



UNITED STATES  
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

June 1, 2000

Mr. Edward M. Davis  
President and Chief Executive Officer  
NAC International, Inc.  
655 Engineering Drive  
Norcross, GA 30092

**SUBJECT: PART 21 REPORT REGARDING NS-4-FR MATERIAL SUPPLIED BY  
NAC INTERNATIONAL, INC.**

Dear Mr. Davis:

By letter dated May 26, 2000, Holtec International (Holtec) notified the Nuclear Regulatory Commission (NRC) under the reporting requirements of 10 CFR 21.21 of a potential defect in shielding material supplied by NAC International, Inc (NAC). Holtec stated in this report that it acquired NS-4-FR from NAC under a safety-related purchase order. Holtec stated it found unexpected voids in the material samples after receipt and, subsequently, found evidence of thermal failure during testing of these samples. Holtec stated that these potential defects could cause increased dose rates from spent fuel storage casks and result in a substantial safety hazard.

We request that you review the information contained in this report and resolve this information under your Quality Assurance Program and in accordance with the requirements of 10 CFR Parts 21, 71, and 72. We also request that you inform NRC of your planned corrective actions and resolution of this matter, as appropriate, within 14 days of the date of this letter. Your planned resolution should include notification of potentially affected licensees, as appropriate. The Part 21 report submitted by Holtec, excluding proprietary information, is enclosed. If you have any questions concerning this request, please contact Mr. Wayne Hodges of my staff at 301-415-2398.

Sincerely,

E. William Brach, Director  
Spent Fuel Project Office  
Office of Nuclear Material Safety  
and Safeguards

Docket Nos. 71-0018, 71-9235, 72-1015, 72-1020 & 72-1025

Enclosure: Holtec ltr. dtd. May 26, 2000

June 1, 2000

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NAC International, Inc.  
655 Engineering Drive  
Norcross, GA 30092

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/RA/

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Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053

Telephone (856) 797-0900  
Fax (856) 797-0909

**BY FAX<sup>1</sup> AND OVERNIGHT MAIL**

May 26, 2000

U. S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, DC 20555-0001

Subject: 10 CFR 21 Notification for Fabrication of NS-4-FR Neutron Shield Material

Reference: NRC Special Inspection of Holtec International No. 71-0784/00201, held May 18-19, 2000

Dear Sir:

Pursuant to Holtec Quality Procedure HQP 15.1, "Reporting of Defects and Noncompliances per 10CFR21", Holtec International hereby notifies the Commission of a potential defect in a shielding material (sold under the name of NS-4-FR) by NAC International of Norcross, Georgia. The detailed historical information with respect to the potential defect in this material is contained in proprietary Holtec Report HI-2002396, "Holtite-A: Development History and Thermal Performance Data" (Enclosure 1).

A focused audit of our company's Holtite-A<sup>TM</sup> shielding material test qualification and manufacturing program was conducted by the Holtec Users' Group on April 12-14. The audit report, issued to us on May 12, 2000 identified a *finding* related to Holtec's failure to follow its QA program with respect to 10 CFR 21 notification in the wake of the company's discovery of defective NS-4-FR material supplied under a safety significant procurement. Upon receipt of the audit report (Enclosure 2), the company's Quality Initiatives Committee informally reviewed this matter and determined that our failure to issue the Part 21 notification is inconsistent with our corporate practice to maintain a low threshold for reporting nonconformances and the corporate mission to uphold the highest levels of vigilance for public health and safety. Our quality procedure HQP 15.1 is currently being upgraded accordingly to ensure that a lapse such as delayed filing of this Part 21 notification does not occur again.

We trust that this filing also comports with the position of the NRC inspection team that visited our headquarters on May 18-19, 2000. The specific information required by 10 CFR 21.21(d)(4) is provided below.

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<sup>1</sup> Cover letter only



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Document ID: HL1020-006  
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Name and Address of Individual Informing the Commission:

Mr. Mark Soler  
QA Manager  
Holtec International  
Holtec Center  
555 Lincoln Drive West  
Marlton, NJ 08053

Identification of the Basic Component Supplied Which Contains a [Potential] Defect:

NS-4-FR neutron shield material.

Identification of the Firm Supplying the Basic Component Which Contains a [Potential] Defect:

NAC International  
655 Engineering Drive  
Norcross, GA 30092

Nature of the [Potential] Defect and the Safety Hazard Which Could Be Created by the [Potential] Defect:

Samples of the NS-4-FR neutron shield material supplied by NAC International under Holtec's safety-related Purchase Order No. 7071MI (Appendix 2 of Enclosure 1) exhibited deviations in two areas:

1. The purchase order required that "The manufacturing processes and materials used to make the NS-4-FR samples shall be the same as that which has been used and shall be used in the future when manufacturing NS-4-FR for dry cask storage use." Contrary to this technical requirement in the purchase order, the NAC-supplied samples of NS-4-FR contained internal voids where solid shield material was expected to be present. In responding to Holtec's letter informing them of these voids and the requirements of the purchase order, NAC International stated, in part, "Observation of these voids is not surprising. Material formulation and mixing were controlled. Mixed material was poured into a mold without development of a specific installation procedure to eliminate



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voids in the cured sample<sup>2</sup>.” The absence of a specific installation procedure to eliminate voids in the poured samples was contrary to the technical requirements of the purchase order and brought into question NAC International’s ability to implement all requirements of a nuclear safety-related purchase order under their quality assurance program. Voids in the neutron shield material in an in-service dry spent fuel storage cask could create a substantial safety hazard in the form of increased dose rates from the cask.

2. Despite the voids in the samples as described above, Holtec still considered the samples suitable for use in thermal stability testing, since the chemical analyses of the samples seemed in order. After approximately 150-200 days of thermal testing at 325° F, the NAC-supplied NS-4-FR samples began failing as evidenced by splitting, bubbling, and a step change in weight loss. Disintegration of the neutron shield material, particularly in conjunction with potential voids as described in item 1 above, could create a substantial safety hazard in the form of increased dose rates from the cask.

The Date on Which the Information of Such [Potential] Defect was Obtained:

1. The information for item 1 above was obtained by Holtec corporate engineering on April 6, 1998. NAC International was notified of the observed anomaly by letter on April 20, 1998.
2. Conclusive evidence of thermal test failures described in item 2 above was obtained by Holtec’s chief nuclear scientist in the Fall of 1998<sup>3</sup>. NAC International was not informed of these test results at that time for two reasons: a) considering the thermal test failures and unsatisfactory responses to the issue of voids in the samples, Holtec decided to suspend its efforts to qualify NAC International as a supplier of NS-4-FR neutron shield material and b) we were not aware that NAC had installed NS-4-FR in any cask with significant heat load which would cause elevated temperatures.

The Number and Location(s) of the Basic Component Which Contains the [Potential] Defect

Since Holtec is not the supplier of the hardware with the potential defect, the total number and locations where the basic component is in service is unknown to us.

<sup>2</sup> See Appendix 4 of Enclosure 1 for Holtec’s April 20, 1998 letter and NAC’s response of April 23, 1998.

<sup>3</sup> See Appendix 6 of Enclosure 1.



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The Corrective Action Which Has Been, Is Being, or Will Be Taken, Name of Individual or Organization Responsible for the Action, and the Length of Time That Has Been, or Will Be Taken to Complete the Action:

Holtec suspended qualification of NAC International as an approved supplier of NS-4-FR neutron shield material after failure of the material samples in thermal stability tests. We are unaware of the status of corrective actions, if any, NAC International has taken or will be taking.

Any Advice Related to the [Potential] Defect about the Basic Component That Has Been, Is Being, or Will Be Given to Purchasers or Licensees:

Holtec has no NAC-supplied NS-4-FR in any of the cask systems supplied to its customers.

This submittal includes information in the form of Holtec Report Number HI-2002396, which is commercially sensitive to Holtec International and is treated by us with strict confidentiality. This information is of the type described in 10CFR2.790(b)(4). Portions of this report are considered proprietary to Holtec and are marked as such. The attached affidavit sets forth the bases for which the information is required to be withheld by the NRC from further disclosure, consistent with these considerations and pursuant to the provisions of 10CFR2.790(b)(1). It is therefore requested that the proprietary information enclosed be withheld from public disclosure in accordance with applicable NRC regulations. A non-proprietary version of this report will be submitted to the NRC by June 9, 2000.

If you have any questions or require additional information, please contact me at (856) 797-0900, extension 619.

Sincerely,

Mark Soler  
QA Manager



**HOLTEC**  
INTERNATIONAL

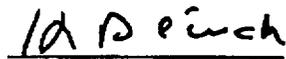
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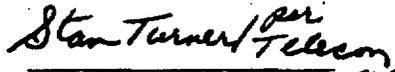
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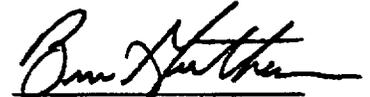
Approval:

  
K. P. Singh, PE, PhD

Concurrence:  
Materials Specialist

  
Stan Turner, PhD, PE

Concurrence:  
Licensing

  
Brian Gutherman, PE

cc: Mr. Oscar Shirani, ComEd (w/o encl. and attach.)  
Mr. Kirk Lathrop, USNRC (w/encl. and attach.)  
Mr. E. William Brach, USNRC (w/o encl. and attach.)

Attachment: Affidavit Pursuant to 10 CFR 2.790

Enclosures: 1. Holtec Report HI-2002396, "Holtite-A - Development History and Thermal Performance History", Revision 0, April 17, 2000 (proprietary version)  
2. ComEd Audit Report on Audit No. SR-2000-289 dated May 9, 2000.

Document I.D.: HL1020-006

Commonwealth Edison Company  
1411 Opus Place  
Downers Grove, IL 60515-5701

RECEIVED

MAY 12 2000

HOLTEC INTERNATIONAL  
NEW JERSEY OFFICE

**ComEd**

May 9, 2000  
SES-00-72

Mr. Mark Soler  
Quality Assurance Manager  
Holtec International Incorporated  
555 Lincoln Drive West  
Holtec Center  
Marlton, NJ 08053

**Subject:** ComEd Audit, SR-2000-289 of Holtec, Inc., related to the use of Holtite-A vs. NS-4-FR as alleged by NAC in the HI STAR 100 Dry Storage Casks

Mr. Soler:

Enclosed is a copy of the ComEd Audit Report No. SR-2000-289 that was conducted on April 12-14, 2000 at your Marlton, NJ facility. **This Audit resulted in the identification of one Finding (SR-2000-289-01) in your Corrective Action Program.** The Audit finding does not have any adverse impact on the results of this audit regarding the Holtite-A's performance.

ComEd Supplier Evaluation Services (SES) decided to investigate this matter for quality purposes and did not plan on performing an audit. This effort identified a nonconforming condition. When the nonconforming condition was identified, the investigation was declared to be an audit. The audit was declared to allow for the issue of a finding which documents the nonconforming condition identified. ComEd Supplier Evaluation Services (SES) performed this audit with the assistance of three technical specialists from ComEd, New York Power Authority (NYPA), and Southern Nuclear Operation Company (SNOC). This audit focused on the Holtec's Neutron shielding material used in Holtec designed dry storage casks known as Holtite-A. The audit included the review of associated qualification testing and manufacturing processes, material procurement, and the review of commitments made in your submitted TSAR to the USNRC.

The audit was performed to assess the adequacy, effectiveness and implementation of the Holtec Quality Assurance Program for the control of Holtite-A material in accordance with the applicable sections of 10CFR 50 Appendix B, 10CFR 71 Subpart H, and 10CFR 72 Subpart G,

and the latest Holtec's QA Manual and associated procedures. This audit was conducted as performance based and verified Holtec's control of the material, procurement, and suitability of material application independent from NAC NS-4-FR material.

Please provide a written response for the Finding Nos.: SR-2000-289-01 by June 12, 2000. Your response should include a description of the cause, proposed corrective actions, actions to prevent recurrence, and expected completion dates. The response is to be signed by the appropriate Holtec's Manager(s) and concurred with your signature. This response should be directed to:

Oscar Shirani, PE  
ComEd/Supplier Evaluation Services  
1411 Opus Place, Suite 250  
Downers Grove, IL 60515-5701

The cooperation and assistance extended to the audit team by Holtec International personnel during the audit is greatly appreciated.

Please refer questions to Oscar Shirani, ComEd Supplier Evaluation Services (SES), at Tel. No.: 630-663-5873.

Sincerely,



Oscar B. Shirani, PE  
Audit Team Leader

cc: Audit File SR-2000-289  
Duplicate File  
J. Reiss  
N. Leech  
P. Planing  
B. Christel  
T. Frazier at UST&D  
K. Singh (Holtec)  
M. Stoltz (SNOC)  
D. Harrison (NYPA)

**ComEd**  
**A Unicom Company**

**Audit Report**

For

**ComEd Audit No. SR-2000-289**

Of

**Holtec International Incorporated**  
**555 Lincoln Drive West**  
**Holtec Center**  
**Marlton, NJ 08053**

Prepared By:   
Oscar B. Shirani, PE  
Audit Team Leader

Date: 5/9/00

Approved By:   
Russell A. Bastyr  
Supplier Evaluation Services Manager  
And NUPIC Representative

Date: 5-9-00

**Vendor Name/Address**

Holtec International Incorporated  
555 Lincoln Drive West  
Holtec Center  
Marlton, NJ 08053

**Audit Dates**

April 12-14, 2000

**Audit Purpose and Scope**

Holtec International was contracted by ComEd Dresden Station Unit 1 and other HUG (Holtec Users Group) members to perform Dry Cask Storage Design and Fabrication activities. ComEd Supplier Evaluation Services (SES) decided to investigate this matter for quality purposes and did not plan on performing an audit. This effort identified a nonconforming condition. When the nonconforming condition was identified, the investigation was declared to be an audit. The audit was declared to allow for the issue of a finding which documents the nonconforming condition identified. SES performed this audit with the assistance of three technical specialists involved in the dry cask storage projects from ComEd, New York Power Authority (NYPA), and Southern Nuclear Operation Company (SNOC). This audit focused mainly on the Holtec's neutron shielding material used in Holtec designed dry storage casks known as Holtite-A. The audit included the review of associated qualification testing and manufacturing processes, material procurement, and the review of commitments made in the Holtec submittal TSAR to the USNRC.

The audit was performed to assess the adequacy, effectiveness and implementation of the Holtec Quality Assurance Program for the control of Holtite-A material in accordance with the applicable sections of 10CFR 50 Appendix B, 10CFR 71 Subpart H, and 10CFR 72 Subpart G, and the latest Holtec's QA Manual and associated procedures. This audit was conducted as performance based and verified Holtec's test/inspection, procurement, and suitability of material application.

**Audit Team:** Oscar Shirani, PE - Audit Team Leader - ComEd  
Joseph Reiss - Technical Specialist - ComEd  
Marlin Stoltz - Technical Specialist - SNOC  
Douglas Harrison - Technical Specialist - NYPA

**Audit Reference:** This audit did not utilize any checklist and was conducted with the focus on the suitability of Holtite-A material for application. Procurement control and test/inspection processes were evaluated in accordance with the requirements of Holtec International Quality Assurance Program. This audit was based on the requirements of:

- 10CFR : 0 Appendix B
- 10CFR Part 21
- 10CFR 71 Subpart H, and 10CFR 72 Subpart G
- Holtec TSAR
- Holtec's Quality Assurance Manual and associated procedures

### **Executive Summary**

Overall, the Audit Team determined that Holtec International has established and implemented acceptable quality assurance program elements for the testing/inspection and procurement of Holtite-A neutron shielding material independent of NAC NS-4-FR material from its Marlton, NJ facility.

This Audit resulted in the identification of one Finding (SR-2000-289-01) in Holtec Corrective Action Program. The Audit finding does not have any adverse impact on the results of this audit regarding the Holtite-A's performance.

### **Summary of Findings**

The Finding No.: SR-2000-289-01 will be documented in ComEd PIF (problem Identification Form) and Action Tracking System for further follow-up.

### **Finding No. SR-2000-289-01**

Holtec International QA Manager failed to implement its corrective action program for the identified discrepant material received from a sub-supplier which did not meet the purchase order requirements.

### **Narrative**

#### **Introduction**

Holtite-A is the Holtec International's neutron shielding material used in the company's HI-STAR 100 dual-purpose overpacks in the dry cask storage containers. Thermal characterization studies performed on Holtite-A by Holtec are documented in the HI-STAR Topical Safety

Analysis Report (TSAR), Holtec Report No. HI-941184 Revision 10, and HI-STAR Safety Analysis Report (SAR), Holtec Report No. HI-951251 Revision 8.

TSAR provides detailed information on Holtite-A that formed the basis for the regulatory acceptance of Holtite-A material for its use in the HI-STAR 100 casks. Holtec Report No. HI-2002396 Rev. 0 provides a development history and thermal performance data for Holtite-A.

In this report, the following topics were reviewed:

- Holtite-A and its relationship to NS4-FR
- Holtite-A thermal environment in HI-STAR 100
- Prior work on Holtite-A thermal characterization
- Recent work on thermal aging testing of Holtite-A and NAC-NS-4FR by Holtec International with many figures from various test results, etc.

The above report stated that Holtite-A emulates the neutron shielding material sold under the trade name NS-4-FR by the company Bisco Products which was involved in the development and marketing of neutron absorber material in the 1980s.

### Audit Summary

#### Procurement Control

Holtec has established acceptable quality assurance program requirements for the control of procurement activities. Per the requirements of their QA Program, Holtec initiated the process to secure NAC as a supplier of NS-4-FR (a safety significant material) and placed a safety related purchase order number 7071 MI to NAC in January 26, 1998.

The scope of the subject purchase order was for NAC to provide a limited quantity of NS-4-FR (with B4C loading between 1 and 1.2 weight percent and weight concentration of hydrogen of 6.0 +/- 0.1%) under NAC's 10CFR Part 72 Subpart G and 10CFR71 Subpart H QA Programs. NAC accepted the purchase order and delivered 4" dia. 24" long bars of NS-4-FR to Holtec for testing and evaluation.

The audit team determined that the use of the terminology "Safety Related" in the purchase order to NAC was incorrect. However, in the Attachment B of the subject purchase order, the appropriate code requirements (i.e. 10CFR 21, 10CFR71 Subpart H, 10CFR72 Subpart G) were evident and NAC's certificate of conformance certified to 10CFR71, Subpart H and 10CFR72, Subpart G.

Holtec's QA Manager took an action and documented that 10CFR50 Appendix B guidelines are almost identical to 10CFR71 Subpart H and 10CFR72 Subpart G and for a material manufacturer or fabricator, the certification to any one of these three CFRs would ensure compliance to the other two CFRs.

Holtec's QA Manager indicated that in most cases, fabricators and vendors are not familiar with 10CFR71 or 10CFR72, but are familiar with 10CFR50. Therefore Holtec typically imposes 10CFR50 Appendix B on any Safety Related or Important to Safety purchase orders. Holtec then certifies to the 10CFR71, Subpart H and 10CFR72, Subpart G standards as part of the final documentation package for the fabricated item. After November 1999, Holtec Procedure HQP 4.1 Rev. 6 has clarified the safety categories as "Safety Related" for wet storage procurements and "Important to Safety" for dry storage procurements. QA documentation of this issue was found to be acceptable.

NAC provided a Certified Material Test Report (CMTR) as required by Holtec purchase order attesting to the properties of the supplied material. During this audit all the associated documents were reviewed. Holtec sliced the submitted bars into 0.5" and 1.3" thick disks for thermal testing in Holtec's Florida Laboratory. The second piece revealed a disconcerting condition indicating that the disk contained "voids". Holtec's Dr. Turner, in his memorandum to Holtec's QA Manager, dated April 6, 1998 stated that NAC's NS-4-FR is not acceptable material for use as the neutron absorber material in the HI-STAR cask system. The samples did not meet the purchase order requirements and Holtec decided to disqualify NAC as a material supplier of NS-4-FR.

Holtec's QA Manager failed to initiate a nonconformance report in accordance with Holtec's QA Program requirements. The multiple correspondences between Holtec and NAC were reviewed during this audit. In NAC's correspondences to Holtec, NAC repeatedly stated that their product pouring and samples may not reveal the same results as the sample sent to Holtec and defended the quality of their neutron shielding material. NAC further stated that this material has been used in Japan and the United States. Holtec's QA Manager also failed to notify the NAC International that their product may be subjected to a potential Part 21 reportability. These two conditions are identified as **Finding No. SR-2000-289-01**.

Holtec P.O. No. 7118 TF, dated 10/14/99 to Galbraith Laboratories for the raw material testing imposed 10CFR 21, 10CFR50 Appendix B. The audit team reviewed the Holtec Approved Vendor List (AVL) Rev. 24, dated April 11, 2000. Galbraith Laboratories of Knoxville, TN was listed as a provider of analytical testing for Safety Related approved quality level. The basis for qualification of this vendor was the Audit No. 98-E08. Holtec's QA Manager conducted the subject audit on May 11, 1998. This audit expiration date was May 11, 2001 and no restriction was imposed on the vendor.

The review of the audit report and the checklist revealed that the subject audit had adequately covered the applicable quality assurance program requirements and was in compliance with the Holtec's QA Program.

#### Test and inspection Control

Holtec has established acceptable quality assurance program requirements for the control of testing and inspection of the Holtite-A material.

The audit team reviewed the Holtec manufacturing and testing Procedure for Holtite neutron shielding material, Holtec Document ID No. HPP-70718-10 Rev. 2, dated 8/20/99. The subject procedure included requirements for equipment, raw material testing and control, raw material batching, raw material mixing, Holtite Pouring and Holtite testing. Holtite-A is poured-in-place solid borated synthetic neutron absorbing polymer having a specified gravity, minimum hydrogen content, minimum boron carbide content and once poured must be void free. The responsibilities of Project and QA Managers, Fabricator's Project Manager and Quality Control Inspector and Shop personnel were all delineated in the procedure. The audit team reviewed the following requirements in the subject procedure:

- Required equipment, agitators and drive, vacuum hood, mix can with the specified features and control, etc.
- Equipment set up
- Material Receipt and testing
- Kit Batching including Warning on the instructions and use of Material Safety Data Sheet (MSDS) for handling and mixing activities for the applicable raw material
- Premixing preparation
- Mixing and vacuuming operation with Warning on the appropriate use of ATH to avoid an excessive amount of powder escaping into the atmosphere with monitoring the temperature during mixing of Holtite
- Material pouring operation
- Clean up
- Curing time, etc.

The subject procedures were found to contain adequate acceptance criteria and control.

For the technical review of the Holtite-A investigation and assessment, refer to the following three Technical Specialists' Summaries:

**Joseph Reiss (ComEd) Technical Summary**

The following References were reviewed during this audit

1. Letter from R.Smith to K.Singh dated 3/15/00
2. Letter from K.Singh to E.Davis dated 3/20/00
3. Letter from M.Soler to R.Smith dated 3/21/00
4. Letter from R.Smith to M.Soler dated 3/23/00
5. Letter from R.Smith to W.Brach dated 3/27/00
6. Inside NRC Volume 22, Number 7, dated 3/27/00
7. Letter from M.Soler to R.Smith dated 3/28/00
8. Letter from R.Smith to M.Soler dated 3/31/00

9. SpentFUEL dated 4/3/00
10. Holtec HI-STAR TSAR, Report HI-941184, Revision 10

### Allegation

References 1 - 9 contain the details of the NAC allegation, Holtec's responses to the allegation, and NAC's official notification to the NRC

### Investigation

Reference 10 clearly specifies the functional performance criteria for Holtite-A. These criteria are:

1. Attenuation of neutron radiation and associated neutron capture to appropriate levels.
2. Durability of the shielding material under normal conditions, in terms of thermal, chemical, mechanical, and radiation environments.
3. Stability of the homogeneous nature of the shielding material matrix.
4. Stability of the shielding material in mechanical or thermal accident conditions to the desired performance levels.
5. Predictability of the manufacturing process under adequate procedural control to yield an in-place neutron shield of desired function and uniformity.

Each of the performance criteria will be discussed separately.

### #1 Neutron attenuation and capture

Reference 5 states that Holtite-A has increased quantities of two critical constituents, hydrogen and boron.

NAC is correct in their assessment that the increased quantities of hydrogen and boron will alter the performance of Holtite-A as compared to NS-4-FR. Holtite-A will have improved performance as compared to NS-4-FR.

Increasing the amount of hydrogen present will result in more neutrons being thermalized (slowed down). The majority of the neutron dose from the HI-STAR cask is due to fast neutrons. Therefore, increasing the amount of hydrogen alone would reduce the neutron dose from the HI-STAR cask. However, the gamma dose would increase due to the increase in neutron capture reactions ( $n, \gamma$ ). The Elements of Nuclear Reactor Theory by Glasstone, et. al., describes the manner in which a target nucleus captures a thermalized neutron and produces a compound

nucleus in the excited state. The excess energy contained in this compound nucleus is emitted as gamma radiation:



Increasing the amount of boron will result in more thermalized neutrons being absorbed. If the amount of boron alone were increased, fast neutrons would be unaffected and the neutron dose would increase, while the gamma dose would decrease due to fewer (n,  $\gamma$ ) reactions.

When increases in hydrogen and boron are combined, the result is a reduction in both the neutron and gamma doses from the HI-STAR cask using Holtite-A as opposed NS-4-FR.

#### Durability of the material under normal conditions

Holtite-A has four ingredients:

1. Resin
2. Hardener
3. Aluminum trihydrate
4. Boron carbide

The first two are the essential ingredients for durability considerations. The last two are the manner in which the amounts of hydrogen and boron in the final mixture are controlled. Since Holtite-A uses the same resin and hardener as the original Bisco formula for NS-4-FR, the material's stability under normal thermal, chemical, mechanical, and radiation environments will be the same as that for the original Bisco product, which has been fully tested and in use in the nuclear industry for years without difficulty or incident.

Holtec's report HI-2002396 contains the details of additional long-term thermal testing at elevated temperatures. The purpose of this testing is to attempt to demonstrate that Holtite-A may be used at temperatures above 300° F. While this testing is incomplete, it does not matter, since the decay heat load limits contained in the current HI-STAR CoC will ensure that the thermal limits of Holtite-A will never be challenged.

#### Stability and homogeneous nature of the material matrix

Holtec procedures HPP-70718-10 and HPP-70718-11 developed during the manufacture of the full-scale prototype HI-STAR cask clearly demonstrate, by use of destructive examinations, that Holtite-A is both stable and homogeneous when the ingredients conform to the procurement requirements and are prepared and placed in accordance with the proper procedural processes.

#### Stability of the material under accident conditions

Section 5.1.2 of reference 10 (as well as the transportation SAR) clearly states that all Holtite-A is assumed to be completely destroyed under accident conditions and is replaced by a void in the supporting analyses. Therefore, despite the fact that all of the Holtite-A would not be destroyed under accident conditions, the analyses are conservative and the stability of Holtite-A under accident conditions is not an issue.

Predictability of the result of the manufacturing and placement processes

Holtec procedures HPP-70718-10 and HPP-70718-11 developed during the manufacture of the full-scale prototype HI-STAR cask clearly demonstrate, by use of destructive examinations, that Holtite-A is predictably uniform (hydrogen and boron properly distributed throughout the material) when the ingredients conform to the procurement requirements and are prepared and placed in accordance with the proper procedural processes.

Conclusion

The NAC allegation is completely without basis in technical fact. My review of the Holtite-A material and associated documentation during this audit determines that Holtite-A meets or exceeds all of the functional and performance requirements of both the HI-STAR TSAR and SAR.

Marlin L. Stoltz (SNOC) Technical Summary

Southern has been made aware of alleged issues regarding the qualification of Holtite-A as a neutron shield material deployed in the HI-STAR 100. On April 13th I represented Southern in a joint industry-initiated review to determine if there is substance to these allegations presented by NAC International. The scope of my personal review was to answer the question as to whether the presence of significant voids in NAC produced NS-4-FR samples purchased by Holtec International had a relevance to the product or process used by Holtec to install a neutron shield material similar to NAC NS-4-FR in production HI-STAR 100 Overpacks beginning with serial number 001.

A short list of questions was answered during my review to deduce whether Additional qualification efforts would be required of Holtec to properly certify Holtite-A for use in the HI-STAR 100.

Q1] Is Holtite-A the same material as NAC produced NS-4-FR?

A1] No. These products are very similar. However, Holtite-A is equivalent to Bisco produced NS-4-FR. Due to NAC's treatment of the NAC NS-4-FR formulation as proprietary, the only information available for

comparison of composition and properties to Holtite-A comes from a NAC Technical Brochure, which does not provide complete information. The information available leads one to conclude these products are similar, but not identical. Also NAC's correspondence with Holtec indicates that NAC NS-4-FR is a different product than Holtite-A.

Q2] Are the voids present in the NAC product samples indicative of voids that might be present in Holtite-A?

A2] NAC asserts in their explanation of these voids that no qualified process that would ensure a void free product was used to create the Holtec purchased samples. Conversely, Holtite-A is mixed and "poured" using a procedure recommended by one of the original developers of NS-4-FR's and verified to be free of significant voids during test pours and post-pour destructive examination.

Q3] Are mechanisms known that could result in the voids present in the NAC produced material?

A3] At least two such mechanisms were identified during interviews with Holtec's Indresh Rampall, i.e. introduction of air into the sample after initial set of the resin had begun, and internal gassing of the NS-4-FR caused by insufficient cooling for the test samples produced. NAC asserted in their correspondence to Holtec that no provisions were made to ensure voids were not present in the samples produced for Holtec.

Q4] Has Holtec applied appropriate rigor in their production of Holtite-A to ensure that the production pours is void-free?

A4] Holtec has documented calculations that demonstrate for a set of controlled conditions a void large enough to have a significant effect on Holtite-A's neutron shield performance would not exist. This assertion was demonstrated in the laboratory by deliberately introducing voids in scaled models of a HI-STAR 100 channel and noting the extremely rapid release of these voids prior to the initial set of the epoxy resin. Finally, a set of test pours was performed prior to production pours. These samples produced by the Holtec procedure were sectioned and examined and found to be void-free.

### Conclusion

The presence of voids in the NAC NS-4-FR samples does not indicate that similar voids should be expected in Holtite-A. The Holtec procedure is specifically designed to ensure voids are not produced during the mixing process nor introduced during the channel pours. By contrast, NAC asserted that no such care had been taken in producing the samples provided to

Holtec.

**Douglas R. Harrison (NYPA) Technical Summary**

The purpose of this evaluation is to review the documentation supporting material qualification of Holtite-A as a neutron shielding material. Due to a concern raised by NAC that Holtite-A is different from NS-4-FR and therefore cannot be qualified based upon test data used to license NS-4-FR, the basis and test data available for Holtite-A only is considered in this evaluation. The HI-STAR TSAR states that the design function for Holtite-A, a neutron shielding material, is:

1. Attenuation of neutron radiation
2. Durability during normal conditions, in terms of thermal, chemical, mechanical and radiation environments
3. Stability of the homogeneous material matrix
4. Stability of the shielding material during accident conditions
5. Predictability and repeatability of the manufacturing process

The TSAR lists the essential properties of Holtite-A in Appendix 1.B as:

1. hydrogen density
2. thermal stability of the hydrogen density
3. uniformity in distribution of the B4C

These are the acceptance criteria to be used when evaluating the test data and report for thermal and radiation testing.

The following documents were reviewed:

- Holtec Thermal Test Report
- Document Package for Holtite-A Mixing and Pouring Qualification Testing
- HI-STAR TSAR Appendix 1.B

There is abundant information on the history of NS-4-FR and the subsequent development of Holtite-A. This evaluation focuses on the information and test data to support Holtite-A, a new material, as a qualified neutron shielding material without reference to and reliance on previous data for BISCO NS-4-FR or NAC NS-4-FR. The reason these are listed as different materials is that there appears to be a difference between the NS-4-FR originally developed by BISCO, which Holtec claims is identical to Holtite-A, and NAC NS-4-FR which was supplied to Holtec in 1998 for confirmation testing.

The document package for the qualification of the mixing and pouring of Holtite-A was reviewed for both technical adequacy and QA requirements. The quality requirements specified

were appropriate given the quality categorization of Holtite-A, ITS Cat B, and were met for the testing and processing of Holtite-A. This satisfies requirement #5 for predictability and repeatability of the manufacturing process.

Criterion #1 requires that the material attenuate neutrons. This was measured successfully for the test samples and for the test pours from the fabrication of the first HI-STAR system. This will continue to be met for each application by testing prior to service.

Criterion #2 concerns the durability of Holtite-A in terms of the environmental conditions that it will experience during the lifetime use of the product. The thermal conditions have been analyzed and the most severe conditions emulated during thermal testing. The preliminary results substantiate previous testing of Bisco NS-4-FR and establish qualification of the material for 20 years of service. Holtite-A will not be subjected to adverse chemical and mechanical conditions during use. The radiation testing program is ongoing. The initial neutron attenuation capability was established via testing.

Criterion #3 concerns the stability of the homogenous matrix. Initial chemical analysis and post thermal testing inspection validate the stability of the material.

Criterion #4 for accident conditions does not require validation testing since Holtite-A integrity is not credited in any of the accident analyses.

#### Summary

The documentation provided to the NRC for the licensing of Holtite-A along with the previous test data of Bisco NS-4-FR and the testing completed by Holtec alleviate the concern raised by NAC that Holtite-A is unqualified or indeterminate. Holtec has demonstrated that Holtite-A meets the requirements detailed in the HI-STAR TSAR.

However, for use in cask systems at NYPA, material qualification is still ongoing. NYPA has questions related to the basis and results presented in the Thermal Report. Also, NYPA is awaiting receipt of the Radiation Test Report before acceptability for use at NYPA is approved. As stated upfront, NYPA's assumption is that Holtite-A is a new material and no credit for previous test data is given.

cc: Audit File SR-2000-289  
Duplicate File  
J. Reiss  
N. Leech  
P. Planing  
B. Christel  
T. Frazier at UST&D  
K. Singh (Holtec)  
M. Stoltz (SNOC)

D. Harrison (NYPA)

**Attachments**

Attachment 1 – Finding No.: SR-2000-289-01

Attachment 2 - Entrance/Exit Meeting Attendance/Personnel Contacted During the Audit

**Attachment 1**

**Finding No. SR-2000-289-01**

**Requirements:**

- Holtec QA Manual, Section 15, Rev. 8, Subsection 3.5 states “Noncompliance reports shall include a provision to evaluate the nonconformance for potential reportability under 10CFR21”.
- Holtec QA Manual, Section 15, Rev. 8, Subsection 4.1 states “It is the responsibility of any personnel functioning under the fabric of Holtec’s QA Program who detects a noncompliance to report it in accordance with applicable nonconformance procedures”.

**Discrepant Condition:**

Contrary to the above requirements, no nonconformance report (or corrective action report) was initiated by Holtec Engineering nor QA Manager for voids found in the NAC’s NS-4-FR samples. The sample was sent by NAC in accordance with the requirements of Holtec’s safety significant purchase order invoking NAC’s 10CFR 71 Subpart H and 10CFR72 Subpart G. The samples were tested by Holtec for acceptance and found to contain voids. The NAC’s sample did not meet the Holtec’s purchase order requirements.

In addition, Holtec received several correspondences from NAC claiming that the NAC’s NS-4-FR is a good quality product and has been used in Japan and the United States. Holtec’s review of the further correspondences from NAC revealed that Holtec was still not satisfied with the NAC’s technical arguments and disqualified NAC as a qualified supplier. Holtec did not practice its obligation to its QA Program requirements for notifying NAC for potential reportability under 10CFR 21 knowing that a safety significant item is used as claimed by NAC and that may have an adverse impact on public safety. Holtec should realize that implementation of the QA Program for meeting the requirements of 10CFR 21 is not a choice, but rather an obligation.

**Commitment**

Holtec shall identify the cause, corrective action, and action to prevent recurrence, and the expected completion dates.

**Attachment 2**

**Entrance / Exit Meeting Attendance/ Personnel Contacted During the Audit**

<u>Names</u>	<u>Entrance</u>	<u>Exit</u>	<u>Contacted</u>
Oscar Shirani, Audit Team Leader ComEd	X	X	
Mark Soler, QA Manager, Holtec	X	X	X
K. Singh, President, Holtec	X	X	X
J. Reiss, Project Engineer, ComEd	X	X	
M.. Stoltz, Project Manager, SNOG	X	X	
D. Harrison, Project Manager, NYPA	X	X	
I. Rampall, Lead Thermal Engineer, Holtec	X		X
Bernard Gilligan, Project Manager, Holtec	X		X
Evert Redmond, Lead Shielding/Criticality Engr.	X		X