time intervals that correspond to each reported measurement. The profile sheets in Section 11 (Appendix D) of Test Plan 90, along with Tables 5.1a-f in Section 5 of the SAR both list external radiation levels in terms of mrem per hour; Figure 23 should be consistent with those units.

b. Clarify how and when the measurements were taken, particularly:

i) specify what source was used for each test (see RAI no. 5-1), and provide the source characteristics,

ii) specify the detector type (e.g., Geiger-Mueller, etc.) used to measure the reported values, providing manufacturer's information (such as detector efficiency) and all other relevant information, and

iii) specify whether the external radiation profile was determined pre- or post-test.

c. Explain why identical values are reported for the following test specimens:

i) TP90 (B) and TP90 (D), and

ii) TP90 (C) and TP90 (E).

d. Explain and, if applicable, correct the apparent discrepancies between Figure 23 and the data presented in Section 11 (Appendix D) of Test Plan 90 and Tables 5.1 a-f in Section 5 of the SAR. For example, the Shielding Profile and Inspection Form for inner shield Model 855, serial number 8, gives an adjusted surface reading of 29 mR/hr at the top of the shield, whereas Figure 23 lists a surface reading of 27 mR/hr at the top of the shield. There are numerous such discrepancies between the data in Section 11 (Appendix D) of Test Plan 90 and Figure 23 in Section 6 of Test Plan 90, and all should be justified or corrected.

The information requested in items (a) through (d) above is required to ensure compliance with 10 CFR 71.35.

5-4 Discuss the surface correction factor and capacity correction factor. Provide a discussion of both the surface correction factor and the capacity correction factor. Explain the physical significance of each, show the calculations used to determine these factors, and discuss how and why they were applied to the external radiation profile data.

This information is required to ensure compliance with 10 CFR 71.35.

5-5 Clarify the applicability of the profile sheets in Section 11 (Appendix D) of Test Plan 90 to each test sample listed in Figure 1 of Section 3 of Test Plan 90.

It is unclear in Section 11 (Appendix D) of Test Plan 90 which profile sheets contain data for the test sample numbers in Figure 1 of Section 3 of Test Plan 90. To ensure compliance with 10 CFR 71.35, provide the following in SAR Section 5:

a. A chart relating the data on the profile sheets to the samples listed in Chapter 3 of the Test Plan 90.

b. A discussion justifying that test sample TP90 (G) is representative of multiple inner shield models.

c. A discussion of the applicability of the tests performed on the Model 976 transport drum with inner shield Model 855 to inner shield Model 3078 from a shielding standpoint.

5-6 Correct the following references:

a. Pages 5-1 and 5-4 refer to Appendix 2.12.2. Appendix 2.12.2 does not exist in this application.

b. Page 5-1 of the application refers to Appendix 1.4, rather than Section 1.4.

This information is required to ensure compliance with 10 CFR 71.7.

5-7 Provide the following information concerning Tables 5.1a-f of Section 5:

a. Provide an analysis relating the data in the tables to the data in the profile sheets in Section 11 (Appendix D) of Test Plan 90. Include all relevant information and calculations, including the calculations extrapolating external radiation levels to each maximum activity capacity of Ir-192. Clarify whether the profile sheets represent normal transport conditions or hypothetical accident conditions.

b. Explain and, if applicable, correct the apparent discrepancies between these tables and Figure 23 in Section 6 of Test Plan 90 (see RAI no. 5-3).

c. For each table, provide a specific reference to where the data was obtained within Test Plan 90.

d. Provide representative confirmatory calculations of these measurements. Note that staff's confirmatory calculations (using MicroShield V.5) indicate considerably higher external radiation levels at the bottom of inner shield Model 3056 than those reported in Table 5.1c.

This information is required to ensure compliance with 10 CFR 71.35.

5-8 Clarify whether inner shield Models 3015, 3018, and 3078 were tested.

Section 3 of Test Plan 90 indicates that only inner shield Models 855 and 3056 were tested, however Section 11 (Appendix D) of Test Plan 90 contains shielding profile and inspection forms reporting measurements taken from inner shield Models 855, 3015, 3018, and 3078. Provide a discussion on the procedures used to obtain external radiation profile data for these inner shield models, making sure to include information regarding whether or not each shield was subject to the tests described in Section 2.1 and 2.2 of Test Plan 90. This information is required to ensure compliance with 10 CFR 71.35.

5-9 Provide the Transport Index in Chapter 5 of the SAR. It is required by 10 CFR 71.47 that non-exclusive use shipments have a transport index of less than 10.

Chapter 7 - Package Operations

7-1 Modify the procedures to confirm that sources, loaded into a Model No. 976, for each of the shield configurations, are securely locked in position before shipment.

The need for this information is specified in NUREG-1609, *Standard Review Plan for Transportation Packages for Radioactive Material*, and to show compliance with 10 CFR 71.87(k).

7-2 Clarify that loading operations are dry. If any of the shield configurations are to be wet loaded, clarify this in the procedure and provide steps to include that the package is appropriately drained.

This information is needed to show compliance with 10 CFR 71.43(b).

Chapter 8 - Acceptance Test and Maintenance Program

8-1 Modify Section 8 to include verification that appropriate periodic tests are performed to demonstrate shielding effectiveness and any wearing of the J-tubes.

The need for this information is specified in NUREG-1609, *Standard Review Plan for Transportation Packages for Radioactive Material*, and to show compliance with 10 CFR 71.87(k).