

November 20, 2007

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Naval Sea Systems Command Detachment  
Radiological Affairs Support Office (RASO)  
Department of the Navy  
NWS P.O. Drawer 260  
Yorktown, VA 23691-0260

SUBJECT: NRC REVIEW OF DOCUMENTS RELATING TO DECOMMISSIONING  
ACTIVITIES AT THE GREAT LAKES NAVAL STATION,  
GREAT LAKES, IL

Dear Dr. Doremus:

This refers to the NRC's review of the Navy's technical reports dealing with decommissioning and final status survey activities being conducted at the Naval Station Great Lakes, Great Lakes, Illinois. Specifically, my staff reviewed technical reports as follows: 1) Site-Specific DCGL Determination Report; 2) Final Site-Specific Derived Concentration Guideline Level Addendum; 3) Coal Ash Determination Sampling Report; and 4) Final Status Survey Plan, Building 324 and Vermont Court Housing Report.

After review of the Navy's technical reports, your remediation and final status survey plans and dose model appear to be consistent with NRC unrestricted release criteria, and thus we have no further questions. However, once remediation activities have been completed, we request that you provide a copy of your final status survey report, which will be used to demonstrate compliance with your dose modeling assumptions. I have attached a copy of the NRC's Safety Evaluation Report documenting NRC staff's review of the above documents.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). The NRC's document system is accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html>.

S. Doremus

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We appreciate your cooperation and if you have any questions, please do not hesitate to contact me at (630) 829-9627 or Mr. Mike McCann (630) 829-9856.

Sincerely,

*/RA/*

Patrick L. Loudon, Chief  
Decommissioning Branch

Docket Nos.: 040-08306, 040-08680 (terminated)  
License Nos.: SMC-01207, SUC-01332 (terminated)

Enclosure:  
Safety Evaluation Report

cc w/encl: Howard Hickey, Remediation Program Manager,  
Naval Facilities Engineering Command, Midwest  
David Horton, Health Physicist,  
US Army Field Support Command

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## **SAFETY EVALUATION REPORT**

FORMER LICENSEE: Engelhard Minerals and Chemicals Corporation (Out of Business)

LICENSE NO.: SMC-01207 and SUC-01332 (Terminated)

DOCKET NO.: 040-08306 and 040-08680 (Terminated)

SUBJECT: SAFETY EVALUATION REPORT - DOCUMENTING THE NRC REVIEW OF NAVY DOCUMENTS RELATING TO REMEDIATION ACTIVITIES AT THE NAVAL STATION GREAT LAKES, GREAT LAKES, IL

### **1.0 EXECUTIVE SUMMARY**

Since the March 2000 discovery of thorium-232 contamination in an industrial area at the Naval Station Great Lakes, the Navy and the NRC have worked cooperatively to characterize and remediate areas impacted by the radiological contamination. This working agreement has involved the Navy providing the NRC Region III Decommissioning Branch documents and procedures for review and included a number of onsite inspections. The documents describe how the Navy plans to conduct and document radiological characterization and final status surveys; establish derived contamination guideline limits (DCGLs) for unrestricted use of the impacted areas; and perform and document the determination of public dose using the radiological computer dose model (RESRAD). Since 2000 the NRC has performed seven inspections at the Naval Station Great Lakes (References 1-7). Based on current Navy projections, the remediation and survey activities should be completed by mid-year 2008.

The purpose of this Safety Evaluation Report (SER) is to document the NRC's review of the Navy's request to change the site-wide DCGL for thorium-232 contamination from 1.0 picocurie per gram (pCi/g) to 4.0 pCi/g. This increase in the DCGL is based on the Navy's request to change the current RESRAD Resident Farmer Scenario used to release impacted areas, to a proposed Resident Gardener Scenario. The Navy believes that the proposed Resident Gardener Scenario to be a reasonable foreseeable scenario based on the assumptions and current site conditions. Specifically, the Navy provided four documents for NRC review to support their current request as follows: Final Coal Ash Determination Report dated March 2007 (Reference 12); Site Specific DCGL Report dated March 2007 (Reference 13); Final Status Survey Plan (FSSP) for Bldg 3214 and Vermont Court Housing dated April 2007 (Reference 14); and Final Site-Specific Derived Concentration Guideline Level Addendum Naval Station Great Lakes, Radiological Remediation Great Lakes, Illinois dated August 2007 (Reference 15).

### **2.0 FACILITY HISTORY**

#### **2.1 License Number/License Activities/Authorized Activities**

NRC staff has reviewed its files for Engelhard Minerals and Chemicals (Engelhard), the former licensee, regarding the Great Lakes Naval Station. The review was conducted according to Consolidated Decommissioning Guidance, Volume 1 (NUREG 1757). Based on the review, the staff has determined, that the U.S. Atomic Energy Commission

Enclosure

(AEC) granted licenses SMC-01207 and SUC-01332 to Engelhard to package and ship a strategic stockpile of monazite sand from the Great Lakes Naval Training Center to other AEC/NRC licensees. The SMC-01207 license was terminated in 1975 and the SUC-01332 license was terminated 1983. The former licensee was authorized to possess 119,829.33 kilograms of natural thorium (Monazite Sand) under SMC-01207 and 67,965 kilograms under SUC-01332.

## **2.2 Decommissioning Activities/Radiological Status**

During a March 2000 NRC radiological scoping survey, radiological concentrations of thorium-232 ranging from 0.93 pCi/g to 64.31 pCi/g, with an average concentration of approximately 17.0 pCi/g, were identified in an industrial park area of the Naval Stations Training Center. The industrial area containing the monazite sand encompassed an area of approximately 90,000 square yards in a former tank farm area.

Between 2000 and 2005, the NRC conducted seven inspections of the Navy contractor's remediation activities at the site. These inspections included a review of remediation activities including observations of radiological surveys and reviews of work instructions.

On July 7, 2005, the NRC identified additional thorium-232 contamination outside of the former tank farm area along a nearby stream. The NRC findings described previously unidentified contamination in a housing area known as the "Public-Private Venture Forrestal Village Area." The Navy, in a September 7, 2006, letter updated its ongoing thorium remediation project (ML062630173). In December 2006, the Navy submitted the "Sampling Plan for Task 3: Coal Ash Determination," (ML070800402) for NRC review. The Navy used this plan to ascertain if the contamination was a result of the migration or deposition of contaminated soils containing monazite sand or a result of past deposition from naturally occurring radioactive materials emitted from local smoke stacks, which would have occurred many years in the past.

On July 12, 2005, Region III management met with personnel from the Navy's Radiological Affairs Support Organization, Great Lakes Environmental Department, and Cabrera Services (contractor) management to discuss the need to further characterize the site, establish new site boundaries, and develop remediation and final status survey plans for the site. During this meeting the Navy also discussed its plans to develop and submit for NRC review a new site-specific DCGL.

On March 21, 2007, the Navy submitted for NRC review the Coal Ash Determination Sampling Report (ML070810101), which discussed the results of its survey findings and conclusions regarding the source of the thorium-232. On March 22, 2007, the Navy submitted a Site-Specific DCGL Determination Report (ML070860326) which discussed its basis and modeling for revising the site clean-up DGCL, and on April 13, 2007, a Final Status Survey Plan to be used for surveying and releasing for unrestricted use Building 3214 and the Vermont Court Housing was provided (ML071060175). On August 31, 2007, a Final Site-Specific Derived Concentrations Guideline Level Addendum" Naval Station Great Lakes Radiological Remediation Great Lakes, Illinois (ML072430741, ML072430754), which provided the technical and modeling information for the Navy's proposed RESRAD Resident Gardener Scenario, was also submitted for NRC review. This last document was a supplement and revision to the Navy's March 2007 DCGL Report.

Based on a review of the above documents, NRC staff has found that the Navy has provided sufficient information to aid NRC staff in evaluating the Navy's determination of the radiological status of the facility and the Navy's planned decommissioning activities, to ensure that the decommissioning can be conducted in accordance with NRC requirements. The NRC staff findings are discussed below:

### **3.0 FACILITIES DESCRIPTION**

#### **3.1 Site Location and Description**

The Naval Station Great Lakes Training Site is located in Lake County, Illinois, 36 miles north-northwest of Chicago and slightly west of the Lake Michigan shore, occupying an area of approximately 1,600 acres. The site is located in an urbanized area of the County, on the eastern edge of the Upper Illinois River Basin (UIRB) (USGS 1999). The site is located in an urbanized area of Lake County, used predominantly for single and multi-family residences, as well as industrial use. The Naval Station is currently bounded on three sides by residential areas and industrial properties, and the fourth side (eastern) is bounded by Lake Michigan. The size of residential properties at the site is typical of residential lots, averaging approximately 0.25 acres but not exceeding 0.5 acres. The Great Lakes Naval Training Center is the Navy's only recruit training site and has been in operation since 1911. As site owner, the Navy has assumed responsibility for the Great Lakes site cleanup.

#### **3.2 Population Distribution**

The U.S. Census Bureau estimated the Lake County population in 2005 to be 702,680. Like many urban areas in proximity to Lake Michigan, the Site obtains potable water from a public water supply.

#### **3.3 Current/Future Land Use**

The Naval Station is the Navy's only recruit training site, and has been in operation since 1911 with no anticipated changes within the foreseeable future.

#### **3.4 Groundwater and surface water Hydrogeology**

Due to the relatively insoluble nature of the thorium, groundwater and surface water impacts are not considered to be a concern.

### **4.0 Dose Analysis**

#### **4.1 Unrestricted Release Using Site-Specific Information and Background**

The Site Specific DCGL Report (March 2007) presented site-specific DCGLs for the radiological contaminant of concern in soil at the Naval Station Great Lakes within an area designated for industrial use. The radiological contaminant of concern in the soil within the industrial area was natural thorium and decay products in secular equilibrium, which resulted from storage of monazite sand prior to 1974. The Navy initially proposed the "industrial use" DCGL to provide a realistic, site specific clean-up level based on reasonable site specific conditions. In determining the DCGL, the Navy used several conservative and reasonable factors in the dose modeling assessments. The Navy

RESRAD analysis evaluations resulted in a site-specific DCGL for natural thorium in soil within the site industrial area of 5 pCi/g. This site-specific DCGL represented the amount of soil contamination above background in the site industrial area that would result in a total effective dose equivalent (TEDE) of 25 mrem to a member of the critical group (industrial worker) in an area of 10,000 square meters (m<sup>2</sup>) uniformly contaminated with natural thorium to a depth of 1 meter. This DCGL was to be applicable to the parent, as well as each of the individual decay products associated with natural thorium.

The August 2007 Final Site-Specific Derived Concentration Guideline Level report was an addendum to the March 2007 Site Specific DCGL Report. The March Report was based on an "industrial use" scenario. However, the Navy determined that areas of thorium existed in areas other than the initially identified industrial area, and that the land use areas involved mix use conditions that are both industrial and residential. Thus after further consideration, the Navy decided that a more conservative approach to achieve unrestricted use of the site was appropriate. Specifically, the Navy decided to switch the RESRAD analysis from an "industrial use" scenario to a "resident gardener" scenario.

#### **4.2 Surface Soil**

The Navy used the Argonne National Laboratories RESRAD Version 6.3, Computer Code (Yu 2005) to calculate the TEDE per year per unit concentration or area, respectively, of natural thorium. The Navy's results computed TEDE as a function of time, out to 1,000 years, in order to determine allowable soil concentrations to meet the requirements of 10 CFR 20.1402. The RESRAD Computer Code default input parameters are based on a worst case "resident farmer" conceptual site model. This assumes the area of a site that may be occupied by a future resident is large enough to support raising livestock for meat and milk, and growing crops, fruit, etc. to support a large portion of the resident farmer's dietary intake needs, as well as provide feed for livestock.

The Navy's conceptual site model was developed on the basis of a site review, how the site is currently used and the most reasonable foreseeable use of the site once released, and a complete understanding of the most relevant exposure pathways to site occupants and residents on the Site. Since the Great Lakes Naval Training Center is not in a rural location conducive to farming activities at present, nor is it expected to change within a reasonably foreseeable future, the Navy decided to use a resident Gardener site-specific exposure scenario based on the following justifications:

- The site is located in an urbanized area of Lake County, used predominantly for single and multi-family residences, as well as industrial use.
- The site is currently bounded on three sides by residential areas and industrial properties, and the fourth side (eastern) by Lake Michigan).
- The site is approximately 36 miles from Chicago, Illinois, which is a rapidly expanding urban area.
- Portions of the site are already designated for residential use and privatization efforts are underway to further utilize this area for residential purpose.

- The size of residential properties at the site is typical of residential lots, averaging approximately 0.25 acres, but not exceeding 0.5 acres. This property size is not sufficient to support a farm with livestock as a source of food and milk or raising crops for food. Additionally, typical urban area zoning ordinances prohibit the raising of livestock in areas zoned as residential.

The exposure pathways evaluated by the Navy for use in the RESRAD Computer Code for the resident gardener model are:

- direct radiation from radionuclides in the soil,
- inhalation of re-suspended contaminated dust,
- ingestion of home grown produce in the contaminated soil,
- ingestion of water from a contaminated well, and
- ingestion of contaminated soil.

The Navy evaluated the drinking water pathway even though the site is supplied by public water sources. The Navy assumed that the resident installed a well on the property to provide a source of drinking water. Even though this was believed highly unlikely, this assumption provided a reasonable amount of conservatism in the model. The Navy noted that considering the low thorium mobility in soil, leaving the water pathway “on” had no impact on the resulting site-specific DCGL for natural thorium compared to the values generated with the water pathway suppressed.

The aquatic foods pathway was not considered in the site model, since there are no bodies of water on the Site with sufficient size to support aquatic life, which can be reasonably used as a source of food for a resident gardener. Likewise, the radon pathway was also not considered by the Navy who cited as its basis a Federal Register Notice (NRC 1994), issued as a result of comments received from a radon workshop, which indicated that “radon would not be evaluated when developing release criteria.”

The Navy Report used a unit concentration of 1.0 pCi/g for the site radionuclides of concern (natural thorium with decay products in secular equilibrium) in the RESRAD evaluations. This approach provided dose-to-source ratios (DSRs) in units of mrem/yr per pCi/g, calculated for exposed individuals over a 1000 year time period. The DSRs represent the maximum dose to a member of the critical population group (resident gardener) over the 1000 year time period. A DCGL (pCi/g) for the radionuclides of concern in site soil was determined by dividing the DSR into the primary dose limit of 25 mrem per year. As a result of the RESRAD analysis, the site-specific DCGL for natural thorium in site soil using resident gardener input parameters was determined to be 4.0 pCi/g. This site-specific DCGL represents the amount of soil contamination above background that would result in a total effective dose equivalent (TEDE) of 25 mrem to a member of the critical group in an area of 10,000 square meters uniformly contaminated with natural thorium to a depth of 0.46 meters. This DCGL is applicable to the parent, as well as each of the individual decay products associated with natural thorium.

Based on the evaluation of the Navy’s site-specific report and addendum, discussed above, NRC staff concludes, that there is reasonable assurance that the health and safety of the public will not be endangered by the use of the DGCL (4.0 pCi/g) for unrestricted use, and that remaining residual contamination satisfies the unrestricted release criteria specified as being below a TEDE to an average member of a critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from

groundwater sources of drinking water, as specified in Title 10 of the CFR, Part 20, Section 20.1402, "Radiological criteria for unrestricted use." This value is also below the NRC – USEPA Memorandum of Understanding, which requires NRC consultation with the EPA if a trigger is exceeded. The MOU trigger for thorium-232 is 5.0 pCi/g.

### 4.3 Building Surfaces

The Final Status Survey Plan for Building 3214 and Vermont Court Housing dated April 2007, was provided by the Navy for Building 3214 (the woodshop) and the residential structures on Vermont Court within the Public Private Venture (PPV) area at the Naval Station Great Lakes. The Navy's Plan will be used to demonstrate that the buildings are suitable for unrestricted use.

As part of the Navy's historical site assessment of licensed radioactive material storage at the site, a review was performed to determine if any structures were impacted as a result of the past use of thorium. This review identified seven potentially impacted structures, which included Building 3214 (the woodshop) and six residential structures on Vermont Court. The residential structures include five duplexes (Buildings 4236, 4237, 4238, 4239, and 4241) and one triplex (Building 4240); with a total of thirteen separate residential areas. Because of the low potential for residual radioactivity on structure surfaces, Building 3214 and each of the 13 residential areas were designated as Class 3 survey units in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC, 2000) guidance.

MARSSIM guidance classifies areas based on contamination potential as follows:

- Class 1: The area had been contaminated above the release criteria and it is possible to find radioactivity above the DCGL.
- Class 2: The area had radioactive material use, but it is unlikely to have radioactivity above the DCGL.
- Class 3: The area had some use of radioactive material, but it is very unlikely to have radioactivity greater than a fraction of the release criteria.

Concentrations of residual radioactive contamination on surfaces in each survey unit will be determined through surface scans to identify the presence of radioactivity, direct surface radioactivity measurements, and removable radioactivity measurements. If direct measurements for surface activity or removable surface activity in a survey unit do not exceed 50 percent of the DCGL, and the statistical test for the survey unit passes, the survey unit will be determined acceptable for unrestricted release. Based on the survey unit classification the Navy limited the area of interest to floor surfaces and walls up to two meters (m) from the floor surface within Building 3214 and the Vermont Court housing units. The DCGLs was based on total alpha emissions for thorium-232 plus progeny using NUREG/CR-5512, Volume 3, Table 5.19 (NRC, 1999). The surface area DCGL was set at 224 disintegrations per minute per hundred centimeters squared (dpm/100 cm<sup>2</sup>), and a DCGL limit for test of removable contamination was set at 22 dpm/100 cm<sup>2</sup>.

Based on the evaluation of the Navy's Final Status Survey Plan for Building 3214 and Vermont Court Housing, the NRC staff concludes that the Plan is consistent with MARSSIM Guidance. Additionally, the staff believes that there is reasonable assurance that the health and safety of the public will not be endangered by the use of the DGCL for unrestricted use, and that remaining residual contamination satisfies the unrestricted release criteria specified as being below a TEDE to an average member of a critical group that does not exceed 25 mrem (0.25 mSv) per year as specified in 10 CFR, Part 20, Section 20.1402.

#### **4.4 Other Radiological Considerations**

The primary purpose of the Final Coal Ash Determination Report dated March 2007 was to determine if radioactive contaminants present in the areas of interest at Naval Station Great Lakes is due to the presence of monazite sand or simply the result of other, non-licensed material, with similar naturally occurring radionuclides, such as coal fly ash. To accomplish this task, soil samples were obtained from the following locations:

- Non-Impacted Background Reference Area
- Former Monazite Sand Storage Area (Area 18)
- Public Private Venture Areas 3A, 3B, 3C, 3D, 3E, and 3F

Soil samples collected were submitted to an off-site laboratory for analysis to determine the concentration of the naturally occurring radionuclides present in both the background soils as well as the soils in the areas of interest.

Based on NRC staff review of the Navy's report, the staff concludes that the Navy's technical report demonstrates that the Navy is capable of discriminating between environmental radiological contaminants resulting from past license activities and those resulting from naturally occurring sources.

#### **4.5 ALARA Considerations**

The Navy committed to implementing ALARA for all its decommissioning activities. The Navy employed several conservative controls in its determination of the dose to the public and workers as follows:

- The Navy committed to a lower than calculated Site-Specific DCGL (Reference 15), which resulted in a DCGL<sub>w</sub> of 4.46 pCi/g. The Navy elected to use a DCGL<sub>w</sub> of 4.0 pCi/g in keeping with the ALARA requirement in 10 CFR Part 20.
- The Navy committed to use a DCGL of 1.0 pCi/g in all residential areas. The 4.0 pCi/g limit would be used only in areas currently designated as industrial use areas.
- The Navy used a number of conservative measures in planning input parameters into the RESRAD model. For example, the Navy indicated that thorium-232 was insoluble and that ground water was not a concern, but the Navy used the water pathway in RESRAD, and determined that the pathway did not have a significant impact on the DCGL result.

- The staff determined that the Navy used a uniform 4.0 pCi/g level of thorium contamination when projecting dose. The NRC staff review of Navy's characterization and final status surveys note that site contamination is not uniform, that is large areas of the existing impacted site are below release limits.
- The Navy committed to a more than necessary conservative final status survey work plan. The Navy work plan was previously reviewed and found acceptable by the NRC. The survey plan parameters are based on a more conservative sampling and survey approach. Specifically, the Navy's MARSSIM surveys will be based on a previously accepted DCGL of 1.0 pCi/g above background. Therefore, the survey sensitivity and the number of samples to be taken will be greater than that which would be required for the 4 pCi/g release limit.

Based on NRC staff review of the Navy's reports, the staff concludes that the Navy's technical reports demonstrate that the Navy has adequately addressed ALARA for the scope of work to be performed.

#### REFERENCES:

##### NRC Inspection Reports and References Relating to the Remediation Activities at the Great Lakes Naval Station, Great Lakes, IL

1. Inspection No. 040-08306/00-001 (ML003683391, ML003683396)
2. Inspection Report No. 040-08306/00-002 (ML003746615)
3. Inspection Report No. 040-08306/03-001 (ML032750081)
4. Inspection Report No. 040-08306/03-002 (ML040120893)
5. Inspection Report No. 040-08306/03-003 (ML040120892)
6. Inspection Report No. 040-08306/04-002 (ML050310025)
7. Inspection Report No. 040-08306/05-001 (ML052560100)
8. Work Plan for Radiological Remediation and Final Status Survey of the North Fence Area and Soil Pile, Project USN 2000-003, Phase III, Modification I, Revision 3, Dated June 16, 2003 (ML072920104)
9. Work Plan for the Characterization of the Recreation and Center Tank Areas and Radiological Remediation and Final Status Survey of the North Fence Area, Project USN 2000-003, Phase Iii, Modification I, Revision 2, Dated August 2004 (ML042720159)
10. Work Plan for the Remediation of the Recreation and Center Tank Areas and Site-Wide Final Status Survey, Project USN 2000-003, Phase IV, Modification 1, Cabrera Project No. 05-3060.01, Revision 0, Dated November 2004 (ML072980843)

11. Final Report Remediation and Final Status Survey Former Monazite Sand Storage Area North Fence Area, Recreation Area, and Center Tank Area Naval Station Great Lakes – Great Lakes, Illinois Project USN 2000-003, Phase IV, Modification 4, Cabrera Project No. 05-3060.01, Dated June 2006 (ML072910402)
12. Coal Ash Determination Sampling Report, Naval Station Great Lakes, Great Lakes, Illinois, Dated March 2007 (ML070810101)
13. Final Site-Specific DCGL Determination Report, Naval Station Great Lakes Radiological Remediation, Great Lakes, Illinois, Dated March 2007 (ML070860326)
14. Final Status Survey Plan Building 3214 and Vermont Court Housing Report, Naval Station Great Lakes, Great Lakes, Illinois, Dated April 2007 (ML071060175)
15. Final Site-Specific Derived Concentration Guideline Level Addendum, Naval Station Great Lakes Radiological Remediation, Great Lakes, Illinois, Dated August 2007 (ML072430741, ML072430754)