May 14, 1996

FOR: The Commissioners

FROM: James M. Taylor /s/
Executive Director for Operations

SUBJECT: STAFF'S PROPOSAL FOR LICENSE TERMINATION FOR SCHOTT GLASS TECHNOLOGIES, INCORPORATED, DURYEA, PENNSYLVANIA, AND REMOVAL OF THE SITE FROM THE SITE DECOMMISSIONING MANAGEMENT PLAN

PURPOSE:

To inform the Commission of staff's planned actions to terminate the license at Schott Glass Technologies, Incorporated (Schott), in Duryea, Pennsylvania, and remove the site from the Site Decommissioning Management Plan (SDMP). This action would release the site, including an onsite landfill that contains relatively small, discrete volumes of thoriated glass chips and refractory block (containing unimportant quantities of source material), for licensee-proposed restricted use. The basis for release would be currently approved release criteria, as interpreted by the staff to address the discrete concentrations of disposed of radioactive material.

BACKGROUND:

In SECY-90-121, the original SDMP, and in subsequent revisions to the SDMP (SECY-91-096, 92-200, 93-179, and 95-209), the staff identified approximately 50 sites that warranted special oversight by the U.S. Nuclear Regulatory Commission to ensure timely and safe remediation of residual radioactive material in excess of the current NRC criteria for release for unrestricted use. One of these sites is the Schott property in Duryea, Pennsylvania.

Waste glass and materials from manufacturing of glass, including thoriated glass, were placed in a landfill on the licensee's property from 1969 until 1980. Schott received NRC staff approval, under 10 CFR 20.302 (now 10 CFR 20.2002), in 1990, for disposal of thoriated glass at the onsite landfill. After beginning the remediation actions approved in early 1990, on September 28, 1990, the licensee informed NRC Region I that the remedial action would not continue until a modified remediation plan was approved by both the Commonwealth of Pennsylvania Department of Environmental Resources (PADER) and NRC, because lead, a non-radioactive hazardous material, had been found in the landfill.

Staff proposes to authorize the thoriated glass to remain in the landfill with the refractory block, based on Option 1 of the Branch Technical Position (BTP) "Disposal or On-site Storage of Thorium (Th) or Uranium Wastes from Past Operations" (46 FR 52601, October 23, 1981), as identified in the "Action Plan to Ensure Timely Cleanup of Site Decommissioning Management Plan Sites" (57 FR 13389-13392, April 16, 1992). Critical to this authorization proposal is staff's determination that the radioactivity in the thoriated glass and refractory block can be averaged over the landfill mass.(1) This material is uniformly distributed with much larger quantities of non-radioactive glass (cullet) and smaller amounts of lead oxide.

To address potential issues regarding (1) the discrete nature of the disposed of radioactivity, and (2) the commingling of the radioactive material with the hazardous material, the staff believes the licensee's proposal for capping the landfill and implementing appropriate deed restrictions is reasonable and prudent and complies with "as low as is reasonably achievable" (ALARA) principles. These actions will reduce any potential for future exposures to lead and will address the radiological issues unique to this site.

A detailed history of the site is provided in Attachment 1. Attachment 2 discusses the site characterization and the remediation plan. The remediation plan for the lead contamination was approved in March 1993, by PADER (now PA Department of Environmental Protection (PADEP)), and PADER requested that NRC promptly make its decision regarding approval of the remediation plan (see Attachment 3). PADEP endorsed this view again during discussions between Schott, NRC, and PADEP representatives on March 19, 1996. The U.S. Environmental Protection Agency (EPA) does not have to give a separate approval from that of PADEP.

Staff generally informs the Commission about its intent to release an SDMP site after completion of the remedial action. However, in this case, the staff is providing the Commission an opportunity to review the proposed remedial action in advance because the staff is applying the radiological criteria for decommissioning to the disposal of discrete concentrations of radioactive material. For most SDMP sites, the soil concentration criteria are applied in a manner that allows limited averaging over a local area. In the case of Schott Glass, the staff is applying the 10µR/hr exposure rate criterion along with the soil concentration criterion for Th averaged over the entire volume of the landfill. Although the average concentrations for Th fall below the 10 pCi/g criterion in Option 1 of the 1981 Branch Technical Position, individual pieces of glass that contain the Th may be well in excess of 10 pCi/g (e.g., 50,000 pCi/g). The staff believes that this application of the criteria is justified by the particular circumstances at Schott Glass (i.e., previous disposal; licensed material intermingled with hazardous waste, enhanced naturally occurring radioactive material and non-radioactive waste; and low public health risk).

DISCUSSION:

Although individual pieces of the thoriated glass have a higher concentration, the thorium limit in the BTP (0.37 becquerels (Bq) or 10 picocuries (pCi) per gram (g)) and the uranium limit in the BTP (0.37 Bq (10 pCi)/g) are met by averaging the thorium in individual pieces of glass, and thorium and uranium in certain refractory materials, over the entire landfill mass. The multi-layered cap in the licensee's remediation plan will reduce external dose rates to within the normal background variation, for the site vicinity, of 0.07-0.18 microSievert (µSv) or 7-18 microrem (µrem) per hour. Leaving the thoriated glass and refractory block undisturbed in the landfill also reduces exposure of remediation workers to lead, a hazardous material, and limits releases of lead by air and water to offsite areas during remediation. Attachment 4 provides the staff's consideration of the consequences of hypothesized cap-intrusion scenarios, using unique site features, the ALARA analysis, and the staff's evaluation of alternate remediation options.

The multi-layered cap, deed restrictions, and the relative unlikelihood of interactions with the thoriated (i.e., unattractive yellow) glass, reduce any possibility of an intruder excavating for collectibles in the future and substantially interacting with the thoriated glass. Staff has, however, assessed the hypothesized situation where the restrictions fail, an intrusion takes place, and an individual both periodically wears a thoriated glass pendant and lives in a house with a display jar of the thoriated glass. This hypothetical individual would not receive an annual dose in excess of 1.04 mSv (104 mrem). If this same individual also excavated and shaped the pendant, an additional one-time dose of 0.53 mSv (53 mrem) could be incurred.

NRC staff will require that Schott take the actions outlined below, in addition to its proposed actions, before granting license termination.

CONCLUSIONS:

Based on staff review of the docket files, NRC radiological survey reports, and soil sample results conducted to date, as well as the staff ALARA analysis, the staff concludes that the licensee's proposed final remediation plan for an onsite disposal of thoriated glass, and release of the site for restricted use, is acceptable upon completion of the following actions.

The staff will require that Schott: (1) provide a timetable for completion of the landfill remediation plan (e.g., installation of the multi-layered cap); and (2) inform Region I when all activities are completed and ready for Region I final confirmatory inspection of the landfill, and the buildings, and unaffected areas. In addition, staff will support, as prudent and reasonable actions, licensee's plans to file with Luzerne County a deed that (1) identifies the landfill area subject to a PADEP-approved solid waste closure plan; (2) limits the site to industrial use, and imposes restrictions on excavations; and (3) permits access to both Schott and PADEP for a period of 10 years, for purposes of inspection of the multi-layered cap, to control migration of lead. Region I will conduct inspections during installation to establish if the cap is constructed in accordance with the design, and conduct a final close-out survey of the landfill and the manufacturing building.

The final remediation plan that the licensee proposed, with inclusion of the aforementioned PADEP conditions for release, is the most cost-effective remediation alternative and represents the best balance between the costs and the risks associated with this site. Region I will meet with Schott to discuss implementation of the above actions, after approval of these recommendations. We expect State participation in these discussions.

On completion of a final confirmatory survey, Region I will transmit a copy of the final inspection report and confirmatory survey to PADEP, as the EPA- designated State agency for hazardous waste. When the above actions are completed, the staff will notice in the Federal Register (FR) that the site meets NRC guidelines for release, and NRC intends to terminate the license and remove the site from the SDMP. The FR notice will announce a public meeting to solicit public comments on the NRC actions. Following the public meeting and review of comments, the staff will inform the Commission of its intent to terminate the license and remove the site from the SDMP and provide a summary of the completion of the remedial action.

RECOMMENDATIONS:

Note that it is the staff's intention to pursue the course of actions described, unless instructed otherwise by the Commission, within ten working days from the date of this paper.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objection.

James M. Taylor
Executive Director for Operations

Attachments:
1. Site History
2. Characterization Activities and Remediation Plan
3. PADER Letter to NRC Region I, dated 3/18/93
4. ALARA Analysis

ATTACHMENT 1

SITE HISTORY

Schott Glass Technologies, Inc. (Schott) is located on 26 hectares (65 acres) in a small industrial park on the outskirts of Duryea, in northeastern Pennsylvania. Duryea is approximately 12 kilometers (km) (7 miles (mi)) north of Wilkes Barre and 12 km (7 mi) south of Scranton, Pennsylvania. This is a hilly region, with a low population density. An apartment house, a cluster of homes, and a ball field are located beyond 152 meters (m) (500 feet (ft)) north and northwest of the property. An unrelated manufacturing facility is beyond 244 m (800 ft) northeast of the property. Woods and underbrush are located to the south and east.

The Schott property is located on a hilltop and includes a steep hillside. The Schott building, constructed of masonry and steel, has 23,100 square meters (m^2) (248,700 square feet (ft^2)) of manufacturing, office, and laboratory space. Schott manufactures glass in various shapes and forms, including leaded glass shielding windows. These are not always sold as finished products, but rather as intermediary products used by other glass and electronic optical companies. From 1969 to 1980, Schott manufactured about 7700 kilograms (kg) (17,000 pounds (lbs)) of glass containing up to 30 percent (with an average of 17 percent) by weight of thorium, under the authorization of U.S. Nuclear Regulatory Commission License No. STB-988. The 7700 kgs (17,000 lbs) is a small fraction of the total glass produced by Schott during that time. The building used to manufacture the thoriated glass was surveyed for contamination in 1979 and the licensee reported that no radioactive contamination exists in the building.

Waste glass and materials from manufacturing glass, including thoriated glass, were placed in a parabolic-shaped landfill area on the licensee's property, west of the Schott building, from 1969 until 1980. Schott's current NRC license authorizes possession of this glass incident to decommissioning only.

Schott received the NRC staff approval, pursuant to 10 CFR 20.302 (now 10 CFR 20.2002), in 1990, for disposal of thoriated glass at Schott's onsite landfill. The approval was based on the review by NRC Region I and the Division of Low-Level Waste Management and Decommissioning (now the Division of Waste Management).

The remediation plan submitted in 1988, approved in 1990, and later revised to address NRC comments, was based on Option 1 of the BTP "Disposal or On-site Storage of Thorium or Uranium Wastes from Past Operations." Option 1 limits the concentrations of total thorium (thorium-232 and thorium-228) to less than 0.37 becquerels (Bq) (10 picocuries) (pCi))/gram (g). This criteria was met by averaging the total thorium contained in the thoriated glass over the entire burial volume. The licensee estimates that 0.01 percent of the total volume of the landfill is thoriated glass.(2)
The remediation plan was to be implemented in four phases. A preliminary survey would be conducted of the affected area, unaffected areas, and buildings. Offsite background measurements would be taken to determine an average background exposure rate for the area. During the second phase, small pieces of thoriated glass located within the top 1.2 m (4 ft) of cover were to be excavated and transferred to a licensed facility for disposal. Clean soil from unaffected areas would be placed over the excavated area in the third phase, restoring the topography of the landfill. Lastly, in the fourth phase, a final survey of the landfill would be conducted, after which the area would be planted with a ground cover for erosion control.

On May 29, 1990, NRC approved the proposed plan and incorporated into Schott's license an additional requirement to remove thorium scrap pieces within the top 1.2 m (4 ft) and replace voids with clean soil. It was expected that only a small fraction of the thoriated glass would be recovered during implementation of this remediation plan.

In June 1990, while digging test pits around the landfill to delineate the landfill boundaries, batch glass, which contains lead oxide, was observed. Soil samples were taken and elevated lead levels were found in the landfill and in an erosion washout that extended to a local ball field.

On September 28, 1990, the licensee informed the NRC that the remedial action would not continue until a modified remediation plan was approved by both Pennsylvania Department of Environmental Resources (PADER) (now PA Department of Environmental Protection) and the NRC, because lead, a non-radioactive hazardous material had been confirmed in the landfill and offsite. Schott stated that the NRC and PADER should approve the modified remediation plan because it is the most cost-effective way to prevent an airborne lead hazard to remediation workers and offsite lead contamination. PADER approved the remediation plan, which is described next, in Attachment 2.

ATTACHMENT 2

CHARACTERIZATION ACTIVITIES AND REMEDIATION PLAN SCHOTT GLASS TECHNOLOGIES, INC., DURYEA, PENNSYLVANIA

CHARACTERIZATION

The licensee developed the following characterization information through extensive review of operational records, interviews of employees, and physical measurements at the landfill.

Located on the west side of the Schott Glass Technologies, Inc. (Schott) manufacturing building, the landfill is approximately 7757 square meters (m^2) (83,500 square feet (ft^2)) in areal extent and contains 11,468 cubic meters (m^3) (15,000 $yards^3$) of scrap cullet, thoriated glass, refractory block, grinding sludge, and off-spec batch. The landfill contents are uniformly distributed at depths from 15 centimeters (cm) (6 inches (in.) to 6.1 m (20 ft) of the current surface with an average depth of 1.5 m (5 ft). The depth of the material varies because the landfill boundaries extend down a very steep slope.

The cullet, which is non-radioactive waste glass in various colors and forms, accounts for approximately 80 to 90 percent of the landfill. The thoriated waste glass varies from small chips to pieces about 60 cubic centimeters (cm^3) (36 cubic inches ($in.^3$)) in size with thorium concentration from 148 becquerels (Bq) (4000 picocuries (pCi))/gram (g) to 1.8 kilobecquerels (kBq) (0.05 microcuries (µCi))/g. The licensee estimates there are about 3700 kgs (8,100 lbs) of thoriated glass in the landfill. At an average concentration of 17 percent thorium, the thoriated glass contains approximately 629 kgs (1,377 lbs) of source material, with an estimated volume of 0.85 m^3 (30 ft^3) filling 0.01 percent of the landfill volume. This volume estimate is based on an average density of 4.33 g/cm^3 for the thoriated glass, which is similar to the other cullet. The remainder of the landfill contents are conservatively estimated at 2 g/cm^3 to determine concentrations on a weight basis.

The licensee estimates that 162 Megagrams (178 tons) or less than 1 percent of the landfill material, is used AZS (Alumina-Zirconium-Silica) refractory block. This material is used to line the glass furnaces and contains natural thorium and uranium in concentrations of about 0.6 Bq and 5.5 Bq (17.7 pCi and 150 pCi)/g, respectively. The refractory was exempt from the requirement for an U.S. Nuclear Regulatory Commission license (10 CFR 40.13) because the concentration is less than 0.05 percent by weight (calculated to be 0.03 percent). Nevertheless, this material has been considered in the assessments and conclusions in this paper. An additional 4.4 mBq (0.12 pCi)/g total thorium and 37 mBq (1 pCi)/g of total uranium contribute to the average source term of 0.2 Bq (6 pCi)/g of total thorium from the thoriated glass.

The licensee estimates that 7 percent of the landfill material are off-specification batch and grinding sludge that contains lead oxide. This is produced during the finishing of some products. Samples indicate lead levels as high as 29,757 parts per million (ppm); pockets of pure lead oxide are known to be present in the landfill. Soil containing lead was excavated in 1991 from an erosion washout that extended to an offsite ball field and is stored adjacent to the landfill. The licensee proposes to add this soil, which contains residual lead concentrations, to the landfill, during the closure process.

Licensee site characterization surveys at 20 meter (m) (66 ft) grid points indicate a general area dose rate of 0.16 microSieverts (µSv) (16 microrem (µR))/hour (hr) with an average background radiation dose rate of 0.10 µSv (10 µrem)/hr. Highest surface and one meter (3 ft) height dose rates are 2 µSv (200 µR)/hr and 0.9 µSv (90 µR)/hr, respectively. These values are in agreement with the average external dose rate, 0.09 µSv (9 µR)/hr, calculated using dose conversion factors from Federal Guidance Report 12 for thorium and uranium in equilibrium with its progeny. During preliminary survey activities in June 1994, approximately 1100 kgs (500 lbs) of thoriated glass were removed, resulting in a reduction of the dose rates to these values. The licensee determined from field observations that the major contributor to the dose rate above background is the refractory material. Contact measurements on the refractory block are as high as 1.10 to 1.20 µSv (110-120 µR)/hr. Soil samples from the landfill average less than 74 mBq (2 pCi)/g, approximately the site background. This is similar to local background and indicates that thorium has not moved from the thoriated glass or the refractory block.

The ground water in this industrial area was assessed by the licensee as a condition of the Pennsylvania Department of Environmental Resources (PADER), now Pennsylvania Department of Environmental Protection (PADEP), approval. The licensee's consultant reported ground water is greater than 30.5 m (100 ft) below the surface and this water is non-potable because of its high mineralized content from former coal mining activities. The primary drinking water aquifer is within the Catskill Formation, which is several hundred feet below the surface. The thoriated glass is very stable and relatively non-leachable, meaning that the thorium is not readily available for transport in the ground water. The thorium and uranium is not expected to leach from the refractory material, which is ceramic and very stable. Although material leaching test data are not available, there is no evidence of thorium in surface or ground water and it was not transported off-site when erosion moved lead oxide from an area of the landfill. Consequently, transport via groundwater or surface water does not appear to be a significant pathway.

REMEDIATION PLAN

The "Final Remediation Work Plan" submitted by Schott (letter dated November 5, 1992) and the "Revised Schott Remediation Work Plan" submitted by Schott (letter dated June 1, 1993) differ from the previously approved plan in that the first 1.2 m (4 ft) of the landfill will not be disturbed. Therefore, no additional buried thoriated glass will be removed. Instead, a multi-layered cap and erosion control plan consisting of a high-density polyethylene (HDPE) textured synthetic liner, HDPE composite drainage net, and granular drainage layer, with either a vegetative soil layer or asphalt layers will cap the existing landfill. The HDPE, below-grade liner will have an additional cover of at least 76 cm (30 in) of soil and structural fill. One-third of the landfill area will be paved with asphalt and the other two-thirds will be raised to grade level by the addition of foundation fill.

The Schott remediation plan requires measurement of gamma exposure rates at undisturbed locations near the landfill and within the fill area before construction of the cap. The fill area will be systematically surveyed at 10 meter (33 feet) spacings at the surface, and at 1 meter (3 ft) heights. Grid points will be further divided if elevated exposure readings (greater than 0.1 µSv (10 µrem)/hr are identified. Any thoriated glass found on the surface will be removed and disposed of at a low-level radioactive waste facility. A replicate survey of the area will be completed after installation of the cap.

Schott proposes that these added layers will reduce the external dose to regional background levels, provide long-term erosion control, and reduce the likelihood of future excavation of the landfill.

In March 1993, PADER conditionally approved the plan submitted in December 1992. Schott revised and resubmitted the plan based on PADER's conditional approval and NRC Region I comments on June 1, 1993. PADER approved the revised proposal, which included a condition requiring a corporate deed delineating the landfill site and closure plan for waste management activities. The Region I staff conducted an inspection in 1993 to gather additional information, and requested and received additional information from the licensee in letters dated July 30, 1993; June 14, 1994; July 24, 1995; and March 11, 1996. NRC engineering staff reviewed the architectural/engineering documents for the proposed cap system and found that it is structurally sound. Analysis of future hypothetical exposure scenarios and an ALARA (as low as is reasonably achievable) analysis (Attachment 4) indicate the landfill presents an overall low risk to the public.

COMPARISON WITH NRC GUIDELINES

The engineered cap will reduce average external dose rates to within the normal background variation for the site vicinity of 0.07-0.18 µSv (7-18 µrem)/hr, resulting in no increased dose from undisturbed occupancy. There will be little or no migration of thorium to drinking water, even over extended time, because the thorium is in vitrified glass, or the thorium and uranium are incorporated into a ceramic brick. Therefore, no dose is expected from this pathway. The criteria in NRC's Branch Technical Position (BTP) are met by averaging the total thorium and total uranium over the entire landfill, giving an average concentration of 0.2 Bq (6 pCi)/g and 37 mBq (1 pCi)/g, respectively. Evaluations, however, have been made that consider interactions with the discrete concentrations of thorium from pieces of thoriated glass, presuming failure of the cap in the future.

Using the information submitted by the licensee on June 14, 1994, and July 24, 1995, including evaluation of future scenarios, limited ALARA analysis, and lead remediation criteria, the NRC staff verified the licensee's conclusions using the Microshield and RESRAD computer codes, and prepared a formal ALARA analysis. Attachment 4 contains the ALARA analysis and provides additional details about the staff's evaluation of other remediation options.

The staff evaluated the potential Total Effective Dose Equivalents (TEDE) for three hypothesized scenarios: (1) a one-time annual TEDE of 1.57 mSv (157 mrem) and, thereafter, a Deep Dose Equivalent (DDE) of 1.04 mSv (104 mrem)/yr to the individual who excavates the landfill, fashions a 50-carat pendant by grinding, wears the pendant occasionally, and displays the thoriated glass in a display jar at home; (2) a one-time TEDE of 530 µSv (53 mrem) and, thereafter, a DDE of 40 µSv (4 mrem)/yr for an individual who fashions a 50-carat pendant by grinding, and wears the pendant once a week; and (3) a TEDE of 100 µSv (10 mrem)/yr to future workers, based on working in a building erected over the landfill, without benefit of the cap.

Considering these results in light of (1) the likelihood of the specific scenarios evaluated and (2) the few individuals likely to receive any dose, the staff believes that it is acceptable to proceed with release of the site under Option 1 of the BTP.

Before terminating the license, NRC staff will continue to support, as reasonable and prudent, the licensee's actions (i. e., filing a deed that identifies the landfill area that requires a PADEP approved waste closure plan, restricts use to non-residential and limits excavation, and allows access by Schott and PADEP for periodic inspections of the engineered cap). These actions will increase the assurance that the cap will remain effectively in place.

ATTACHMENT 4

ALARA ANALYSIS

U.S. Nuclear Regulatory Commission staff completed an as low as is reasonably achievable (ALARA) analysis. Four remediation alternatives are compared by considering radiological and non-radiological fatal risks, cost impacts, and, based on limited information, social, cultural, and resource impacts.

ESTIMATE OF IMPACTS

Impacts were evaluated based on information submitted by Schott Glass Technologies, Inc. (Schott) in letters dated June 14, 1994, and July 24, 1995, and NRC independent radiological calculations using RESRAD and Microshield computer codes, NRC guidance, and NRC judgements. Schott's submittals include data from assayed samples of thoriated glass, exposure rate measurements, and calculations of radiological impacts, as requested by NRC, for evaluation of the remediation workers, post-remediation workers, an individual glass scavenger and members of the public. This analysis also lists the risks from lead exposure, qualitatively. NRC staff generally agree with the licensee's qualitative assessments, except for the cap alternative, in the distant future, when the effectiveness of the cap is uncertain. NRC staff practice, beyond that of the licensee's, has been to assume no cover when evaluating future exposures. Under these assumptions, NRC has assessed low to medium potential risk from the thorium and lead, respectively. This radiological risk is judged acceptable under NRC "Action Plan To Ensure Timely Cleanup of Site Decommissioning Management Plan Sites" (57 FR 13889-13392).

NRC staff considered a variety of pathways, identified the critical pathways and made independent calculations of the exposures from those pathways. In addition, the staff performed qualitative assessments of other risks associated with the alternatives. A summary of the qualitative risk assessment performed by NRC staff is provided as Table 1; a listing of radiological data used is provided in Table 2.

NUREG/CR-5512, *Residual Radioactive Contamination from Decommissioning* (October 1992), describes scenarios for evaluating future doses from decommissioned facilities. The residential family farm and drinking water scenarios, described in NUREG/CR-5512, are not applicable for this site for the following reasons: The Schott facility is in an industrial area; two-thirds of the landfill are on a steep gradient with mostly compacted glass chips and very little intermixed soil; the ground water assessment performed by the licensee's contractor found the water non-potable because of previous coal mining activities; and the relatively small quantity of thoriated glass is in a vitrified glass form, with negligible quantities in the form of grinding sludge. These factors preclude farming, make it unreasonable for a house foundation to be placed in a hillside, and limit the transport of thorium to the groundwater - which is not potable, in any case.

NMSS Policy and Guidance Directive PG-8-08: *Scenarios for Assessing Potential Doses Associated with Residual Radioactivity*, states that if the existing and projected future uses of the site are most likely industrial, the ALARA analysis can place greater emphasis on the dose estimates from the industrial- use scenario. Therefore, because there is currently no building on the area, construction of an office building with the foundation set in the level area of the landfill was considered.(3)

The source term selected was 0.2 becquerels (Bq) (6 picocuries (pCi))/gram (g) of total thorium (Th-232 and Th-228) and 37 millibecquerels (mBq) (1 pCi)/g of total uranium in equilibrium with its progeny (average based on the volume of radioactive thoriated glass and refractory material in the landfill) as an infinite plane volume source. Because the thorium and uranium are fused into the glass matrix or incorporated into the ceramic brick, the primary exposure pathway is external exposure from an infinite plane, but the inhalation pathway is also included. Using the RESRAD computer code with combined external and inhalation pathways, a potential Total Effective Dose Equivalent (TEDE) of 100 microSievert (µSv) (10 millirem (mrem))/year (yr) to future workers in such a building was calculated.

Potential dose commitments to an individual member of the public were determined assuming an individual excavates the landfill by hand; collects thoriated glass; grinds and wears a 50-carat pendant containing 1.85 kilo bequerels (kBq) (0.05 microcuries (µCi)/g) of thorium; and collects and then displays a jar of thoriated glass containing 1.4 megabecquerels (MBq) (39.1 µCi) at his/her residence. Calculated dose rates were 0.38 µSv (38 µR)/hr to the breast tissue while wearing the pendant, and 0.42 µSv (42 µrem)/hr at one meter (m) (3 feet) from the display jar. This scenario was included in the evaluation despite the current non-monetary or non-aesthetic value of the yellow glass and the difficulty of excavating rock-like surfaces under the multi-layered cap.

ASSESSMENT OF RISKS AND COSTS

The four options considered are: Option 1: No Action; Option 2: Cap/Erosion Control Plan (as proposed by licensee); Option 3: Removal of Entire Landfill, 100 Percent Disposal as Mixed Waste; and, Option 4: Removal of Entire Landfill, Separation of Thorium from Hazardous Waste with 100 Percent Disposal. The "no-action" alternative assumes the present condition with the thoriated glass mixed within the landfill with no cover and the lead- contaminated soil, removed during the previous offsite remediation, piled under a plastic cover. The second option is the licensee's proposal, which is an onsite disposal of both the thoriated glass and lead for a cost of $0.4 million. Options 3 and 4 both involve disturbing the landfill and removing the material, with Option 3 disposing of all material as mixed waste for a cost of $77 million; and Option 4, separating the thorium from the lead, and disposing of the thoriated glass and lead-contaminated soil separately, for a cost of $8.6 million.

The assessments are summarized in Table 1. This comparison shows that the small incremental increase in risk for the individual glass collector (Options 1 and 2) is similar to the remediation worker's incremental increase in risk for Option 4. However, Schott does not believe a collector would select the thoriated glass over the more desirable glass cullet of cobalt blue, red, and white that are more prevalent in the landfill. Therefore, the risk from this pathway is far less likely than stated.

The more significant radiological and non-radiological impacts are to workers in the future years, from Options 1 and 2. This assessment assumes 30 persons in an office building (2585 square meters (m^2) (3092 square yards) (yds^2) set into the level portion of the landfill about 100 years in the future. The occupants are exposed to thorium and lead, because the cap is assumed to have been removed along with no decrease in the thorium or lead concentrations. The licensee proposed deed restrictions for the landfill will reduce the likelihood of this scenario.

Lead risks have the potential to vary from low to high in all four options for both workers, and the general public. However, medium to higher risks are more certain now -- with no action, or by disturbing the landfill, in comparison with the more uncertain future conditions. ALARA guidance in the *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD* suggests that known risks should be emphasized more than hypothetical risks.

For removal and 100 percent disposal (Options 3 and 4), costs are a factor of 20 to 200 times higher than Option 2, with Option 2 presenting a small increase from hypothesized radiological risks (less than 10 person- centiSieverts (cSv) or person-rem in thirty years) and a higher risk from lead exposure to future workers. From only the radiological standpoint, the cost per unit of reduced collective exposure for Options 3 and 4 would be greater than $960 thousand per person-cSv (person-rem), without considering that the remediation inherent to these options will result in some collective exposure. To provide some perspective, NRC (in *NUREG-1530*), currently recommends $2000 for a person-cSv (person-rem) of collective exposure in order to place all values and impacts on a common basis. Options 3 or 4

could also result in economic and social impacts from potential loss of employment if Schott were to cease operations. Transportation and accident risks are negligible for all three remediation options, because of the limited road miles and duration of the project associated with any of the removal options.

ALARA ANALYSIS CONCLUSIONS

The overall collective risks from Schott's proposal (Option 2) are similar to the significantly more costly Options 3 and 4. In any case, it appears that the presence of the lead contributes most of the risk for all scenarios. The plan has been approved by Pennsylvania Department of Environmental Resources (PADER), now the Pennsylvania Department of Environmental Protection (PADEP), the agency responsible for control of risks from lead.

The use of institutional controls would alter the scenarios for Option 2, reduce the likelihood of excavation or intrusion into the landfill, and place these potential risks on balance with the other potential risks from the other options.

PADER evaluated the lead contamination as part of its approval of Schott's proposal to cap the landfill and to include under the cap the lead-contaminated soil that had moved along the storm cut to a nearby offsite ball field. Although there are no health risk values for direct comparison with risks from ionizing radiation, lead levels, in soil, that would be protective to human health, have been established to not exceed 600 parts per million (ppm) for industrial sites and 200 ppm for non-industrial sites. During the remediation of the wash-out and ball field, soil was considered contaminated if greater than 100 ppm, which was considered not distinguishable from background. Schott representatives are most concerned that disturbing the landfill to locate the small quantity of thorium (<0.01 percent of the landfill material) would create a lead airborne hazard to the workers and could easily spread the contamination offsite.

The costs of achieving the radiological risk reductions in Options 3 and 4 are prohibitively expensive and the associated disturbance of the landfill increases the potential for lead exposure to remediation workers and potential environmental hazard to offsite areas.

Schott has contacted local officials and has informed them of the pending multi-layered cap proposal for the landfill, and NRC staff is not aware of any local officials' concerns regarding this onsite disposal plan.

Based on all the information available and consideration of the options, the best balance of risk and cost is achieved by implementing Option 2.

Table 1: Summary Sheet

	NO ACTION	CAP/EROSION PLAN	100 % MIXED WASTE DISPOSAL	SEPARATE THORIUM 100 % DISPOSAL
Thorium (Th) Risk/Public[a]	0.004	Negligible	Negligible	Negligible
Th Risk/Collector[b]	0.007	0.007	Negligible	Negligible
Th Risk/Remediation Workers	0	Negligible	0.0001[c]	0.0002[c]
Th Risk/Workers/Post Action	Low	Low	0	0
Th Risk/Workers/Future Use[d]	0.01	0.01	0	0
Lead (Pb) Risk/Individual	High	Medium	Negligible	Negligible
Pb Risk/ Offsite Areas	Medium	Low	Negligible	Negligible
Pb Risk/Remediation Worker	0	Low	Medium	High
Pb Risk/Workers/Post Action	Low	Negligible	Negligible	Negligible
Pb Risk/Future Use	High	High	Negligible	Negligible
Cost of Remediation Option	0	$0.4M	$77M	$8.6M
Social/Cultural Impacts[e]	Medium	Low	High[g]	Medium[g]
Ecological/Resource Impacts[f]	Medium	Negligible	Negligible	Negligible

NOTES

Thorium risks are calculated using Collective Statistical Mortality from fatal cancer per NUREG-1500. Transportation and Accident risks are considered negligible.

a. No action presumes 0.06 µSv (6 µrem)/hr, 5360 eff. hrs of exposure, 2500 m^2/person, 70 yr exposure period.
b. Collector risk presumes 1 mSv (100 mrem)/yr, 2 people, 70 year exposure period
c. Remediation Worker Risk presumes 2 mSv (200 µrem)/hr, 10 people, and 3 to 6 month occupational exposure period.
d. Future Use: Beyond life of cap. Assume time=100 years, 100 µSv (10 mrem)/yr, 30 people, 70 yr exposure period.
e. No impacts raised by Pennsylvania DEP, and area officials were informed.
f. Landfill since beginning of operations. Area beneath the facility had been mined for coal.
g. High cost could affect future existence of company.

Table 2: Scenario Data

SCHOTT Measured

Landfill Surface Pendant (2 grams Th)	Contact dose rate - 0.16 µSv (16 µR)/hr; 1 m dose rate - 0.16 µSv (16 µR)/hr 1.1 µSv (110 µR)/hr contact; 0.1 µSv (10 µR)/hr at 15 cm (6 in.) Deep Dose Equivalent (DDE) = 0.04 mSv (4 mrem)/yr based on 400 hours of wear
Committed Dose Equivalent from Grinding	5.1 E-7 µCi/m^3 = 0.5 mSv (50 mrem) for 32 hours
Estimate for Excavation and Transporting Material	DDE = 0.03 mSv (3 mrem)
Display Jar (358 g Th)	20 µSv (2 mR)/hr contact; 0.42 µSv (42 µR)/hr at 1 m DDE = 1 mSv (100 mrem) based on 2527 hours indoors

NRC Calculated

Landfill/No cover/Infinite Depth (Federal Guidance Report No. 12)

Source Term: 0.2 Bq (6 pCi)/g total thorium (Th) and 37 mBq (1 pCi)/g of total uranium
Dose Rate = 0.09 µSv (9 µR)/hr

BUILDING OCCUPANCY SCENARIO (RESRAD)

External, Inhalation, and Radon Pathways Total Effective Dose Equivalent (TEDE) = 100 µSv (10 mrem)/yr
Standard assumptions from PG-8-08, except for time = 100 years; area = 2585 m^2
Average concentration of radioactive material:
0.2 mBq (6 pCi)/g of Th-232 & Th-228 and 37 mBq (1 pCi)/g total uranium
Est. Cost /Collective Exposure 1/(10 mrem/yr x 30 persons x 30 years) x $8.6M = $960K/person-rem

GLASS SCAVENGER SCENARIO (Microshield)

Pendant5 µSv (500 µR)/hr contact0.38 µSv (38 µR)/hr to Breast Tissue
Display Jar0.42 µSv (42 µR)/hr at 1 m
Pendant DDE= 0.15 mSv (15 mrem)/yr based on 400 hours
Display Jar DDE= 1 mSv (100 mrem) based on 2527 hours indoors

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1. The licensee estimates that about 0.01 percent of the volume of the landfill is thoriated glass and less than 1 percent consists of refractory block.

2. This approval did not include the refractory material, because previous NRC policy did not include consideration of "unimportant quantities" of thorium and uranium as defined at 10 CFR Part 40. The characterization and assessment that follow address the commingled NRC licensed and non-licensed material.

3. Schott indicated that it does not plan to build over the landfill, but will use a portion of this area as a turnaround area for trucks.