DOCKET NO: 40-7580
LICENSEE: Fansteel, Inc.
FACILITY: Muskogee, Oklahoma

SUBJECT: SAFETY EVALUATION REPORT FOR LICENSE AMENDMENT APPLICATION TO APPROVE DECOMMISSIONING DATED JULY 24, 2003

1 Executive Summary

1.1 Background

The Fansteel processing facility operated for more than 30 years until operations ceased in 1989. The raw materials used for tantalum and columbium production contained uranium and thorium as naturally occurring trace constituents. These radioactive species were present in the process raw materials at an approximate concentration of 0.1 percent uranium oxide and 0.25 percent thorium oxide. This concentration is sufficient to cause the ores and slags to be classified by the Nuclear Regulatory Commission (NRC) as source materials. Consequently, Fansteel operated under NRC License No. SMB-911 for the possession of source materials.

The ores and slags used for tantalum and columbium production were digested in a hydrofluoric acid (HF) solution. After the digestion step, a series of processes to separate the tantalum and columbium products was conducted. The byproduct of the separation steps (residues from the work in progress [WIP]) was disposed in Pond Numbers 2, 3, and 5, that were called acidic ponds. Acidic and ammonia waters were stored in temporary holding Pond Numbers 1S and 1N respectively prior to treatment. Uranium and thorium in the raw materials were not extracted from the ores by the digestion process, but remained in the residues from the WIP that were disposed in the East Plant Area. Process water and the Pond No. 3 french drain supernatant were treated and then passed on to Pond Numbers 6, 7, 8, and 9, called alkaline ponds, for solids precipitation before passing through a National Pollutant Discharge Elimination System (NPDES) discharge outfall. The WIP residues from the manufacturing process contain U^3O^8 and ThO^2 at similar concentrations either alone or in a calcium fluoride (CaF) precipitate matrix.

In addition, a groundwater interception trench installed east of Pond No. 3 collects alluvial groundwater and reduces the potential for discharge of contaminated groundwater to the Arkansas River. Groundwater is collected in the trench and filtered through a filter press.

In 1993, Fansteel performed a characterization survey at the Muskogee site to determine existing site conditions. The Chemical C Building is contaminated throughout by radioactive ore residues. They also identified isolated areas of radioactive contamination in some of the other site buildings. The process ponds, surrounding soils, and ground water are also contaminated with radioactive material above release limits.

1.2 Purpose and Need for Proposed Action

The proposed action is to remediate the site to the unrestricted release criteria in 10 CFR 20.1402 and terminate the NRC license at the completion of remediation. This is necessary

because Fansteel ceased principal activities and 10 CFR 40.42(d) requires that the licensee decommission the site.

1.3 Description of Proposed Action

Decommissioning will include decontamination of buildings and components by cleaning. It is expected that portions of the floor (10 percent) of the Chemical A and Chemical C buildings will need to be scabbled and disposed as low-level radioactive (LLR) waste. Portions of structures or building facilities and equipment that cannot be cleaned for unrestricted release will be size reduced for handling, shipping, and disposal purposes.

Radiologically impacted soils and residues from WIP are primarily surrounding Pond Numbers 2, 3, 5, 6, 7, 8, and 9, and areas to the east of the Chemical A and Chemical C plant buildings. Soil contamination is also present east of the wastewater treatment ponds and Pond No. 5. The total impacted land area requiring remediation encompasses an estimated area of 180,000 square meters (m^2).

Approximately 16,000 tons of residues from the WIP will be excavated from Pond Numbers 2 and 3 and shipped to a licensed uranium reclamation facility. An estimated 68,000 tons of impacted material will be excavated from the alkaline process water settling ponds that received CaF and process water from the Wastewater Treatment Plant (WWTP) (Pond Numbers 5, 6, 7, 8, and 9). Excavation and disposal of soil from the surrounding plant area and beneath the ponds will account for about 15,855 tons. Soil with concentrations above release criteria will be transported to a licensed or permitted waste disposal facility. The total quantity of soil and residue for off-site disposal is estimated to be approximately 99,855 tons.

The licensee will prepare a Final Status Survey Plan (FSSP) in accordance with MARSSIM guidance for the Fansteel site to demonstrate compliance with release criteria.

Upon approval of the DP by the NRC, Fansteel will undertake preparation of designs and specifications for remedial activities. Subsequently, a contractor will be selected to perform the work.

2 Facility Operating History

Fansteel commenced operation to extract valuable metals from ore in 1958. Tantalum- and columbium-bearing ores were procured by Fansteel from several international locations. After the digestion step, a series of processes to separate the tantalum and columbium products was conducted. The byproducts of the process were disposed in ponds. Termination of plant manufacturing operations occurred in late 1989. Since then, Fansteel attempted a volume reduction process of the WIP. This process was not successful and was suspended in November 2001. Fansteel and its U.S. subsidiaries filed for Chapter 11 bankruptcy in January 2002.

The NRC staff has reviewed the information in the “Facility Operating History” section of the Decommissioning Plan for the Muskogee Site, license number SMB-911, located at Muskogee, Oklahoma according to the Consolidated NMSS Decommissioning Guidance, Chapter 16.

Based on this review, the NRC staff has determined that Fansteel has not provided sufficient information to allow the NRC staff to fully evaluate the licensee's determination of the radiological status of the facility and the licensee's planned decommissioning activities, to ensure that the decommissioning can be conducted in accordance with NRC requirements. Therefore, staff proposed license conditions that require the licensee to provide more information. The Licensee has agreed to the proposed conditions and the additional information will meet NRC's needs.

2.1 License Number/Status/Authorized Activities

Fansteel's materials license number is SMB 911 (NRC Docket No. 40-7580). They submitted a timely license renewal application to the NRC on August 27, 2002. Prior to October 22, 2002, Materials License No. SMB 911 authorized Fansteel to possess, use, store, and transfer uranium and thorium and their progenies contained in processing residues. The specific activities approved were residue processing, metal reclamation, decontamination, remediation, decommissioning, and site restoration. On October 22, 2002, the NRC notified Fansteel that because the August 27, 2002 application did not provide the decommissioning financial assurance required by 10 CFR 40.36(d), NRC denied the request for license renewal. In accordance with 10 CFR 40.42(c), activities at the site are limited to those directly related to decommissioning and maintaining control of the site and licensed material. The NRC further stated that all other conditions of Materials License No. SMB 911 remain in effect until NRC terminates the license, and Fansteel is required to proceed with decommissioning in accordance with 10 CFR 40.42(d).

2.2 License History

The initial issue of License No. SMB 911 was granted by the U.S. Atomic Energy Commission (AEC) on January 27, 1967, in response to a request from the State of Oklahoma, and has been amended and renewed in a timely manner since then. As described in Section 2.3 below, Fansteel submitted and withdrew several amendment requests to approve decommissioning plans (DPs) between 1990 and 2000. Fansteel submitted a timely license renewal application to the NRC on August 27, 2002 to renew the license that was to expire on September 30, 2002. On October 22, 2002, the NRC notified Fansteel that because the August 27, 2002 application did not provide the decommissioning financial assurance required by 10 CFR 40.36(d), the request for license renewal was denied. On January 15, 2003, Fansteel submitted a DP for the site; submittals of February 17, May 8, and July 24 amended the DP.

2.3 Previous Decommissioning Activities

Fansteel states that it closed Pond 1 (also referred to as Ponds 1N and 1S), and Pond 4. However, it provided no documentation of these activities or disposition of materials. Fansteel believes the materials were transferred to other on-site ponds. Surveys of the estimated location of Pond 1 do not show radiation significantly above that in surrounding soils. Fansteel believes that Pond 4 was in the vicinity of Pond 3, but somewhat larger. Survey data shows some elevated radioactive concentrations in this area.

Fansteel previously submitted ten decommissioning plans, starting on July 26, 1990. Except processing of small amounts of WIP, authorized in 1999, and declared by the licensee not to be

a decommissioning activity, none of these plans was implemented. No radioactive waste has been removed from the site.

In 1993, Fansteel conducted a Remediation Assessment that included the installation of soil borings, monitoring wells, and test pits; the collection of soil, sediment, surface water, ground water, and pond samples for chemical and radiological analyses; and a scoping survey for radioactive materials.

After remediation by Fansteel, NRC released from the license approximately 35 acres of the Muskogee facility, designated as the "Northwest Property," for unrestricted use per License No. SMB-911, Amendment No. 6, Condition No. 9, dated August 23, 1996.

2.4 Spills

Pond No. 3 was the source of the only recorded liquid release incident at the facility. On June 18, 1989, a large supernatant discharge from Pond No. 3 occurred from the wet well and french drain system adjacent to the subject pond and several seeps near the southwestern corner of Pond No. 3 causing portions of the french drain system to collapse. The suspected cause of this release was a failure of the Pond No. 3 liner. The released fluid traveled along the natural drainage course around the western and northern sides of Pond No. 3 and discharged to the Arkansas River through storm water Outfall 003. Fluid discharge to the river was terminated by the construction of a temporary dike near Outfall 003 and a second dike near the northwestern corner of Pond No. 3. An estimated 90,000 gallons of fluid was released before the discharge was arrested. Other contamination identified throughout the site during surveys and inspections indicates there were other process spills and leaks resulting in sub-surface contamination.

On June 1, 1999, an F1 tornado (moderate tornado with winds of 73 to 112 miles per hour producing moderate damage) touched down near the Port of Muskogee and moved south for 2.25 miles. This storm also produced very large hail. The tornado struck the Fansteel plant, damaging buildings and causing up to $1.5 million damage. The damaged buildings include the Chemical A, Chemical C, Service, R&D, Sintering, Sodium Reduction, Weir, Machine Shop, Little Bertha, White house, and EB buildings, as well as the Guardhouse and Groundwater Treatment Plant. In addition, the liners of Pond Numbers 3, 8, and 9 were torn above the water line and a stored soils cover was ripped. The damage to the Sodium Reduction Building allowed bagged material to fall out of the building and tear open. The bags were filled with moist, LLR material that had been excavated from Pond No. 5 in 1993. Approximately 500 pounds of material were released to the ground surface within a 10-foot-diameter area before being recovered and bagged.

2.5 Prior On-Site Burials

No on-site burials are known to have occurred at the site other than those associated with Pond No. 1 closure. According to historical documentation, Fansteel excavated and packaged 371 tons of material during closure activities.

3 Facility Description

3.1 Site Location and Description

The Fansteel Muskogee plant is located in Muskogee County, Oklahoma, and occupies approximately 91 acres of land adjacent to the 406-acre Port of Muskogee Industrial Park. It is 2.5 miles northeast (Latitude 35.46.30, Longitude 095.18.15) of the Town of Muskogee. The site lies along the western edge of the Arkansas River (Webbers Falls Lock and Dam and Reservoir, part of the McClellan-Kerr Arkansas River Navigation System) and is bounded on the north by land owned by the Muskogee Port Authority, on the south by U.S. Highway 2, and on the west by Oklahoma State Highway 65 (Muskogee Turnpike) and a service road.

There are 15 structures on the site used for processing and administration, primarily of concrete or block construction; a few are metal "butler buildings." Of the nine ponds constructed during site operations, two have been closed (1 and 4) and the others contain process waste contaminated with chemical and radioactive materials.

3.2 Population Distribution

Muskogee County had a year 2000 population of 68,078. The plant site is adjacent to Cherokee County that had a year 2000 population of 42,521. Other counties adjacent to Muskogee County are described in the DP. The major population center is Muskogee (38,310). The geographical center of Muskogee is approximately 4 miles southwest of the site.

3.3 Current/Future Land Use

The Muskogee plant is in an area zoned for industrial use. This industrial use restriction is expected to persist in the future according to the updated Master Plan for industrial properties issued by the Port of Muskogee (Master Plan of Development for the Muskogee Port and Industrial Park, Muskogee City-County Port Authority, November 28, 1967). The City of Muskogee is a mixed urban area with commercial, residential, and industrial uses. Commercial use is largely related to food products and mineral production. The closest residence is on the west side of State Highway 165, approximately one-quarter mile from the buildings on the site.

Agricultural land use occurs outside the City of Muskogee and is an important component of the economy of the area. Recreational land uses are also important in the area near the site. Rolling scenic hills and man-made lakes are common. Fishing, hunting, and water sports are associated with the lakes.

3.4 Metrology and Climatology

No topographic features significantly affect meteorological conditions. This region exhibits a continental-type climate. The region lies in the zone of prevailing westerly winds and is influenced by a regular progression of high- and low-pressure systems throughout the year. These systems also produce precipitation throughout the year with greater amounts occurring during the spring and autumn months. Winters tend to be mild, although there is influence of cold polar continental air masses during January and February.

The prevailing wind is generally from the south, except during January and February when northerly winds predominate. The annual average wind speed is 10.2 mph. Highest average wind is 11.9 mph, and lowest average wind speeds is 8.8 mph). The annual mean temperature is 60.0F. Monthly mean temperatures range from 82.0F in July to 36.2F in January. The total precipitation averages 44.5 inches per year. Spring is the wettest season (30.3 percent of the total precipitation); winter is the driest season (16.4 percent of the total). From 1950 through June 30, 2001, there were 37 tornadoes observed in Muskogee County.

3.5 Geology and Seismology

3.5.1 Regional Geology

Muskogee, Oklahoma is in the unglaciated Osage Section of the Central Lowlands Physiographic Province. The eastern boundary of the section is delineated by the lapping of westward-dipping Pennsylvanian rocks onto the western edge of the Ozark and the Ouachita uplifts. On the south, the Osage Section abuts the Arkansas Valley and Ouachita Mountains. Much of the Osage Section can be described as scarped plains. The topography ranges from nearly featureless plain and low escarpments to bold escarpments that rise as much as 600 feet above the adjacent plains. Bedrock in the southeastern portion of the Osage Section consists of mostly thin- to massive-bedded sandstone, shale, siltstone, and limestone of Pennsylvanian Age. The sandstone beds are hard and well cemented and the shales and siltstones are compact and dense. Units identified in the Muskogee area include the Hartshorne Sandstone, the McCurtain Shale, and the Warner Sandstone, in ascending order. Permeability in this type of bedrock is generally low and groundwater movement depends on secondary porosity (joints and fractures) rather than primary porosity (intergranular).

The regional structural geology is influenced by its proximity to the Boston Mountains Section of the Ozark Plateau Physiographic Province and the Arkansas Valley Section of the Ouachita Physiographic Province. The Arkansas Valley Section is a trough both topographically and structurally. Closed folding with an east-west trend characterizes the Arkansas Valley. The Muskogee site is on the northern flank of the Arkansas Valley. Bedrock dips typically are to the south toward the axis of the basin. Alluvial deposits nearly entirely overlie bedrock at the Muskogee site. The general regional topography of the bedrock beneath the alluvial deposits is relatively uniform with minor variations due to differential erosion. Terrace deposits having upper surfaces ranging from 20 to 120 feet above the floodplain border the alluvial deposits in segments on both sides of the Arkansas River. These deposits are composed predominantly of silt, fine sand, coarse sand, and gravel near the base.

3.5.2 Site Geology

The Fansteel Muskogee plant is on the west-plunging faulted nose of the Ozark Uplift. The bedrock is Pennsylvanian Age, consisting of mostly sandstone and shales. The plant site is on the west bank of the Arkansas River that has a low relief but reaches a topographic difference of 50 to 60 feet above the river channel. The subsurface geology of the study area is characterized by a downward vertical gradation of finer-grained alluvial materials into coarser-grained unconsolidated sediments that bottom in shale.

Unconsolidated deposits underlying the Fansteel site range in thickness from approximately 8.75 feet to approximately 34.5 feet. These unconsolidated materials consist of natural soils and heterogeneous fill material. At the base of the unconsolidated deposits and overlying bedrock is a medium- to-coarse-grained sand unit ranging in thickness from approximately 1.5 feet to 17.5 feet. This sand unit is generally saturated throughout its entirety with few exceptions. The bedrock encountered beneath the facility is the McCurtain Shale. Few relatively intense zones of horizontal fracturing were observed which included the presence of a few fractures on a 45-degree plane from horizontal. Some fractures in the basal 30 feet of shale are clay filled, indicating groundwater flow through fractures in this portion of the shale. The overall morphology of the bedrock surface beneath the Fansteel Muskogee site resembles an elongate swale with a north-south axis. A depression occurs on the bedrock surface in the northeast quadrant of the site

3.5.3 Seismology

The Fansteel Muskogee plant is in a quiet seismic region of the United States considered to be of minor seismic risk. A probabilistic acceleration map of the contiguous United States indicates that the horizontal acceleration in the region of the Fansteel Muskogee plant, with a 90 percent probability of not being exceeded in 50 years, is less than 5 percent of gravity.

3.6 Surface Water Hydrology

The Muskogee site is in the Middle Arkansas Basin. Major tributaries in Basin One are the Verdigris and Neosho rivers. Waters of the Arkansas River at Muskogee are generally well regulated by upstream flood protection facilities on the main stem of the Arkansas River and its major tributaries. During the period of record, peak streamflow ranged from 63,000 cubic feet per second (cfs) to 384,000 cfs. Mean annual streamflow for the period of record ranged from 1,902 cfs to 42,120 cfs. The 100-year floodplain zone is approximately 517 feet msl and the maximum probable flood level is reported as 525 feet msl; the Fansteel buildings and ponds are above 530 feet msl.

3.7 Groundwater Hydrology

3.7.1 Regional Hydrogeology

Shale bedrock permeability is generally low and, therefore, does not readily transmit groundwater in the Muskogee area. However, a small amount of water is produced from bedrock aquifers throughout the area for domestic and stock use, presumably from fractures or joints with the bedrock. Depths to water measured in wells completed into the bedrock average approximately 30 feet below ground surface. Alluvial deposits are the most important aquifers in the Muskogee area and along the Arkansas River in general. Precipitation is the primary recharge. Natural discharge is mainly by seepage into streams and evapotranspiration. Quantities of groundwater adequate for domestic or stock use are available almost everywhere on the alluvial floodplain. Wells completed into the alluvium have been recorded to yield between 300 and 5,000 gallons per minute (gpm). Groundwater in the alluvium is predominantly a hard, calcium, magnesium bicarbonate type. Precipitation, geology, water movement, and hydraulics of the alluvium affect the observed groundwater quality. The water is suitable for irrigation and for domestic, stock, and limited industrial purposes.

The most important source of groundwater in the region is the shallow alluvial aquifer found along the Arkansas River. The alluvial deposits consist of sand and gravel which are typically highly permeable and often relatively thick. Wells yield from 20 to 400 gpm or more, and a properly built well should yield 100 gpm anywhere along this stretch of river. Terrace deposits along the Arkansas River are another favorable source of groundwater. This aquifer is defined as Class II (potential drinking water source) by the Oklahoma Department of Environmental Quality (ODEQ).

3.7.2 Site Hydrogeology

Groundwater flow through the unconsolidated materials is at the base of the sediments within the coarse-grained materials; across the majority of the Fansteel Muskogee site it is toward the east and the Arkansas River. There is an east-west divide in the direction of groundwater flow in the northwest corner of the facility which results in radial flow to the northeast, southeast, and southwest. The hydraulic gradient across the facility is very low and varied according to the flow direction. Shallow groundwater flow across the southernmost portion of the site is toward the south, parallel to the flow direction of the river.

Groundwater within the McCurtain Shale was encountered in deep monitoring wells installed to communicate with a zone of fractured shale that produced a measurable quantity of water. (The rock core above and below this fractured sequence was dry, based on core inspection.) Groundwater in this zone of saturation was encountered under confined conditions and is separated from the overlying unconsolidated zone of saturation by approximately 30 feet of shale bedrock. The significant difference in static groundwater elevation observed between shallow monitoring wells (designed to communicate with the overlying unconsolidated material) and deep monitoring wells (designed to communicate with the shale bedrock) indicates that these sets of monitoring wells communicate with two distinct zones of saturation. Groundwater in the shale bedrock unit beneath the Muskogee site has bidirectional flow: one component of flow is to the west-northwest, and the second is to the east. The flow to the northwest has a hydraulic gradient of 0.017. The hydraulic gradient of the easterly flow is 0.00565.

3.8 Natural Resources

3.8.1 Mineral and Hydrocarbon Resources

Oklahoma's mines exclusively produced industrial minerals; no metals were mined in the state. Minerals produced in Muskogee County include clay, feldspar, sand, and gravel. Surrounding counties (Wagoner, Cherokee, Sequoyah, and Haskell) also produced sand, gravel, crushed stone, and lime. Muskogee County belongs to the Cherokee Platform, Province 60, and is associated with five geological plays with varying probabilities for production of oil and natural gas. The undiscovered accumulations in these plays, which extend to the northwest of Muskogee County, total 67.2 million barrels of oil and 163.2 billion cubic feet of natural gas.

3.8.2 Water

A significant but more localized drought occurred during 1984-1986. The most recent short-term droughts have occurred during 1995-1996 and 1998. Conditions improved in March

and early April, 1999, with above-normal rainfall for most of the state; however, storage in five reservoirs in the state still was below full capacity.

3.9 Ecology/Endangered Species

3.9.1 Ecology

As documented in the environmental assessment of December, 1997, no threatened or endangered plants or animals are known to occur at the Fansteel site.

4 Radiological Status of Facility

In 1993, Fansteel performed a characterization survey at the Muskogee site to determine existing site conditions. Radiological survey activities were conducted over the interior and exterior of the site structures and the external open land areas of the Fansteel site. Results of this study are presented in this section. While the characterization event occurred about a decade ago, Fansteel believes that the data remain representative of current site conditions and are, therefore, suitable for DP purposes. Fansteel's belief is based primarily on the fact that site operations since 1992 have been largely limited to asset maintenance and preservation. Except for ground water transport of soluble radionuclides, the staff agrees that there have been no activities on the site that would significantly alter the distribution of the contamination.

4.1 Contaminated Structures

Fansteel performed surveys on building exterior surfaces, building interior surfaces, and equipment. Measurements of total (fixed + removable) alpha and total beta/gamma contamination, and gross gamma were obtained on contact and at 1 m above the surface. No radionuclide-specific analyses were performed during the survey, nor were exposure rates measured inside structures. The staff notes that there was no characterization beneath building floors, such as around floor drains and joints.

Licensed activities occurred in most of the structures on the south and east portions of the property. These structures, therefore, contain, or potentially contain, residual licensed radioactive material and are characterized "impacted" for purposes of an initial radiological characterization:

* Chemical "C" Building (Building No. 13)
* Chemical "A" Building (Building No. 16)
* Thermite Building (Building No. 9)
* Sodium Reduction Building (Building No. 11)
* R&D Laboratory Building (Building No. 15)
* Groundwater Treatment Facility (former Gunch House)

* Bertha Building (Building No. 12)
* Weir Building (Building No. 10)
* Ore Storage Pad

Licensed activities did not occur in the following structures; they are, therefore, characterized as "nonimpacted" for purposes of an initial radiological characterization:

* New Maintenance Building (Machine Shop)
* Chemical Equipment Room (Building No. 17)
* Pond No. 3 Pump Motor Control Center (Building No. 19)
* Chemical "C" Building Power Control Room (Building No. 20)
* White House (Building No. 7)

The following impacted structures no longer exist at the Muskogee site, but were surveyed for radiological contamination in 1992 during performance of the remediation assessment:

* Bulk Sodium Building, Old Maintenance Building (Building No. 8)
* Electrical Control Building for Lime Neutralization (Building No. 14)
* Contractor's Tool Crib (Building No. 18)
* Old White House (Building No. 7)
* Gunch House

The NRC staff has reviewed the information in the "Facility Radiological Status" section of the Decommissioning Plan for the Muskogee Site, license number SBM-911 located at Muskogee, Oklahoma according to the Consolidated NMSS Decommissioning Guidance, Chapter 16.4 ("Radiological Status of Facility"). Based on this review, the NRC staff has determined that the licensee Fansteel has not described the types and activity of radioactive material contamination at its facility sufficiently to allow the NRC staff to evaluate the potential safety issues associated with remediating the facility, whether the remediation activities and radiation control measures proposed by the licensee or responsible party are appropriate for the type of radioactive material present at the facility, whether the licensee's or responsible party's waste management practices are appropriate, and whether the licensee's or responsible party's cost estimates are plausible, given the amount of contaminated material that will need to be removed or remediated. Therefore, staff has proposed license conditions for additional characterization of radiological contamination. The Licensee has agreed to the proposed conditions and the additional information will meet NRC's needs.

4.2 Contaminated Systems and Equipment

Equipment and furnishings (i.e., components) inside the buildings were also surveyed. No measurements of radioactivity on internal surfaces of components were made.

4.3 Surface Soil Contamination

The instrument surveys of open land soil surfaces were not conclusive. Measurements of alpha and beta/gamma contamination of soil surfaces are not useful due to the short ranges of these

particles and the uneven porous surface of soil; gross gamma surveys did detect uranium and thorium radionuclides in soil.

Table 4-2 Summary of 1993 Characterization Results for Surface Soil

	Gross Alpha	Gross Beta	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Th-228 (pCi/g)	Th-230 (pCi/g)	Th-232 (pCi/g)
Min	0.5	1.2	0.3	0.0	0.3	0.9	0.7	1.0
Max	160.0	89.0	17.0	0.8	18.0	12.0	14.0	11.0
Avg	26.7	26.3	3.4	0.2	3.6	3.0	4.8	2.9
Std Dev	28.6	14.7	3.6	0.2	3.7	2.4	4.0	2.3
Number	96	96	29	29	29	29	29	29

4.4 Subsurface Soil Contamination

4.4.1 Soil Background Determination

The background soil radioactivity was determined by obtaining soil samples from 30 off-site locations near the Fansteel facility. The sampling locations were selected in areas assumed to be unaffected by Fansteel's operations at the Muskogee site. The average total uranium and thorium activity concentrations were 1.1 ± 0.6 pCi/g and 3.3 ± 0.9 pCi/g respectively. The maximum total uranium and thorium activity concentrations were 3.1 pCi/g and 5.9 pCi/g respectively. As expected for secular equilibrium and geochemistry conditions in undisturbed soil, the results for ^{226}Ra and ^{228}Ra were very similar to the divided uranium and thorium results at 1.0 ± 0.1 pCi/g and 1.2 ± 0.2 pCi/g respectively. The maximum concentrations of ^{226}Ra and ^{228}Ra were 1.1 ± 0.2 pCi/g and 1.4 ± 0.2 pCi/g respectively. Based on the soil sample locations selected and the data obtained, Fansteel concludes that the results are representative of unimpacted soils in the region.

4.4.2 Soil Concentration Determination

A total of 96 borings were completed to characterize the soil conditions only and, therefore, were advanced to the top of the uppermost zone of saturation. Boreholes for shallow monitoring wells were advanced to the top of bedrock to characterize soil and shallow groundwater conditions. Boreholes for deep monitoring wells were advanced into bedrock to characterize groundwater conditions within the underlying shale.

Some samples were selected for laboratory analysis for radiological and/or chemical constituents from each of the borings, except for the deep monitoring wells. Soil samples were analyzed for gross alpha and beta by direct counting of 100 milligrams (mg) of soil using a gas-flow proportional counter. If either gross alpha or gross beta were detected at levels exceeding twice background, isotopic analyses were performed to determine the contributing species. Gamma spectroscopy and radiochemical analysis determined specific radionuclides.

Table 4-4 Summary of 1993 Characterization Results for Subsurface Soil

	Gross Alpha	Gross Beta	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Th-228 (pCi/g)	Th-230 (pCi/g)	Th-232 (pCi/g)
Min	0.5	0.5	0.3	0.0	0.4	0.6	0.4	0.7
Max	360.0	130.0	54.0	2.3	59.0	20.0	30.0	21.0
Avg	19.6	24.2	8.6	0.4	9.2	3.3	4.7	3.0
Std Dev	36.7	17.2	13.7	0.7	14.9	4.9	7.2	4.8
Number	162	162	25	25	25	25	25	25

4.5 Surface Water Contamination

Table 4-20 Summary of 1993 Characterization Results for Sediment Samples

	Concentration (pCi/g)									
Sample ID	Gross Alpha	Gross Beta	U-234	U-235	U-238	Th-228	Th-230	Th-232	Ra-226[1]	Ra-228[2]
SS-002	28	26	2.7	0.1	2.8	1.2	1.7	1.2	3.9	1.6
SS-003	24	32	5.9	0.6	6.5	1.7	3.2	1.8	1.8	1.4
SS-005	16	17	-	-	-	-	-	-	0.0	-
SS-1[4]	110	150	8.9	-0.1	5.4	-	8.6	-	0.0	-
SS-2	18	18	-	-	-	-	-	-	0.0	-
SS-3	15	28	-	-	-	-	-	-	0.0	-
Min	15.0	17.0	2.7	-0.1	2.8	1.2	1.7	1.2	0.0	1.4
Max	110.0	150.0	8.9	0.6	6.5	1.7	8.6	1.8	3.9	1.6
Avg	35.2	45.2	5.8	0.2	4.9	1.5	4.5	1.5	0.9	1.5
Std Dev	37.0	51.7	3.1	0.4	1.9	0.4	3.6	0.4	1.6	0.1

4.5.1 Surface Water and Sediment Sampling

A total of seven surface water and six surface sediment samples were collected at the locations identified in Figure 4-11 of the DP. Surface water samples were analyzed for gross alpha and gross beta. Generally, if gross alpha was detected in excess of 15 picocuries per liter (pCi/L) or gross beta was detected in excess of 50 pCi/L, the sample was analyzed for individual radionuclides. Sediment samples were also analyzed for gross alpha and gross beta. The summary results of the sediment sample analyses are presented in Table 4-20, and surface water results are presented in Table 4-21 below.

4.5.2 Surface Water, Sediment, and Ponds Characterization

The Muskogee site contains several residue ponds in addition to surface water. The ponds were sampled by coreboring and the resulting samples were analyzed using the same protocol as soil coreboring samples. Samples were analyzed for a number of radiological and chemical

parameters including uranium, thorium, gross alpha, and gross beta. At each sample location for Pond Numbers 2 and 3, a sample of the entire column of process residue was obtained. Uranium and thorium were present in all samples at hundreds of pCi/g. Evaluation of the decay product activities showed that the residues were in approximate equilibrium. The summary results for Pond 2, that are representative, are presented in Table 4-6.

Table 4-21 Summary of 1993 Characterization Results for Surface Water Samples

Concentration (pCi/L)

Sample ID	Gross Alpha	Gross Beta	U-234	U-235	U-238	Th-228	Th-230	Th-232	Ra-226	Ra-228
Min	2.0	4.0	8.3	-0.1	5.4	1.8	1.3	1.8	3.4	1.5
Max	110.0	150.0	8.9	0.5	8.2	14.0	8.6	17.0	5.9	11.0
Avg	27.5	41.0	8.6	0.2	6.8	7.9	5.0	9.4	4.7	6.3
Std Dev	43.8	59.1	0.4	0.4	2.0	8.6	5.2	10.7	1.8	6.7

Pond No. 5 is a dry basin that has been used both for storage of ore-processing residues and for wastewater treatment. Radioactivity levels in the Pond No. 5 materials are slightly higher than the levels found in the other wastewater treatment ponds.

Wastewater treatment ponds (Pond Numbers 6, 7, 8, and 9) were sampled at several locations. The summary results for Pond 7, that has the highest concentrations, are presented in Table 4-14.

Table 4-6 Summary of 1993 Characterization Results for Pond No. 2

	Gross Alpha	Gross Beta	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Th-228 (pCi/g)	Th-230 (pCi/g)	Th-232 (pCi/g)
Min	2,300.0	920.0	170.0	5.3	170.0	160.0	420.0	160.0
Max	6,700.0	3,100.0	550.0	29.0	580.0	560.0	860.0	560.0
Avg	4,477.8	2,091.1	344.4	15.2	356.7	360.0	696.7	360.0
Std D	1,465.2	644.4	140.2	7.7	148.2	131.1	132.3	131.1

Table 4-14 Summary of 1993 Characterization Results for Pond No. 7

	Gross Alpha	Gross Beta	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Th-228 (pCi/g)	Th-230 (pCi/g)	Th-232 (pCi/g)
Min	310.0	130.0	26.0	1.3	25.0	15.0	24.0	15.0
Max	680.0	270.0	74.0	3.9	81.0	37.0	54.0	37.0
Avg	495.0	200.0	50.0	2.6	53.0	26.0	39.0	26.0
Std Dev	261.6	99.0	33.9	1.8	39.6	15.6	21.2	15.6

4.6 Groundwater

During the 1993 remediation assessment, 29 groundwater monitoring wells were installed to determine the radiological character of groundwater. Groundwater samples were analyzed for gross alpha and gross beta activity concentrations in pCi/L. If the gross alpha activity was detected in excess of 15 pCi/L or the gross beta activity was detected in excess of 50 pCi/L in a sample, individual radionuclide analyses were performed to determine the contributing species.

Groundwater in the unconsolidated zone of saturation exhibited radioactive contamination over the site. All but three of the monitoring wells exhibited some degree of radiological contamination. Two wells east of the wastewater ponds showed elevated gross beta radioactivity only. The source of this groundwater contamination probably is leakage from the wastewater treatment residue ponds that may have experienced partial loss of liner integrity (Ponds 5, 6, and 7 have clay liners; Ponds 8 and 9 have synthetic liners). Groundwater samples from three wells directly east of the main process area of the plant exhibited elevated gross alpha and gross beta radioactivity.

The former Pond No. 2 was a clay-lined WIP residue impoundment. Consequently, the wells associated with this impoundment are strongly affected. Groundwater samples from wells located down gradient and immediately adjacent to Pond No. 2 contained up to 2,600 pCi/L of gross alpha radioactivity and 930 pCi/L of gross beta radioactivity. Monitoring wells located on the north side and west side of Pond No. 3 also exhibited some contamination above background.

Water samples from the four deep monitoring wells, in the bedrock zone, were analyzed for gross alpha and gross beta radioactivity. Radionuclide concentrations in the bedrock monitoring wells were below the OWRB values for alpha and beta radioactivity. Subsequent to several sampling and analysis events, it was concluded that elevated radioactivity was not present in the bedrock monitoring wells. Based on these results, radioactive contamination of groundwater appears to be confined to the alluvium at the top of bedrock. To preclude potential cross contamination with the shallow water aquifer, all of the deep wells were closed and abandoned as approved by the ODEQ in a letter dated April 14, 1995. The most recent groundwater sampling and analysis event occurred in the spring of 2002. A summary of 2002 characterization survey results for groundwater samples is shown in Table 4-24 below.

5 Dose Modeling Evaluations

The licensee intends to release the site for unrestricted use in compliance with the requirements of 10 CFR 20.1402. Therefore, residual radioactivity levels that are distinguishable from background remaining at the site at the time of license termination cannot result in a total effective dose equivalent (TEDE) to an average member of the critical group that exceeds 25 mrem/y. Residual radioactivity must also be reduced to levels that are as low as reasonably achievable (ALARA). Dose modeling has been used to assess the TEDE to an average member of the critical group from residual radioactivity at the Fansteel site.

5.1 Unrestricted Release using Site-Specific Information

The dose modeling evaluations were performed to demonstrate compliance with the release criteria of the NRC final rule on "Radiological Criteria for License Termination," Subpart E to 10 CFR Part 20. Based on the current and expected future industrial land use of the Fansteel

Table 4-24 Summary of 2002 Results for Groundwater Samples

	Concentration (pCi/L)									
Sample ID	Gross Alpha	Gross Beta	U-234	U-235	U-238	Th-228	Th-230	Th-232	Ra-226	Ra-228
MW-51S	18.6	13.1	0.6	0.0	0.1	0.6	0.0	0.3	NA	NA
MW-52S	12.9	17.8	NA	NA	NA	NA	NA	NA	NA	NA
MW-53S	21.2	27.6	0.4	0.1	0.5	0.6	0.8	0.5	NA	NA
MW-54S	5.1	4.6	NA	NA	NA	NA	NA	NA	NA	NA
MW-55S	3.2	4.4	NA	NA	NA	NA	NA	NA	NA	NA
MW-56S	26.4	18.9	9.6	0.5	8.3	0.4	0.9	0.3	NA	NA
MW-57S	0.3	143	0.8	0.1	0.6	0.2	0.2	0.0	NA	NA
MW-58S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-59S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-60S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-61S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-62S	21.9	199	9.5	0.6	9.6	0.2	0.2	0.1	NA	NA
MW-63S	6.4	69.3	0.7	0.1	0.6	0.5	0.5	0.3	NA	NA
MW-64S	21.5	73.9	4.3	0.2	4.4	0.7	1.1	0.5	NA	NA
MW-65S	21.8	103	3.8	0.3	3.0	0.6	0.9	0.6	NA	NA
MW-66S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-67S	2130	1290	774	28.1	768	1	1.9	0.2	NA	NA
MW-68S	13.6	18.4	NA	NA	NA	NA	NA	NA	NA	NA
MW-69S	12.2	8.4	NA	NA	NA	NA	NA	NA	NA	NA
MW-70S	30.7	807	3.5	0.1	2.4	0.1	0.2	0.2	NA	NA
MW-71S	70.7	107	36.9	1.5	40	0.3	0.3	0.2	NA	NA
MW-72S	20.7	24.4	2.7	0.2	2.1	0.1	0.0	0.0	NA	NA
MW-73S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-74S	329	343	69.4	2.8	70.6	1.4	0.9	0.9	NA	NA
MW-75S	3.6	10.1	0.4	0.0	0.4	0.2	0.0	0.1	NA	NA
Minimum:	0.3	4.4	0.4	0.0	0.1	0.1	0.0	0.0		
Maximum:	2130	1290	774	28.1	768	1.4	1.9	0.9		
Average:	146	173	65	2.5	65	0.5	0.6	0.3		
Stdev.:	486	330	205	7.4	203	0.4	0.5	0.3		
Number:	19	19	14	14	14	14	14	14		

site, an industrial use scenario is appropriate to derive site-specific $DCGL_W$s for the residual radioactivity present in soil and on building surfaces at the time of FSS and Fansteel site release. The future use of the Fansteel site is controlled in accordance with the updated Master Plan for industrial properties issued by the Port of Muskogee (Master Plan of Development for the Muskogee Port and Industrial Park, Muskogee City-County Port Authority, November 28, 1967). Accordingly, it is anticipated that buildings will be used for similar industrial processes as those previously conducted at the Fansteel site.

Because the site is in a zoned industrial area and is surrounded by other industrial sites, industrial workers are considered to be the critical group. The industrial worker spends 8 hours

per day on the site. Of the 8 hours, 6 hours are spent indoors and the remaining 2 hours are spent outside. The primary activity of the industrial worker during the 8 hours on site is work. Dose assessment results and corresponding DCGLs derived for the industrial occupancy scenario have been utilized for analysis, planning, design, and implementation of decommissioning activities at the site.

External exposure to penetrating radiation, inhalation of soil dust (while outdoors and during building occupancy), and inadvertent ingestion of soil are the exposure pathways considered in deriving radionuclide-specific $DCGL_W$s for residual radioactivity in site soil for the industrial worker dose assessment. Exposure pathways considered in the derivation of radionuclide-specific $DCGL_W$s for residual radioactivity on building and component surfaces included direct external gamma exposure including submersion, inhalation of resuspended residual radioactivity, inadvertent ingestion of residual radioactivity from surface sources, and ingestion of deposited radioactivity resulting from resuspension. Table 5-2 summarizes the exposure pathways identified for use in the industrial worker scenario. Fansteel assumed that no water or food from the site is consumed. The staff does not agree with this assumption; see §5.3 below. The groundwater sample results from 1993 show that Fansteel has impacted the shallow groundwater with licensed material; however, it will remediate this contamination prior to license termination.

Site-specific dose modeling evaluations were performed using the deterministic mode of RESRAD Version 6.21 to derive the radionuclide-specific $DCGL_W$s for the residual radioactivity in soil at the time of the Fansteel site FSS and site release. The deterministic mode of RESRAD-Build Version 3.21 was used to derive the radionuclide-specific $DCGL_W$s for the residual radioactivity on building and component surfaces at the time of the Fansteel site FSS and site release. Estimates of physical, behavioral, and metabolic parameter values were developed from either site measurements or literature review. Available site-specific characterization data include meteorological, topographical, hydrogeological, soil texture characterization, and location and extent of contamination. Thus, site-specific data for annual precipitation, wind speed, area, and thickness of the contaminated zone were used in the RESRAD analyses. Physical parameters related to industrial worker building occupancy used with RESRAD-Build, such as room size, deposition velocity, resuspension rate, building air exchange rate, air release fraction, and time for source removal, were adapted directly from NUREG/CR 6755 as recommended for deterministic analysis.

5.1.1 Building Surfaces

Individual radionuclide DCG_Ws for the residual radioactivity on building and component surfaces were calculated using RESRAD-Build. Table 5-9 lists the individual radionuclide $DCGL_W$s for the residual radioactivity on building and component surfaces calculated using RESRAD-Build. The year of the peak dose associated with each radionuclide is year zero, because the radionuclide decay chains at Fansteel are already in equilibrium. The RESRAD-Build results show that more than 87 percent of the TEDE at the time of peak dose (time zero) is attributable to the inhalation and ingestion exposure pathways. In addition to the DCGLw values used to determine compliance for structural survey unit mean concentrations, the $DCGL_{EMC}$ concentration values for limited areas within a survey unit have been calculated. The $DCGL_{EMC}$ values will be used to assess compliance for survey units as long as the following sum of fractions is satisfied:

$$\sum\left[\left(\delta / DCGLw\right)+\left[\left(avgconc-\delta\right) / DCGLemc\right]\right]<1$$

where:

δ is the average concentration for all samples outside the elevated area, and
avgconc is the average concentration in the elevated area

Table 5-2 Summary of Industrial Worker Exposure Pathways

Pathway	Industrial Worker Soil DCGL Pathways	Industrial Worker Building Occupancy DCGL Pathways
External Gamma Exposure	Yes	Yes
Inhalation of Dust or Resuspended Indoor Radioactivity	Yes	Yes
Ingestion of Plant Foods	No	No
Ingestion of Meat	No	No
Ingestion of Milk	No	No
Ingestion of Fish	No	No
Ingestion of Soil/Residual Radioactivity on Building Surface	Yes	Yes
Ingestion of Water	No	No

The dose assessment employed a deterministic approach to modeling using single input parameter values and RESRAD Version 6.21. Uncertainty has been addressed by providing reasonable assurance that the estimated dose or $DCGL_W$s values were derived using parameter values that can be demonstrated as being conservative. This is accomplished by use of a simple modeling approach, simple assumptions, and parameter values that readily can be demonstrated as being conservative. The behavioral and metabolic characteristics of the average member of the critical group are conservative default values identified in the literature including NUREG/CR-5512 Vol. 2, NUREG-5512 Vol. 3 (NRC, 1998), or RESRAD Version 6.23. The uncertainty associated with physical parameters has also been addressed by using conservative values from NUREG/CR 5512 Vol. 2, NUREG 5512 Vol. 3 (NRC, 1998), or RESRAD Version 6.23. In addition, a sensitivity analysis has been used to identify physical

Table 5-9 Industrial Worker Building Occupancy
Individual Radionuclide $DCGL_w$s

Radionuclide and Progeny	Dose Conversion Factors Based on RESRAD-Build Calculations (mrem/yr)/(1 dpm/100 cm2)	Time of Maximum Dose (yrs)	Industrial Worker [a]DCGLws at Time Zero (dpm/100 cm)
U-238 (Th-234, Pa-234m, Pa-234)	4.3 x 10-4	0	58,140
U-234	4.6 x 10-4	0	54,349
U-235 (Th-231)	5.2 x 10-4	0	48,076
Pa-231	6.2 x 10-3	0	4,032
Ac-227 (Th-227 to stable Pb-207)	2.3 x 10-2	0	1,087
Th-232	5.5 x 10-3	0	4,545
Th-230	1.1 x 10-3	0	22,727
Th-228 (Ra-224 to stable Pb-208)	1.6 x 10-3	0	15,625
Ra-226 (Rn-222 to Po-210)	1.2 x 10-3	0	20,833
Ra-228 (Ac-228)	7.9 x 10-4	0	31,646
Pb-210 (Bi-210 thru Stable Pb 206)	1.6 x 10-3	0	15,625

a. Based on calculations by RESRAD-Build using the parameters specified in Table 5-7

input parameters to which the calculated $DCGL_w$s or peak annual dose is most sensitive. There are no parameters sensitive to changes over the range of realistic yet conservative values that any given parameter value could take on at the Fansteel site.

5.1.2 Surface Soil

Table 5-8 lists the individual radionuclide $DCGL_w$s for soil calculated by RESRAD for the residual radioactivity in soil at the Fansteel site. The year of the peak dose associated with each radionuclide is year zero because the radionuclide decay chains at Fansteel are already in equilibrium. For radionuclide decay chains already in equilibrium, the single radionuclide soil guidelines are in the RESRAD Summary Report Single Radionuclide Soil Guidelines G (i,tmax). As expected under an industrial use scenario with the radionuclides present at the Fansteel site, the RESRAD results show that more than 97 percent of the TEDE at the time of peak dose (time zero) is due to the external exposure from residual radioactivity.

Table 5-8 Industrial Worker Scenario Individual Radionuclide DCGLws for Soils

Radionuclide and Progeny	Industrial Worker [a]$DCGL_w$s at Time Zero (pCi/g)	Time of Maximum Dose (yrs)
U-238 (Th-234, Pa-234m, Pa-234)	967	0
U-234	7915	0
U-235 (Th-231)	211	0
Pa-231	251	0
Ac-227 (Th-227 to stable Pb-207)	54.6	0
Th-232	255	0
Th-230	3,300	0
Th-228 (Ra-224 to stable Pb-208)	19.2	0
Ra-226 (Rn-222 to Po-210)	14.7	0
Ra-228 (Ac-228)	22.8	0
Pb-210 (Bi-210 thru Stable Pb-206)	799	0

a. Calculated by RESRAD using the parameters specified

The sum of fractions rule combined with the $DCGL_W$s presented in Table 5-8 will be used to determine whether the site has met the unrestricted release conditions during the FSS. Based on the characterization data presented in Chapter 4.0 and the anticipated radiological conditions at the time of the FSS, the U-238, U-235, and Th-232 decay chains are expected to each be in secular equilibrium and the Thorium 232 to Uranium 238 activity ratio is expected to be approximately 1:1. Uranium 235 activity is expected to comprise approximately 2.3 percent of the total uranium activity while Uranium 238 and Uranium 234 are expected to comprise approximately 97.7 percent of the total uranium activity which is typical for natural uranium.

In addition to the $DCGL_W$ values used to determine compliance for survey unit mean concentrations, the $DCGL_{EMC}$ concentration values for limited areas within a survey unit have been calculated. The $DCGL_{EMC}$ values are applicable to small, elevated areas of residual radioactivity within a larger survey area. Sensitivity analyses indicate that the $DCGL_{EMC}$ values are not sensitive to thickness beyond the base case of 0.85 m.

5.2 Proposed DCGLs

Activity concentrations at the listed DCGL value for any of the radionuclides will result in 25 mrem/y TEDE. The sum of fractions rule is applied to the soil DCGL values and to the structures DCGL values, based on the anticipated activity fractions of the radionuclides, to show compliance with the dose criterion. To ensure compliance with the 25 mrem/y annual peak dose limitation, regardless of the ratio of Uranium 238 to Thorium 232, but taking secular

equilibrium conditions into account for the U 238, U 235, and Th 232 decay chains, the DCGLws in Tables 5-11 and 5-12 below will be used in conjunction with the sum of fractions rule to evaluate FSS results and compliance.

5.3 Staff Evaluation

The staff has reviewed the dose modeling analyses for an industrial land scenario with no ground water pathway as part of the review of the Fansteel 's decommissioning plan, using NUREG-1757 Volume 2.

5.3.1 Site Release Criteria

The licensee intends to release the site for unrestricted use in compliance with the requirements of 10 CFR 20.1402. Thus, residual radioactivity levels that are distinguishable

Table 5-11 Industrial Worker Scenario Individual Radionuclide Decay Chain $DCGL_w$s for Soils

Radionuclide and Entire Decay Chain in Equilibrium	Industrial Worker $DCGL_w$s at Time Zero (pCi/g)	Time of Maximum Dose (yrs)
U-238 – Uranium Chain	14.1	0
U-235 – Actinium Chain	37	0
Th-232 – Thorium Chain	10	0

Table 5-12 Industrial Worker Scenario Individual Radionuclide Decay Chain $DCGL_w$s for Building and Component Surfaces

Radionuclide Decay Chain $DCGL_w$	Industrial Worker $DCGL_w$s at Time Zero (dpm/100 cm^2)	Time of Maximum Dose (yrs)
U-238 – Uranium Chain	5,200	0
U-235 – Actinium Chain	840	0
Th-232 – Thorium Chain	3,160	0

from background remaining at the site at the time of license termination cannot result in a total effective dose equivalent (TEDE) to an average member of the critical group that exceeds 25 mrem/yr. Residual radioactivity must also be reduced to levels that are as low as reasonably achievable (ALARA).

The development of DCGLs that will be used to demonstrate compliance with the regulations for releasing the site is discussed in Section 5 of the decommissioning plan (DP). The licensee has developed two sets of DCGLs for radionuclides found at the site. These include a set of DCGLs for residual radioactivity remaining on interior building surfaces and another set for residual radioactivity remaining in soils and sediments around the site. The DP implies that DCGL values developed for building surfaces will also be used for releasing components within

buildings. However, it should be noted that the exposure pathways considered for building surfaces may not include all the routes that someone could be exposed to residual radioactivity remaining on components (e.g., equipment and piping), especially if the components are removed from the building. Thus, the DCGLs developed for building surfaces should not be used for determining the acceptable release levels for removable components; the limits of Regulatory Guide 1.86 are appropriate.

5.3.2 Scenario Definition and Exposure Pathways

In its analysis to develop DCGL values for the site, the licensee assumed an industrial land-use scenario. Use of this scenario is based on the fact that the site is currently used for industrial purposes and the adjacent property is restricted to industrial use in accordance with the Muskogee Port and Industrial Park Master Plan of Development. Staff finds that some type of residential farming use of the site in the future cannot be completely ruled out because the site is in a rural area, where some agriculture (livestock and dairy) takes place. As a bounding analysis, staff determined that DCGL values for soils and sediments under a residential farming scenario would be an order of magnitude lower than those under an industrial land-use scenario. However, based on the current land-use of the site, and the fact that the site is next to an industrial park, staff agrees that the most likely foreseeable land-use of the site will be for industrial purposes.

DCGL values have been developed for the 11 radionuclides identified in the DP. The list of radionuclides for which DCGL values were developed is consistent with the suite of radionuclides identified as part of the site characterization effort documented in Section 4 of the DP. The suite of radionuclides is also consistent with what is known about the raw material used in the metal production.

For both soils and sediments, and building surfaces, the critical group is considered to be an adult industrial worker. Exposure to residual radioactivity remaining in soils and sediments is assumed to occur through direct external radiation, inhalation of soil dust, and inadvertent ingestion of soil. Exposure to residual radioactivity remaining in the interior of buildings is assumed to occur through direct external radiation, inhalation of resuspended residual radioactivity, inadvertent ingestion of residual radioactivity from surface sources, and ingestion of resuspended residual radioactivity. The licensee assumed that no water or food from the site is consumed.

Staff finds that the exposure pathways considered by the licensee are appropriate given that they are consistent with what would be expected for an industrial-type land use. The exposure pathways assumed for residual radioactivity remaining in the buildings are also consistent with those recommended in the NRC default building occupancy scenario in NUREG-1757 (NRC, 2003). However, staff does not agree with the licensee's exclusion of ground water as a viable exposure pathway. Even under an industrial land-use scenario, it is possible that the ground water at the site could be used for supplying drinking water to workers at the site. The only rationale that the licensee provides for not considering the use of ground water at the site is that it has been impacted by the licensee's licensed material. Use of this argument for excluding the ground water pathway would establish an unacceptable precedent of allowing a licensee to take credit for (or obtain an advantage) from its impacts.

5.3.3 Building Surface DCGLs

Characterization data indicate that the decay chains of U-238, Th-232, and U-235 are in secular equilibrium. The DP states that based on the characterization data presented in Section 4 of the DP and the anticipated radiological conditions at the time of the final status survey, the Th-232 to U-238 activity ratio is expected to be approximately 1:1. Staff's review of the characterization data shows that the assumption of a 1:1 activity ratio may be appropriate for a few areas of the site (i.e., the surface soils and Pond No. 2); however, in general the activity of uranium is at least twice that of thorium, and in some places (such as the subsurface soils and Pond No. 9), it is more than fives that of thorium. Because this ratio is important in correctly applying the unity rule, as will be discussed later, the licensee must determine the actual ratio of radionuclides within any given survey unit, rather than assuming a given ratio is applicable across the whole site.

Because each derived DCGL value (Table 5-12, above) represents the activity equivalent to a dose of 25 mrem/y, the sum of fractions rule, as shown below, must be used to fraction the concentration when multiple radionuclides are present so that the total dose will not exceed 25 mrem/y.

$$\sum_{i=1}^{N} \frac{Conc_i}{DCGL_i} \leq 1$$

where:

$Conc_i \equiv$ concentration of radionuclide i

$DCGL_i \equiv$ derived concentration guideline level for radionuclide i

$N \equiv$ total number of radionuclides

The DCGLs calculated assume secular equilibrium for each decay chain. As previously noted, site characterization data support the assumption of secular equilibrium. However, to correctly apply the sum of fractions rule, the ratio of activity between the decay chains (i.e., U-238 to Th-232 and U-238 to U-235) must be known. The site characterization data shows that these ratios vary considerably across the site; therefore, a singe value cannot be assumed to apply across the site.

To evaluate the acceptability of the building surface DCGL values listed in the DP, the staff made confirmatory runs using RESRAD-Build (Version 3.21) with the licensee's parameter values. The staff was able to verify the licensee's results. The staff also evaluated the acceptability of the parameter values used in the licensee's analysis by comparing them against values recommended in NRC guidance. Staff found that in general the parameter values used by the licensee were consistent with those recommended in NRC guidance (NRC, 1999; and NRC, 2002) for evaluating exposure to an occupant under a light industrial land-use scenario. However, there were three exceptions where the parameter values used by the licensee were not consistent with those recommended in guidance, as shown in Table 5.3-2.

Table 5.3-2 Parameter values used by Fansteel that differs from Recommended Values.

Parameter	***Fansteel's Value***	***Recommended Value***
Occupancy fraction (unitless)	0.17	0.267
Inhalation rate (m^3/d)	31.21	33.6
Removable fraction	0.03	0.1

To evaluate the effect of these parameters on the calculated DCGL values, staff calculated the dose that would have been obtained had the values recommended in guidance been used. It should be noted that in the staff analysis, the removable fraction was kept at 0.03. The reason for this is that the licensee appears to be committing to leaving a removable fraction of radioactivity on the building surfaces of no greater than 3%. This commitment appears to be part of the licensee's effort to demonstrate ALARA. The recommended 0.267 occupancy fraction assumes that the hypothetical worker will spend slightly more than 8-hours/day (i.e., roughly 9-hours/day) inside the building. This is meant to be conservative. The value used by the licensee assumes that the worker spends roughly 6-hours/day in the building. The staff assessment shows that DCGL values would decrease by a factor of 1.6, which is the same as the factor of increase in the occupancy fraction value, with the use of the recommended occupancy fraction value. Thus, while the parameter value used by the licensee is not as conservative as the recommended value, use of the more conservative recommended value would not significantly change the DCGL values. Buildings in the previously released Northwest Property were remediated to the limits of RG 1.86 that, for uranium and thorium result in a dose below the 25 mrem/y limit. Because a person can occupy only one building at a time, consideration of this contribution will not affect the DCGLs necessary to meet the 25 mrem/y limit.

The staff also performed a multi-variable sensitivity and uncertainty analysis where several input parameters (including the occupancy fraction) were treated stochastically. Statistical distributions for the stochastic parameters were taken from NUREG/CR-6755 (NRC, 2002). This analysis shows that DCGL values would not need to be changed significantly over a broad range of input parameter values. Thus, it can be generally concluded that even if the input parameters used by the licensee are incorrect, it is unlikely that someone would get a significant dose from the residual radioactivity remaining in the buildings at the proposed levels, assuming the buildings are used for light-industrial purposes.

5.3.4 Soil and Sediment DCGLs

As with the building surface DCGL values, each derived DCGL value for soil and sediment listed in the DP (Table 5-11, above) represents the activity equivalent to a dose of 25 mrem/y. Accordingly, the sum of fractions rule must be used to fraction the concentration when multiple radionuclides are present so that the total dose will not exceed 25 mrem/y.

Input parameter values used in the licensee's analysis to develop the DCGL values are listed in Tables 5-4, 5-5, and 5-6 of the DP. In the licensee's analysis, the residual radioactivity is assumed to extend over an area of 180,000 square meters, to a depth of 0.85 meters. The 180,000 square meters represent the entire radiologically impacted area of the site. Increasing

the area in the analysis beyond 180,000 square meters does not significantly change the DCGL values. This is because doses from exposure to the suite of radionuclides found at the site, under the assumed scenario, are expected to be primarily from direct radiation, and the large area used in the analysis approximates exposure from an infinite plane source. Thus, in the final status survey, the DCGL values could be applied to survey units of any size.

The 0.85 meters thickness represents the anticipated area-weighted thickness of residual radioactivity expected following decommissioning. Site characterization data show that some radioactivity is known to extend down to a depth of several meters. Thus, it is possible that at least some residual radioactivity may extend over a thickness greater than 0.85 meters after decommissioning. However, again because the dose from the residual radioactivity is expected to be primarily from gamma radiation, the dose attributable to radioactivity below a depth of 0.85 meters is expected to be insignificant, which was confirmed through a staff sensitivity analysis. This is also consistent with the conclusion reached by the licensee as part of its sensitivity analysis. The previously released Northwest Property was remediated to Site Decommissioning Management Program Option 1 criteria for release for unrestricted use. The SDMP criteria are the same as the dose based criteria for thorium. For uranium, the SDMP is slightly lower: 10 vs 14 pCi/g. However, surveys from the licensee (Fansteel, 1996) demonstrate the residual radioactivity is much lower than the limits. Therefore, consideration of contribution to dose from this area will not affect the DCGLs necessary to meet the 25 mrem/y limit.

Staff also performed a sensitivity and uncertainty analysis that involved simultaneously varying several input parameters over a reasonable range of values that were considered to be consistent with an industrial land-use scenario. Based on this sensitivity analysis, it can be concluded that the key parameter in the development of the soil and sediment DCGL values is the fraction of time the hypothetical worker is assumed to spend outside at the site. This was expected because the dose from residual radioactivity remaining in the soils and sediments, under the assumed scenario, is expected to be primarily attributed to external gamma radiation. The licensee's analysis assumes that the hypothetical worker spends roughly 2000-hours/year on the site, with roughly 25% of this spent outside. This is not conservative, but seems reasonable for an industrial land-use scenario.

Based on the staff's multi-variable sensitivity and uncertainty analysis, the DCGL values would not be expected to vary by more than a factor of two for a fairly broad range of input parameter values. Thus, it can be concluded that it is unlikely that someone exposed to the residual radioactivity at the proposed levels, under an industrial-use scenario will get a significant dose for a broad range of input parameter values.

As previously noted, the licensee does not provide an acceptable basis for excluding ground water as a viable exposure pathway. Thus, staff evaluated the effects of excluding the ground water as an exposure pathway, by including it in an analysis. Based on this assessment, staff concluded that the ground water pathway will not significantly contribute to the dose from residual radioactivity remaining in soils at the site. This is because an appreciable concentration of radioactivity from the soils or sediments is not expected to reach the water table within a 1000-year time period, even with a shallow water table. However, it is known

that there are already elevated concentrations of uranium in the ground water from past operations on the site. These elevated concentrations occur primarily in the area near Pond Numbers 2 and 3. Uranium concentrations have been measured close to 50,000 pCi/L in one well. Even if the ground water is assumed to be only used for drinking purposes, it can be easily shown that exposure to measured concentrations of uranium in the ground water will result in a dose exceeding the 25 mrem/y limit. As an example, assuming a water consumption rate of 445.3 liters/year, the concentrations listed in Table 5.5-2 would be the limiting

Table 5.2-2 Example Ground-water Concentrations that are Equivalent to 25 mrem/y.

Radionuclide	***Dose Conversion Factor (mrem/pCi)***	***Concentration (pCi/L)***
Ac-227+D	1.48×10^{-2}	3.8
Pa-231	1.06×10^{-2}	5.3
Pb-210+D	7.27×10^{-3}	7.7
Ra-226+D	1.33×10^{-3}	42.4
Th-230	5.48×10^{-4}	104.2
U-234	2.83×10^{-4}	192.3
U-235+D	2.67×10^{-4}	208.3

concentrations needed for each radionuclide (i.e., assuming that radionuclide is the only radionuclide present). The 445.3 liters/year consumption rate is the average drinking water intake rate of adults, ages 18-54, as reported in Table 3-5 of the Exposure Factors Handbook (US EPA, 1997). To be consistent with what might be used under an industrial scenario, the drinking water intake rate is limited to water consumption, and water used for ice, tea, and coffee.

The licensee has committed to remediating the ground water as Phase 4 of the site decommissioning. Residual radioactive concentrations should ensure that exposures will not result in a dose that exceeds the 25 mrem/y limit from all appropriate pathways.

5.3.5 Elevated Measurement Comparison DCGLs

Use of the DCGL values listed above, for demonstrating compliance with the release criteria assumes a relatively uniform distribution of residual radioactivity within the survey unit. However, there still needs to be a reasonable level of assurance that smaller areas of elevated radioactivity within the survey unit will not result in a dose that exceeds the release criteria. Elevated measurement comparison values ($DCGL_{EMC}$) are intended to ensure that the release criteria will be met for these areas of the site. In addition, $DCGL_{EMC}$ values are needed to develop area factors, which are needed to develop the maximum detectable concentration required by the scan procedure.

$DCGL_{EMC}$ values for buildings and soils were developed by the licensee by running the computer code using the input parameters used to develop the DCGL values with decreasing

areas of residual radioactivity. Building $DCGL_{EMC}$ values are listed in Tables 1 through 8 of Appendix 5-4 of the DP. Different $DCGL_{EMC}$ values were determined to distinguish between elevated radioactivity occurring on the walls versus the floor of the building. Soil and sediment $DCGL_{EMC}$ values are listed in Tables 1 through 11 of Appendix 5-2 of the DP. Through its own independent assessment, staff was able to verify the $DCGL_{EMC}$ values obtained by the licensee.

5.3.6 Conclusions

The staff concludes that the dose modelling completed for an industrial land use scenario with no consumption of on-site ground water is not appropriate for the decommissioning option and exposure scenario assumed. This licensee should consider the effects of use of on-site ground water. However, because the licensee has committed to remediate the ground water and because of the nature of the contaminants, the dose estimate does provides reasonable assurance that the dose criterion in 10 CFR 20.1402 will be met. This conclusion is based on the modeling effort performed by the licensee and the independent analyses and review performed by the staff and proposed license conditions.

In determining the dose, the licensee has used a combination of the conceptual model(s), exposure scenarios, mathematical model(s), and input parameters to calculate a reasonable estimate of dose. The licensee has adequately considered the uncertainties inherent in the modeling analysis. However, the licensee must consider an all pathway dose to determine final DCGLs for both soil and ground water. The staff has proposed license conditions, to which the licensee has agreed, that meet NRC's needs.

6 ALARA Analysis

The Fansteel remediation ALARA analysis plan addresses the following:

* Cost-benefit feasibility analyses (or qualitative feasibility arguments when credible monetary values cannot be assigned) of the preferred and competing alternatives/options postulated to reduce residual radioactivity to levels no greater than the radiological criteria for unrestricted use (25 mrem TEDE per year).

* The method (predetermined or performance-based) for showing compliance with the ALARA requirement at the time decommissioning is completed.

Fansteel will prepare and approve documents (e.g., procedures) implementing the provisions of this section.

6.1 ALARA Compliance Demonstration

Fansteel is evaluating the following two approaches for demonstrating that doses to the average member of the critical group following site decommissioning are ALARA. The first of the approaches is favored for its simplicity:

* Deterministic - Predetermined acceptable remediation dose limit or concentration guideline(s).

* Performance-Based - An acceptable remediation preferred option and decommissioning goal with organizational oversight and review during decommissioning.

Following selection of the compliance approach, Fansteel will amend the DP accordingly.

The staff has reviewed the information submitted by Fansteel to demonstrate that the preferred decommissioning option is ALARA as required in 10 CFR Part 20, Subpart E, in accordance with the criteria in the Consolidated NMSS Decommissioning Guidance, Volume 2, Chapter 6 ("ALARA Analyses"). Based on this review the staff concludes that the preferred option, as modified by license conditions to which the licensee has agreed, provides reasonable assurance that the remediation will result in residual radioactivity levels that are ALARA. The licensee has committed to showing compliance during remediation by meeting the concentration limits established in the decommissioning plan and setting appropriate remediation goals' and establishing a protocol to optimize the remediation activities during decommissioning.

7 Planned Decommissioning Activities

As stated in its letter of May 8, 2003, Fansteel plans to remediate the site in four phases: i) Ponds 2 and 3; ii) Ponds 5-9; iii) buildings, equipment and soils throughout the site; and iv) ground water. Phases 1-3 will be done in sequence; Phase 4, ground water remediation, is currently ongoing and will continue until radioactive contaminants reach release limits.

Planned decommissioning activities for the Fansteel site include the following:

Cleaning of contaminated structures and equipment
Outdoor site remediation preparation
Excavation of affected soil and pond residue
Off-site shipment for disposal or reclamation of above-criteria soil, residue, demolition debris, and equipment
Backfilling of excavations
Diversion of surface water
Restoration of the site
Pumping and treatment of groundwater

Fansteel will complete the decommissioning with the assistance of contractors, subcontractors, and consultants. A conceptual engineering plan for site remediation activities is presented

below. After plan approval by NRC, designs and specifications will be developed to better detail approaches to accomplish the objectives set forth in the approved plan. These detailed plans and specifications may differ somewhat from the conceptual engineering approach provided herein.

7.1 Contaminated Structures

Removable contamination is on surfaces throughout the Chemical “A” and Chemical “C” buildings. Decommissioning will include decontamination of building surfaces to below release criteria. It is expected that portions of the floor of the Chemical “A” and Chemical “C” buildings, and possibly parts of the ore storage pad, will have to be removed and disposed as LLR waste. Other buildings that will be remediated as necessary are listed in Section 4.1 above.

Specific remediation techniques and order of occurrence will be developed in conjunction with contractors for structures at the Fansteel site. Decontamination of building surfaces will consist of cleaning with appropriate solvents, cleaning solutions, high-power vacuum cleaners, pressure washers, etc. Wet techniques will not be used on porous materials.

Debris will be staged in on-site piles and subsequently loaded into disposal containers, or suitably packaged for transport. In addition to some concrete surfaces, other materials such as duct work, corroded sheet metal, porous materials, and flooring materials may be discarded as LLR waste. Alternately, Fansteel may consider scrapping of some material, depending on economic conditions.

Solid material that meets unrestricted release criteria will be disposed off site as conventional construction/demolition debris in accordance with Oklahoma solid waste management regulations (OK 252:520-9). All surface materials and components that will be disposed as LLR will be loaded onto Department of Transportation (DOT) approved trucks or railcars for transportation to an approved off-site disposal facility.

Fansteel does not intend to dismantle structures or buildings under this DP.

The NRC staff has reviewed the decommissioning activities described in the Decommissioning Plan for the Muskogee Site, license number SBM-911 located at Muskogee, Oklahoma according to the Consolidated NMSS Decommissioning Guidance, Chapter 17.1 (Planned Decommissioning Activities). Based on this review the NRC staff has determined that the licensee, Fansteel, has not provided sufficient information to allow the NRC staff to evaluate the licensee’s planned decommissioning activities to ensure that the decommissioning can be conducted in accordance with NRC requirements. Therefore, staff has proposed license conditions, to which the licensee has agreed, that meet NRC’s needs.

7.2 Contaminated Systems and Equipment

The equipment presently at the Fansteel facility will be cleaned to the criteria of RG 1.86. Equipment that cannot be cleaned for unrestricted release will be cut or broken down into the smallest practicable size for handling, shipping, and disposal purposes. Disassembled equipment and debris will be staged in on-site piles and subsequently loaded into disposal containers, or suitably packaged for transport. Alternately, Fansteel may consider scrapping of

some material, depending on economic conditions. At this time, Fansteel does not plan to remove any of the equipment at the site. Specific remediation techniques and order of occurrence will be developed in conjunction with contractors.

Some equipment will be sold. Equipment for sale will be secured in appropriate packing and shipped in appropriate containers for transport to their destination. If the equipment is defined by the DOT as radioactive material following decontamination, all of the DOT requirements for transport of radioactive materials (packaging, placards, labeling, and routing) will be strictly followed.

Effluents from the cleaning operation will be conveyed to a settling basin (or tank) where the particulates will settle out. The supernatant wash water will be sampled and analyzed for dissolved radioactivity. If the wash water is suitable for discharge, the supernatant will be pumped to the site treatment plant for eventual discharge. The solids from the washing operation will be tested for the presence of licensed materials and handled accordingly. Liquid and solid residues that would be hazardous wastes when discarded will be segregated from other wastes and disposed appropriately. Nonhazardous liquid and solid residues from building surface and facility decontamination will be analyzed for total activity prior to being discarded. Solid residues that are not hazardous waste will be packaged and disposed as LLR waste.

7.3 Soil

Radiologically impacted soils and residues are isolated to plant areas within and surrounding Pond Numbers 2 3, 5, 6, 7, 8, and 9, and areas to the east of the Chemical “A” and Chemical “C” plant buildings. Soil contamination was also detected to the east of the wastewater treatment ponds and Pond No. 5, however, at levels typically lower than that exhibited in the areas of the site associated with manufacturing and ore processing.

The planned soil remediation requires identifying soils and pond residues with concentrations above the limiting DCGL, excavating, and segregating it on site. Above-criteria material will be shipped to a licensed or permitted facility in accordance with regulatory requirements. Below-criteria material will be returned to the excavation. Based on current estimates of pond volumes and proposed DCGLs, approximately 16,000 tons (20 percent moisture content by weight) of residues from the WIP will be excavated, packaged, and shipped from Pond Numbers 2 and 3 for reclamation at a licensed facility. An estimated 68,000 tons (20 percent moisture content) of residue will be excavated and disposed from Pond Numbers 5, 6, 7, 8, and 9. Excavation and disposal of soil from the surrounding plant area and beneath the ponds account for approximately 15,855 tons (ambient moisture content).

Prior to pond and soil remediation activities, a segment of the site (most likely to the northwest of the Sodium Reduction Building) will be prepared as a stockpile and material processing area. The stockpile area will be lined with 60-mil high-density polyethylene geomembrane, or equivalent. Berms and ditches will be constructed at the perimeter to handle precipitation falling onto the stockpile. Haul roads, drainage channels, culverts, berms, E&S controls, and access controls will be constructed during the site preparation phase.

Remediation activities within Pond Numbers 2 and 3 requires installation of sheet piling for lateral support and groundwater control. Excavation in the Pond No. 2 area will extend to a

depth of about 12 feet, while excavation in the area of Pond No. 3 will extend down to approximately 14 feet. Soil remediation in the surrounding plant area will vary up to a depth of approximately 20 feet.

Standard construction equipment will be used to complete soil remediation.
Gamma scanning will be used to identify above-criteria from below-criteria materials. Excavated material will be transported to a stockpile area where it will be air-dried and relocated to a feed pile. Oversize materials will be identified and removed before the materials are fed into the segregation system. Segregated materials that are below the limiting DCGL will be stockpiled temporarily and eventually returned to the excavations.

Below-criteria material will be used as backfill in the pond excavations. Additional off-site borrow material will be necessary to bring the site to the final grades. Backfill will be placed in 8-inch loose lifts and suitably compacted.

The site will be restored as each area is completed so that weathering is minimized. Restoration will include placement of vegetative material, seeding and mulching, permanent surface water controls, and permanent E&S controls.

7.4 Surface and Groundwater

Fansteel did not originally include remediation of groundwater in this DP. However, per the supplement of May 8, 2003, the licensee will remediate the ground water as Phase 4 of the DP. The existing groundwater treatment program will remain in place at the Fansteel site during most of the decommissioning activities. Surface water will be managed so that contact with affected material is avoided.

The existing WWTP will be used to process surface water accumulated in ponds and groundwater encountered in excavations until Pond Numbers 6, 7, 8, and 9 are no longer available. The existing plant will then be modified to use sand-drying bed units to filter the water from the solids and remove free liquid from the solids prior to off-site disposal of the recovered solids. The water will be monitored and discharged to the Arkansas River after treatment. If necessary, an activated carbon filtration system may be used as a final wastewater-polishing step prior to its discharge to the Arkansas River. Alternatively, after Pond Numbers 6, 7, 8, and 9 are no longer available, accumulated water may be pumped to an evaporator treatment system to obviate the need for liquid discharges.

7.5 Schedules

Contingent upon NRC approval of this DP, the planned schedule for decommissioning activities, as of May, 2003 is: Phase 1 from 2004 to 2006; Phase 2 from 2006 to 2011, as is Phase 3. Ground water treatment, which will be completed in Phase 4, is currently underway, and will continue until ground water meets release standards, estimated to be in 2023.

8 Project Management and Organization

8.1 Decommissioning Management Organization

The Fansteel Corporate Project Manager (CPM) may revise this organizational structure as deemed appropriate to facilitate execution of the project and to conform to NRC material license conditions. Any revisions of the organizational structure will be documented by the Fansteel CPM.

The Plant Radiation Safety Officer (PRSO), who reports to the CPM, will be responsible for the radiological health and safety of all license activities involving radioactive materials. The Site Project Manager (SPM), who reports to the PRSO, has the direct responsibility for planning and managing remediation activities. The Health Physics Supervisor (HPS) is responsible for directing the Data Manager (DM) and HPT in their assigned work activities. The Quality Control Officer (QCO), who reports to the CPM, has the responsibility and authority to assure that quality control (QC) objectives are met.

The NRC staff has reviewed the description of the decommissioning project management organization, position descriptions, management and safety position qualification requirements and the manner in which the licensee will use contractors during the decommissioning of its facility located at Muskogee according to the Consolidated NMSS Decommissioning Guidance, Chapter 16.9 (“Decommissioning Management Organization”). Based on this review, the NRC staff has determined that the licensee has not provided sufficient information to allow the NRC staff to evaluate the licensee’s decommissioning project management organization and structure to determine if the decommissioning can be conducted safely and in accordance with NRC requirements. Therefore, staff has proposed license conditions, to which the licensee has agreed, that meet NRC’s needs.

8.2 Decommissioning Task Management

Remediation activities will be authorized and conducted in accordance with written and approved remedial action work plans (RAWP). Each RAWP will specify the entire scope of the approved work including provisions to control worker exposure to anticipated H&S hazards. Where required, the RAWP will tier to written procedures for work performance (e.g., establishing radiological controls using the radiation work permit [RWP] program, assuring correct occupational safety controls using an H&S Plan). All necessary programs and procedures will be written and approved prior to RAWP implementation.

An engineering design will be completed and construction specifications will be developed so that the DP can be implemented. Specifications may be performance specifications or may be based upon detailed engineering designs.

8.3 Decommissioning Management Positions and Qualifications

The CPM will ensure that remediation activities meet the established environmental, health and safety (H&S), and quality assurance (QA) requirements, and technical performance, in accordance with written procedures. The CPM has authority to make necessary changes to the contractor’s work and to stop any activity. The CPM must possess a B.A./B.S. degree and

have a minimum of 10 years of management experience including 5 years of health, safety, and environmental management experience.

8.3.1 Radiation Safety Officer

The Plant Radiation Safety Officer (PRSO) will be responsible for the radiological health and safety of all license activities involving radioactive materials. In addition, the PRSO will review the implementation and documentation of all work activities involving radioactive materials including surveying, dosimetry, compliance issues, instrumentation, audits, data interpretation, training, wastes, shipping and receiving, decommissioning, decontamination, and emergency response. The PRSO will have "stop work" authority for all activities involving radioactive material at the site. The PRSO will possess a minimum B.S./B.A. degree in Physical Sciences, Industrial Hygiene, or Engineering from an accredited college or university, or an equivalent (i.e., 2:1) combination of training and relevant experience in radiological protection.

8.3.2 The Site Project Manager (SPM)

The Site Project Manager (SPM) has the direct responsibility for planning and managing remediation activities. The SPM is responsible for ensuring that the remediation project activities meet the established environmental, H&S, and QA requirements; technical performance; budgeting; and scheduling criteria. In addition, the SPM has the authority to make appropriate changes to the QA Plan deemed necessary, as the remediation activities progress. The SPM will possess a minimum of a B.S. in Science or Engineering and have 2 years of management experience, or equivalent experience.

8.3.3 Other Supervisory Position

The Health Physics Supervisor (HPS) is responsible for directing the Data Manager (DM) and HPT in their assigned work activities. In addition, the HPS assists in maintaining proper radiological controls on the project. The HPS has the authority to make appropriate changes to the final status survey plan deemed necessary as remediation activities progress. The HPS will oversee all health physics technicians working at the site. The HPS reports to the PRSO and has the authority to stop work that may be unsafe due to radiological exposure considerations.

The Construction Supervisor (CS) is responsible for overseeing site remediation activities and day-to-day administration of contractor performance to assure that remediation activities are performed safely, in accordance with approved plans, design specifications, and government permits and regulations. The CS has the authority to stop work that may be unsafe or that may violate an approved plan, design specification, government permit, or regulation. The CS reports to the SPM.

The Quality Control Officer (QCO) has the responsibility and authority to assure that quality control (QC) objectives are met. Responsibilities of the QCO include overseeing that appropriate quality management, policy, training, and verification controls are present. Additional QCO responsibilities include conducting QC audits relating to remediation activities and surveillance of contractor activities. The QCO will be allowed to inspect the work at any time and provide all reasonable facilities and equipment necessary to inspect the work. The QCO is not authorized to revoke, alter, or waive any requirements of this plan. The QCO has

the authority to suspend work until any quality-related issues can be resolved and to initiate, recommend, or provide solutions and to verify implementation of solutions.

8.4 Training

Training focused on the objectives of the DP will be required. Annual training and refresher training, as needed, will also be required (in order to comply with 10 CFR 19 and 10 CFR 20). The training program will include general radiation safety training/monitoring, site orientation, site- and job-specific training, and training verification and documentation.

8.5 Contractor Support

The licensee has not defined any contractor work in this plan, but has stated there will be some. The scope of work and qualifications for contractors will be provided to NRC.

9 Radiation Safety and Health Program

The Fansteel Radiation Health and Safety Program (RHASP) planned for implementation at the Muskogee site during the decommissioning and FSS phases is designed to conform to the following two fundamental performance objectives: a) compliance with the regulatory requirements in 10 CFR Parts 19 and 20 and b) radiological controls and monitoring for workers will be commensurate with the risks associated with licensed activities at the Muskogee decommissioning site. The NRC staff has reviewed the information in the Decommissioning Plan for the Muskogee Site, license number SBM-911 located at Muskogee, Oklahoma according to the Consolidated NMSS Decommissioning Guidance, Chapter 17.3 (Radiation Safety and Health Program During Decommissioning). Based on this review, the NRC staff has determined that the licensee, Fansteel, has not provided sufficient information for all planned phases of decommissioning. Therefore, staff has proposed license conditions, to which the licensee has agreed, that meet NRC's needs.

9.1 Workplace Air Sampling Program

The air sampling program will encompass routine, anticipated off normal, and unanticipated conditions. It will be designed to comply with the dose assessment requirements of 10 CFR 20.1204, the survey requirements in 10 CFR 20.1501(a)-(b), and the requirements in 10 CFR 20.1703(a)(3)(i)-(ii), when respirators are worn. Unless otherwise specified, the NRC guidance published in Regulatory Guide 8.25 will be used to specify needed performance and surveillance aspects of the air sampling program.

Air sampling representative of workers' breathing zones will be required when a worker's intake is likely to exceed the criteria in 20.1502(b) in any work areas in which a potential exists for airborne radioactive materials. Sampler selection, use, and filter analysis will provide sufficient sensitivity to detect air concentrations of nuclides of concern or surrogates over the ranges of concentrations encountered in the work areas. Sampler flowmeter calibration will be performed as recommended. Continuous air monitors (CAM) are not planned for use at the Muskogee site.

Action levels for air sampling results, including actions to be taken when they are exceeded and their technical bases, will be as indicated in Regulatory Position 6.1 of Regulatory Guide 8.25. The minimum detectable activity (MDA) for each radionuclide of concern or surrogate that may be collected in air samples will be calculated in accordance with Regulatory Position 6.3 of Regulatory Guide 8.25.

9.2 Respiratory Protection Program

The purpose of the respiratory protection program is to adequately limit intakes of airborne radioactive materials for workers in restricted areas and to keep the TEDE ALARA. The program will meet the requirements of 10 CFR 20.1101(b), 20.1701-20.1704, Appendix A of 10 CFR Part 20, and the applicable guidance in Regulatory Guide 8.15, “Acceptable Programs for Respiratory Protection,” and NUREG-0041, Rev. 1, “Manual of Respiratory Protection Against Airborne Radioactive Material.”

9.3 Internal Exposure Determination

The purpose of the internal exposure determination method is to assign a worker's internal exposure in compliance with 10 CFR 20.1101(b), 20.1201(a)(1), 20.1201 (d) and (e), 20.1204, 20.1502(b), and NRC guidance documents. The NRC guidance documents will be used to specify the determination method.

The internal exposure determination method will specify how estimates of intake of radionuclides by workers will be made including the calculations necessary for the conversion of an intake either to a committed effective dose equivalent or to a total organ dose equivalent.

9.4 External Exposure Determination

The purpose of the external exposure determination method is to assign a worker's external exposure in compliance with 10 CFR 20.1101(b), 20.1201, 20.1203, 20.1501(a)(2)(i), and (c), 20.1502(a), 20.1601, and NRC guidance documents. The NRC guidance documents will be used to specify the determination method include the following:

The determination method will measure worker external exposure using direct (dosimeters worn by workers) or inferred (calculated from measurements with appropriate instruments during surveys in areas where decommissioning activities are carried out) techniques.

9.5 Summation of Internal and External Exposures

The purpose of the exposure summation method is to calculate summed (external and internal) doses in compliance with 10 CFR 20.1202, 20.1208(c)(1) and (2), 20.2106, and NRC guidance documents. The NRC guidance documents that will be used to specify the summation method include the following:

- Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Exposure Data."
- Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses."

- Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus."

The exposure summation method will be as follows:

* Use the results of internal and external monitoring to calculate TODE and TEDE to occupational workers, as indicated in Regulatory Positions 7.1 C7.3 of Regulatory Guide 8.34.

* Sum the internal exposure to the embryo/fetus, which is based on the intake of an occupationally exposed DPW, as indicated in Regulatory Positions C1 to C3 of Regulatory Guide 8.36, with external dose to the DPW to obtain the "dose equivalent" to the embryo/fetus.

* Monitor the intake of a DPW if her internal exposure is likely to exceed the intake criteria indicated in Regulatory Position C1.1 of Regulatory Guide 8.36.

* Follow the program for the preparation, retention, and reporting of records for occupational radiation exposures, as indicated in Regulatory Guide 8.7.

9.6 Contamination Control Program

The purpose of the contamination control program is to monitor and control radioactive contamination during decommissioning operations (prior to the FSS phase) in compliance with the requirements of 10 CFR 20.1501(a); 20.1702; 20.1906 (b), (d), and (f); and NRC guidance documents.

The focus of the contamination control program is on surveys of skin, protective and personal clothing, fixed and removable surface contamination, transport vehicles, equipment (including ventilation surveys), and packages.

9.7 Instrumentation Program

The purpose of the instrumentation program is to provide operable instruments and equipment to make quantitative radiation measurements during decommissioning operations and FSSs in compliance with 10 CFR 20.1501(b) and (c) and NRC guidance documents.

Instrumentation will be used to conduct radiation and contamination surveys, sample airborne radioactivity, monitor radiation levels in work areas, monitor airborne radionuclides in effluents, monitor personnel dose, and analyze environmental media samples.

9.8 Nuclear Criticality Safety

Criticality is not a risk during decommissioning at the Muskogee site because there are no source materials present in concentrations that could result in nuclear criticality.

The results of staff’s review of the licensee’s submittal are that there is no risk to public health and safety from the risk of nuclear criticality during decommissioning.

9.9 Health Physics Audits and Record-Keeping Program

The purpose of the health physics audits, inspections, and record keeping assurance program is to evaluate, control, and monitor H&S procedures to ensure timely identification and correction of H&S issues. The frequency and scope of such activities will be sufficient to ensure uninterrupted compliance with NRC's requirements for the protection of the public H&S and the environment. This health physics assurance program will comply with 10 CFR 20.1101, 20.2102, and incorporate NRC guidance.

10 Environmental Monitoring Program

10.1 Environmental ALARA Evaluation Program

The current site EMP used to conduct licensed activities is compliant with regulatory requirements and will be revised as necessary to include decommissioning activities outside of the current EMP scope.

The environmental monitoring and control program will include management of surface water and groundwater encountered in excavations as well as monitoring for airborne particulates. Periodic sampling (frequency and method of sampling described in Section 11.2) will be conducted to verify that effluent concentrations in the water and air are below the values listed in 10 CFR 20 Appendix B, Table 2 and Table 3 limits for releases to sewers. In addition, the guidance in NRC Regulatory Guide 4.20 "Constraint on Releases of Airborne Radioactive Materials from Materials Facilities" will be used to demonstrate compliance with the NRC 10 mrem dose constraint for individual members of the public from air emissions.

Water and air sampling results will be evaluated by the RSO. In addition, quarterly summary reports will be prepared evaluating the data of EMP activities and be submitted to the RSO. A post-remedial monitoring report will be completed to document all monitoring activities and results during and after remediation. Evaluation of air sample results, water sample results and reports by the RSO will be conducted to ensure that the EMP is maintaining its commitment of ALARA.

The NRC staff has reviewed the information in the Decommissioning Plan for the Muskogee Site, license number SBM-911 located at Muskogee, Oklahoma according to the Consolidated NMSS Decommissioning Guidance, Chapter 17.4 ("Environmental Monitoring and Control Program"). Based on this review, the NRC staff has determined that the licensee, Fansteel, has not provided sufficient information on all phases of decommissioning to the staff to conclude that the licensee's program will comply with 10 CFR Part 20. The EMP requires periodic review and possible update to reflect decommissioning activities not currently used. Therefore a license condition has been proposed, to which the licensee agrees, that meets NRC's needs.

10.2 Effluent Monitoring Program

Fansteel currently has an NPDES permit in place for four outfall locations (Permit No. OK0001643). Outfall 001 discharge consists of process wastewater from the processing

operation, wastewater from site remediation activities, groundwater from the french drain system associated with Pond No. 3, and storm water runoff from the residue processing area. Outfalls 002, 003, and 005 discharges consist of storm water runoff from the southeastern portion of the facility (002), the northern portion of the facility (003), and the southwestern portion of the facility (005). The results of recent effluent sampling events will be used for baseline effluent concentrations to the Arkansas River.

Outfalls are sampled and analyzed for gross alpha and beta radioactivity concentrations. If the gross results exceed 15 (alpha) or 50 (beta), an isotopic analysis is performed. Background concentrations for air monitoring will be established prior to remediation activities. Recent air radioactivity concentration measurements showed that the average gross alpha/beta radioactivity concentration is 3.45 x 10-5 pCi/L.

Storm water and groundwater collected within an excavation or decontamination area will be contained. Within an excavation, the construction of trenches or berms may be used to isolate storm water and infiltrating groundwater, thereby reducing the potential for contamination of these waters. Collected water will be sampled and analyzed for radiological contamination. If activity concentration levels are below the appropriate 10 CFR 20, Appendix B limit (Table 2 or 3), the water will either be released to a permitted outfall or taken off site. Sampling frequency will be established in site procedures.

The frequency of air monitor sampling during remediation will be determined by the RSO. Up to four monitoring stations will be established to evaluate off-site releases. Samples for laboratory analysis will be collected in accordance with site procedures. If required, standard chain of custody protocol will be strictly adhered to during all phases of sample collection, transport, and delivery to the laboratory. MDCs for laboratory analysis will depend on laboratory analysis, instrumentation, and laboratory procedures. MDC concentration will be based on approved release criteria and will be a fraction of the accepted limits.

Quarterly reports will be prepared summarizing the air monitoring results and the groundwater and surface water sampling results. A QA/QC Program will be implemented as part of the EMP.

10.3 Effluent Control Program

Site procedures will be established to ensure releases to permitted outfalls are controlled and maintained to meet the requirements of 10 CFR 20.2003. The procedures will address discharge to sewer systems in accordance with NRC requirements.

Erosion control measures must be in place and operational before excavation, backfilling, or grading operations can begin.

An inspection schedule and reporting protocol will be prescribed in the contractor's work plan. A record of inspection and all repairs made will be noted and kept on-site by the SPM. At a minimum, all erosion control measures will be inspected weekly during soil remediation activities, every 2 weeks during inactive periods, and within 24 hours after each rainfall event exceeding 0.5 inch. During periods when rain is occurring daily, or continuously for days,

control measures will be inspected at least daily. Repairs and maintenance will be performed as soon as practical.

Airborne radioactivity monitoring will be conducted to confirm the effectiveness of radioactive material control practices during work activities. Laboratory results will be compared to the appropriate 10 CFR Part 20 Appendix B, Table 1, derived air concentration (DAC) limit. If it is determined that air concentrations exceed 10 percent the DAC, increased dust control and an evaluation of current engineering controls will occur. If engineering controls are not practical, an evaluation will be performed to demonstrate that utilization of respiratory controls will maintain ALARA. If personal exposure to more than 40 DAC hours in 1 day is suspected, the RSO will evaluate the possibility of an uptake.

Groundwater and surface water that infiltrate the excavation areas may be collected and temporarily stored for settling in holding tanks. Any water that collects in the containment system would be characterized and compared to the criteria outlined in Section 11.1 of the DP prior to discharge to the surface drainage or the facility WWTP.

No measurable doses to the public from effluents are anticipated from decommissioning activities. This expectation is based on the dilution factor for water discharges to the Arkansas River. Likewise, doses due to airborne effluents are expected to be near or below MDCs.

11 Radioactive Waste Management Program

11.1 Solid Radioactive Waste

The Fansteel Radioactive Waste Management Program (RWMP) planned for implementation at the Muskogee site during the decommissioning and FSS phases is designed to control radioactive waste generated as part of the decommissioning process in accordance with NRC, USEPA, and DOT requirements. The RWMP will be implemented using appropriate methods and procedures based upon recognized NRC and other professional health physics or industry organizations' guidance documents.

The solid waste management program will include the following:

* Specify the types of solid radioactive waste that are expected to be generated during decommissioning operations including (but not limited to) soil, structural and component metal, concrete, activated components, contaminated piping, wood, and plastic.

* Specify the estimated volume, in cubic feet, of each solid radioactive waste type expected to be generated during decommissioning operations.

* Specify the radionuclides (including the estimated activity of each radionuclide) in each estimated solid radioactive waste type expected to be generated during decommissioning operations.

* Summarize the volumes of Classes A, B, C, and Greater-than-Class C solid radioactive waste that will be generated by decommissioning operations.

* Specify on site storage (prior to disposal or reclamation) requirements for each solid radioactive waste type expected to be generated during decommissioning operations.

* Describe treatment and packaging activities for stored wastes to conform to the waste acceptance criteria (WAC) for the intended disposal or reclamation facility.

* Describe T&D requirements to conform to DOT requirements.

* Describe controls for volumetrically contaminated material (if required).

* Specify measures to prevent contaminated soil, or other loose solid radioactive waste, from being redisbursed after excavation and collection.

* Specify the name and location of the intended disposal or reclamation facility for each solid radioactive waste type expected to be generated during decommissioning operations.

The NRC staff has reviewed the licensee's descriptions of the radioactive waste management program for the Muskogee Site, license number SBM-911 located at Muskogee, Oklahoma according to the Consolidated NMSS Decommissioning Guidance, Chapter 17.5 ("Radioactive Waste Management Program"). Based on this review, the NRC staff has determined that the licensee's, Fansteel, does not have programs for the management of radioactive waste generated during all phases of decommissioning operations ensure that the waste will be managed in accordance with NRC requirements and in a manner that is protective of the public health and safety. The RWMP requires periodic review and update to reflect decommissioning activities. Therefore, staff has proposed license conditions, to which the licensee has agreed, that meet NRC's needs.

11.2 Liquid Radioactive Waste

The purpose of the liquid waste management program is to ensure that controls on liquid waste stream generation, storage, and disposal or reclamation will be protective of the public H&S and in accordance with NRC requirements. The applicable NRC requirements are 10 CFR Part 20 (Subpart K), 10 CFR 61.55, 61.56, 61.57, and 71.5.

The liquid waste management program will include the following:

* Specify the types of liquid radioactive waste that are expected to be generated during decommissioning operations.

* Specify the estimated volume, in liters, of each liquid radioactive waste type expected to be generated during decommissioning operations.

* Specify the radionuclides (including the estimated activity of each radionuclide) in each liquid radioactive waste type expected to be generated during decommissioning operations.

* Summarize the estimated volumes of Class A, B, C, and Greater-than-Class C liquid radioactive waste that will be generated by decommissioning operations.

* Specify on-site storage (prior to disposal or reclamation) requirements for each liquid radioactive waste type expected to be generated during decommissioning operations.

* Describe treatment and packaging activities for liquid wastes to conform to the WAC for the intended disposal or reclamation facility.

* Describe the T&D requirements to conform to DOT requirements.

* Specify the name and location of the intended disposal or reclamation facility for each solid radioactive waste type expected to be generated during decommissioning operations.

11.3 Mixed Waste

The purpose of the mixed waste management program is to ensure that controls on mixed waste stream generation, storage, and disposal or reclamation will be protective of the public H&S and in accordance with NRC and USEPA requirements. The applicable NRC requirements are 10 CFR Part 20 (Subpart K), 10 CFR 61.55, 61.56, 61.57, and 71.5. The applicable USEPA requirements are 40 CFR 260 270.

The mixed waste management program will include the following:

* Specify the types of solid and liquid mixed waste that are expected to be generated during decommissioning operations.

* Specify the estimated volumes, in cubic feet, of each solid mixed waste type expected to be generated during decommissioning operations.

* Specify the radionuclides (including the estimated activity of each radionuclide) in each type of mixed waste type expected to be generated during decommissioning operations.

* Summarize the estimated volumes of Class A, B, C, and Greater-than-Class C mixed waste that will be generated by decommissioning operations.

* Specify on-site storage (prior to disposal or reclamation) requirements for each mixed radioactive waste type expected to be generated during decommissioning operations.

* Describe treatment and packaging activities for mixed wastes to conform to the WAC for the intended disposal or reclamation facility.

* Describe the T&D requirements to conform to DOT requirements.

* Specify the name and location of the intended disposal or reclamation facility for each mixed radioactive waste type expected to be generated during decommissioning operations.

* Describe the requirements of all other regulatory agencies having jurisdiction over the mixed waste expected to be generated during decommissioning operations.

* Provide evidence that Fansteel possesses the appropriate USEPA or state permits to generate, store, or treat the mixed wastes expected to be generated during decommissioning operations.

* If appropriate and as applicable, incorporate USEPA conditional exemptions (40 CFR 266 Subpart N and 40 CFR 261.3[h]) for certain low-level mixed waste storage, treatment, transportation, and disposal or reclamation activities.

12 Quality Assurance Program

Responsibility for the development, implementation, and revision of the QA program for the Fansteel DP is shared by corporate and on-site personnel. The current site QA program used to conduct licensed activities is compliant with regulatory requirements and will be revised as necessary to include decommissioning activities outside of the current scope.

12.1 Organization

Responsibility for the development, implementation, and revision of the QA program for the Fansteel DP is shared by corporate and on site personnel as delineated below. This organizational structure may be revised by the Fansteel CPM as deemed appropriate to facilitate execution of the project. Any revisions will be documented by the CPM. The CPM has the direct responsibility for operational oversight of remediation activities and for submitting license documentation. The CPM has overall responsibility for planning and management of the decommissioning activities. The CPM will ensure that remediation activities meet the established environmental, H&S, QA requirements, and technical performance, in accordance with written procedures. The CPM has authority to make necessary changes to the contractor's work and to stop any activity.

The SPM has the direct responsibility for planning and managing remediation activities. The SPM is responsible for ensuring that the remediation project activities meet the established environmental, H&S, and QA requirements; technical performance; budgeting; and scheduling criteria. In addition, the SPM has the authority to make appropriate changes to the QA Plan deemed necessary, as the remediation activities progress.

The CS is responsible for overseeing site remediation activities and day-to-day administration of contractor performance to assure that remediation activities are performed safely, in accordance with approved plans, design specifications, and government permits and regulations. The CS has the authority to stop work that may be unsafe or that may violate an

approved plan, design specification, government permit, or regulation. The CS reports to the SPM.

The PRSO will be responsible for the radiological H&S of all license activities involving radioactive materials. In addition, the PRSO will review the implementation and documentation of all work activities involving radioactive materials including surveying, dosimetry, compliance issues, instrumentation, audits, data interpretation, training, wastes, shipping and receiving, decommissioning, decontamination, and emergency response.

The HPS is responsible for directing the DM and HPTs in their assigned work activities. In addition, the HPS assists in maintaining proper radiological controls on the project. The HPS has the authority to make appropriate changes to the FSSP deemed necessary, as remediation activities progress. The HPS will oversee all HPTs working at the site. The HPS reports to the PRSO and has the authority to stop work that may be unsafe due to radiological exposure considerations. The HPTs will ensure all necessary sampling and scanning required in the FSSP are performed in accordance with such plan and written procedures. The HPT is also responsible for sampling of soil stockpiles, off-site borrow material, and transportation containers, and will perform the preliminary review of survey data and analytical results.

The QCO has the responsibility and authority to assure that QC objectives are met. Responsibilities of the QCO include overseeing that appropriate quality management, policy, training, and verification controls are present. Additional QCO responsibilities include conducting QC audits relating to remediation activities and surveillance of contractor activities. The QCO will be allowed to inspect the work at any time and provide all reasonable facilities and equipment necessary to inspect the work. The QCO is not authorized to revoke, alter, or waive any requirements of this plan. The QCO has the authority to suspend work until any quality-related issues can be resolved and to initiate, recommend, or provide solutions and to verify implementation of solutions.

The NRC staff has reviewed the Quality Assurance Program for the Muskogee Site, license number SBM-911 located at Muskogee, Oklahoma according to the Consolidated NMSS Decommissioning Guidance, Chapter 17.6 (“QA Program”). Based on this review, the NRC staff has not determined that the licensee’s, Fansteel, QA program is sufficient to ensure that information submitted to support the decommissioning of its facility should be of sufficient quality to allow the staff to determine if the licensee’s planned decommissioning activities can be conducted in accordance with NRC requirements. The QA program requires periodic review and update to reflect decommissioning activities. Therefore, staff has proposed license conditions, to which the licensee has agreed, that meet NRC’s needs.

12.2 Quality Assurance Program

It is Fansteel's intention to implement appropriate QA program controls for work related to remediation and final radiological survey activities that may affect the H&S of the public and personnel at the site, or the quality of the final survey data. A written QA/QC Program will be developed to guide the performance of the FSS to assure that the results are accurate and that uncertainties have been considered adequately. This program will operate in all stages of the survey through final validation of the data and interpretation of results. The program will be consistent with guidance contained in the following document: NRC Regulatory Guide 4.15,

Quality Assurance for Radiological Monitoring Program--Effluent Streams and the Environment (NRC, 1979).

Any other requirements for a QA/QC program that may be in effect at the time of the plan's generation will be included in the final document. The QA/QC program will be finalized by Fansteel's management and provided to the NRC prior to implementation. No decommissioning activities subject to certification requirements will be performed prior to implementation of the QA/QC program.

The NRC will be notified of changes in procedures and personnel that would impact the commitments of the DP before implementation of the changes. Changes in organizational elements will require NRC notification within 30 days of implementation. Editorial changes or personnel reassignments of a non substantive nature will not require NRC notification.

12.3 Document Control

Preparation, review, approval, distribution, and revisions of the QA/QC Plan and procedures and technical reports will be controlled in a manner that will allow for documents to be revised, as needed, following review and approval. Superceded copies of revised documents will be voided by written notification. Distribution of approved documents will be controlled to ensure that those persons responsible for implementing written project plans and procedures have a current approved copy before work commences. Approved documents will be available at the location where the activity will be performed prior to work commencing.

12.4 Control of Measuring and Test Equipment

Counting systems and instruments will be used in accordance with approved procedures.

12.5 Corrective Action

A deficiency or nonconformance that potentially invalidates the quality of measurement subject to this plan or that is an exception to this plan will be reported to the DM, QCO, HPS, or SPM. Any appropriate person may report a deficiency or nonconformance. Identified exceptions to this plan and the reason for them will be documented and retained with project quality records. Nonconformance shall be investigated and resolved.

12.6 Quality Assurance Records

Records will be maintained to confirm that actions essential to meeting quality objectives were performed. Calibration records, corrective action reports, audit records, training certifications, and log books and forms used to document field activities will be retained and managed as quality records.

12.7 Audits and Surveillances

Audits and surveillances will be conducted by trained personnel not having direct responsibilities for the achievement of quality in the areas being audited. Persons conducting

quality assessments will have the authority and access to managers, documents, and records to:

* identify quality-related problems,
* make findings and directives to resolve quality-related problems,
* confirm implementation and effectiveness of corrective responses, and
* report deficiencies or nonconformance to the SPM in accordance with Corrective Action procedures.

13 Facility Radiation Surveys

13.1 Release Criteria

Fansteel will remediate the site in accordance with decommissioning criteria of Subpart E, Radiological Criteria for License Termination of 10 CFR Part 20, Standards of Protection Against Radiation. Specifically, Subpart E, 10 CFR 20.1402, Radiological Criteria for Unrestricted Use, allows release of a site for unrestricted use if the residual radioactivity distinguishable from background results in a TEDE to an average member of the critical group not exceeding 25 mrem/y, and the residual radioactivity has been reduced to levels that are ALARA.

13.1.1 Building Release Criteria

As described in Chapter 5.0, a dose assessment for the Fansteel site was conducted to determine dose-based decommissioning acceptance criteria for building and component surfaces. Radionuclide-specific $DCGL_W$ values corresponding to the radiological criteria of 10 CFR 20 Subpart E have been derived using the computer code RESRAD-Build. The $DCGL_W$ values were derived for 25 mrem/y TEDE for the industrial worker scenario and are presented below.

Industrial Worker Building Occupancy DCGLw (dpm/100 cm^2)

U-238	U-234	U-235	Pa-231	Ac-227	Th-232	Th-230	Th-228	Ra-226	Ra-228	Bi-210
58,140	54,349	48,076	4,032	1,087	4,545	22,727	15,625	20,833	31,646	15,625

13.1.2 Soil Release Criteria

As described in Chapter 5.0, a dose assessment for the Fansteel site was conducted to determine dose-based decommissioning acceptance criteria for soil. Radionuclide-specific $DCGL_W$ values corresponding to the radiological criteria of 10 CFR 20 Subpart E have been derived using the computer code RESRAD. The $DCGL_W$ values were derived for 25 mrem/yr TEDE for the industrial worker scenario and are presented below.

Industrial Worker Scenario Soil $DCGL_W$s (pCi/g)

U-238	U-234	U-235	Pa-231	Ac-227	Th-232	Th-230	Th-228	Ra-226	Ra-228	Bi-210
967	7,915	211	251	54.6	255	3,300	19.2	14.7	22.8	799

13.1.3 $DCGL_{EMC}$

Area factors (based on MARSSIM guidance) have been developed to be used for elevated measurement comparisons (EMC) and to determine sampling requirements in situations where the scan instrument's MDC is greater than the appropriate DCGLw. The appropriate $DCGL_{EMC}$ values are calculated by multiplying the appropriate DCGLw by the area factors presented below.

$DCGL_{EMC}$ = Area Factor * $DCGL_W$

Floor Area Factors

Radionuclide	1 m^2	2 m^2	3 m^2	5 m^2	10 m^2	15 m^2	30 m^2
U-238	163	84	59	36	19	13.2	6.9
U-234	22	110	74	44	22	15	7.5
U-235	85	46	33	23	12.9	9.6	5.6
Pa-231	216	109	72	44.6	22.1	14.9	7.4
Ac-227	212	101	70	42	21.2	14.7	7.4
Th-232	220	112	75	44	22	15	7.5
Th-230	224	110	75	44	22	15	7.5
Th-228	50.6	28.2	20.5	14.1	9	7	4.4
Ra-226	29.8	16.8	12	8.6	5.8	4.5	3.2
Ra-228	34.8	19.9	14.5	10.1	6.6	5.1	3.5
Pb-210	218	109	70.4	43.5	21.8	14.7	7

Wall Area Factors

Radionuclide	1 m^2	2 m^2	3 m^2	5 m^2	10 m^2	15 m^2	20 m^2
U-238	224	114	75.7	44.7	22.4	15.1	11.4
U-234	221	112	75.4	46	22.1	15.1	11.2
U-235	229	119	79	47.8	25	16	12.1
Pa-231	226	112	74.4	44.6	22.6	15.1	11.2
Ac-227	221	110	74.5	45.1	22.1	14.7	11
Th-232	220	112	74.8	44	22	15	11.2
Th-230	224	114	74.8	44	22.4	15	11.4
Th-228	256	128	83.2	51.8	26.2	17.9	13.4
Ra-226	293	144	96	57.6	30.7	21.1	15.8
Ra-228	278	139	94.8	56.9	29.1	19.6	15.2
Pb-210	218	109	70.4	43.5	21.8	14.7	10.9

Land (Soil) Area Factors

Radionuclide	1 m^2	5 m^2	10 m^2	25 m^2	50 m^2	75 m^2	100m^2	250m^2	500m^2	750m^2	1,000 m^2
U-238	8.9	3.3	2.2	1.7	1.5	1.4	1.3	1.2	1.2	1.1	1.1
U-234	6.1	5.0	4.5	3.9	3.5	3.3	3.1	2.4	1.9	1.6	1.3
U-235	8.8	3.0	2.0	1.6	1.3	1.3	1.2	1.1	1.1	1.1	1.1
Pa-231	10.9	5.6	4.1	3.2	2.8	2.6	2.4	1.9	1.5	1.3	1.1
Ac-227	7.8	3.6	2.5	2.0	1.7	1.6	1.6	1.4	1.3	1.2	1.2
Th-232	7.7	3.6	2.6	2.0	1.7	1.7	1.6	1.4	1.3	1.2	1.2
Th-230	5.7	4.5	3.9	3.4	3.1	2.9	2.7	2.2	1.8	1.6	1.4
Th-228	10.2	3.3	2.2	1.6	1.4	1.3	1.3	1.2	1.1	1.1	1.1
Ra-226	9.9	3.2	2.1	1.6	1.4	1.3	1.2	1.2	1.1	1.1	1.1
Ra-228	9.9	3.2	2.1	1.6	1.4	1.3	1.3	1.2	1.1	1.1	1.1
Pb-210	131	54	35	21	13	10	8.0	3.7	2.0	1.3	1.0

The NRC staff has reviewed the information in the Decommissioning Plan for the Muskogee Site, license number SBM-911 according to the NMSS Standard Review Plan, Section 14.1 ("Release Criteria"). Based on this review, the NRC staff have determined that Fansteel has summarized the DCGL(s) and area factors used for survey design and for demonstrating compliance with the radiological criteria for license termination. However, as stated in Section 5.3 above, final DCGLs for license termination must be determined using all applicable pathways. Therefore, staff has proposed license conditions, to which the licensee has agreed, that meet NRC's needs.

13.2 Characterization Surveys

Fansteel performed radiological characterization surveys of the site in 1993. A detailed discussion of the 1993 characterization surveys and results is in Chapter 4.0 of the DP.

The NRC staff has reviewed the information in the Decommissioning Plan (or Final Status Survey Report) for the Muskogee Site, license number SBM-911 according to the NMSS Standard Review Plan, Section 14.2 ("Characterization Surveys"). This review has determined that the radiological characterization of the site and buildings is not adequate to permit planning for remediation for all phases that will be effective and will not endanger the remediation workers, to demonstrate that it is unlikely that significant quantities of residual radioactivity has not gone undetected, and to provide information that will be used to design the final status survey. Therefore, staff has proposed license conditions, to which the licensee has agreed, that meet NRC's needs.

13.3 Remedial Action Support Surveys

Scanning for gross alpha or gross beta activity will be used as part of status surveys of structural surface survey units to ensure elevated areas of activity are not missed. In addition, static counts of surfaces at predetermined sample points are used to assess total contamination of surfaces. Scanning for gross gamma activity will be used as part of the status survey of open land area to ensure elevated areas of activity are not missed.

13.4 Final Status Survey Design

Section 14.4 of the DP states that an FSSP will be prepared (in accordance with MARSSIM) to support remediation activities for the Fansteel site.

The NRC staff has reviewed the information in the Decommissioning Plan (or the Final Status Survey Report) for the Muskogee Site, license number SBM-911 according the NMSS Standard Review Plan, Section 14.3. Based on this review, the NRC staff has not determined that Fansteel's final status survey design is adequate to demonstrate compliance with radiological criteria for license termination. Therefore, staff has proposed license conditions, to which the licensee has agreed, that meet NRC's needs.

13.5 Final Status Survey Report

Final status surveys will be submitted and reviewed at the end of Phases 3 and 4 of remediation.

14 Financial Assurance

On January 15, 2002, Fansteel, Inc. filed for bankruptcy protection at the United States Bankruptcy Court, District of Delaware. The bankruptcy filing noted a significant increase in Fansteel's estimated costs of decommissioning, which had been based on restricted release, due to the increase in costs resulting from Fansteel's decision to perform an unrestricted release of its Muskogee facility. Shortly after the bankruptcy filing, approximately $4.5 million was deposited in Fansteel's Standby Decommissioning Trust fund. Fansteel entered into a series of negotiations with creditors and the NRC to meet its obligations to the extent of its ability under the circumstances. A portion of Fansteel's operating businesses were sold to raise cash for the creditors. The creditors also were given approximately 55% of the stock in Reorganized Fansteel. Reorganized Fansteel formed FMRI Inc. as a wholly owned subsidiary to be the new licensee with the sole purpose of remediating the Muskogee site. However, Fansteel was unable to cover the full cost of decommissioning the Muskogee facility with cash or guaranteed access to funds. Therefore, Fansteel provided unsecured promissory notes in draft form to describe its financial assurance for decommissioning costs that exceeded the amount in the Decommissioning Trust. The promissory notes committed Reorganized Fansteel to pay for decommissioning out of future earnings. Use of the promissory notes was approved by Fansteel's creditors and the Bankruptcy Court. FMRI also provided a draft Pledge Agreement to describe its method of permitting the NRC to exercise rights as a third party beneficiary to force payments under the Notes, and Fansteel provided a draft Indemnity Letter to describe its method to indemnify NRC against collection costs in the event that NRC exercised its third party beneficiary rights. The draft financial instruments were submitted in support of a request for exemption.

14.1 Cost Estimate

By letter dated January 14, 2003, Fansteel, Inc. submitted a Decommissioning Plan containing a decommissioning cost estimate in the amount of approximately $26.5 million for the Muskogee site. In addition, Fansteel's January 14, 2003 letter simultaneously submitted, under proprietary cover, a closure cost estimate for the Muskogee site in the amount of $41.6 million. By letter dated July 24, 2003, Fansteel submitted a supplement to the DP with a description of the financial instruments used to cover the cost of decommissioning, a table of projected funds available to pay for the decommissioning of the Muskogee site, and resubmitted the proprietary cost estimate of $41.6 million as information subject to public disclosure. By letter dated September 24, 2003, Fansteel submitted its response to a Request for Additional Information which, among other items, stated that financial assurance was provided for all items in the $41.6 million cost estimate.

14.1.1 Evaluation Criteria Applicable to all Cost Estimates For Unrestricted Use

The provisions of 10 CFR 40.42(g)(4)(v) require an updated detailed cost estimate for decommissioning. By letter dated January 14, 2003, as supplemented on July 24, 2003, and September 24, 2003, the licensee provided an updated detailed cost estimate for its Muskogee facility.

Further guidance on evaluating the cost estimate is contained in NUREG-1757, "Consolidated NMSS Decommissioning Guidance," Vol. 3, Financial Assurance, Recordkeeping, and Timeliness. By letter dated July 24, 2003, the licensee submitted a cost estimate of $41.6 million. The staff concurs that all activities required for decommissioning are listed in the July 24 cost estimate.

However, NUREG-1757 states that a 25% contingency factor should be applied to the total, to account for uncertainty in costs. Regarding the Muskogee site, the licensee's estimated volume of soil requiring remediation is subject to uncertainty. The licensee addressed uncertainty in costs by providing a contingent promissory note, in an amount to be determined when additional site characterization is completed, to cover increases in the costs of decommissioning. This arrangement permits the licensee to provide financial assurance to the full extent of its current ability, while maintaining the licensee's responsibility to cover future increases in decommissioning costs, if any, in a manner compatible with the bankruptcy proceedings.

Therefore, the cost estimate is acceptable.

14.2 Certification Statement

By letter dated October 23, 2003, the licensee submitted a Certification Statement as required by 10 CFR 40.36(d). The NRC staff reviewed the certification statement for the Muskogee Site, license number SBM-911, located at Muskogee, Oklahoma according to NUREG-1757, "Consolidated NMSS Decommissioning Guidance," Vol. 3, Financial Assurance, Recordkeeping, and Timeliness, and the regulations of 10 CFR Part 40. The staff discussed the Certification with Fansteel and proposed changes which Fansteel accepted.

Based on this review, the NRC staff has determined that the certification statement committed to by the licensee specifies the appropriate information and level of financial assurance coverage.

14.3 Financial Assurance Mechanism

The NRC staff reviewed the financial assurance instruments for the Muskogee Site, license number SBM-911 located at Muskogee, Oklahoma according to NUREG-1757, "Consolidated NMSS Decommissioning Guidance," Vol. 3, Financial Assurance, Recordkeeping, and Timeliness, and the regulations of 10 CFR Part 40. The Decommissioning Plan must describe the financial assurance that will be used. By letter dated July 24, 2003, Fansteel submitted a supplement to the DP with a description of the financial instruments used to cover the cost of decommissioning. By letters dated September 17 and October 23, 2003, Fansteel submitted drafts of its financial instruments for detailed review.

The July 24, 2003 letter requested an exemption from the requirements of 10 CFR 40.36(e) because the financial assurance instruments submitted by the licensee did not fit the criteria of the regulation. To cover the decommissioning cost estimate of $41.6 million, the licensee paid for $2.2 million in expenses in 2002 and 2003, provided $4.6 million in its Decommissioning Trust, and submitted Promissory Notes (Notes) with a total principal amount of $34.8 million and a provision to increase the principal amount if necessary to cover unanticipated expenses.

The licensee also provided a Pledge Agreement and Indemnity to the NRC as further assurance of payment under the Notes.

Three draft Promissory Notes were submitted: (1) a Primary Note with principal sum of $30.6 million, to be paid over ten years starting in 2004, (2) a Secondary Note with principal sum of $4.2 million, to be paid over fourteen years starting in 2009, and (3) a Contingent Note, with principal sum to be determined after completion of additional site characterization during Phase 3 of the DP. The Primary Note will be used for all decommissioning expenses. The Secondary Note will be used for expenses associated with groundwater remediation starting in 2009 and continuing until 2023, if necessary to continue groundwater remediation for that length of time. The Contingent Note will provide additional funding in the event that costs exceed the licensee's estimate. The amount of the Contingent Note will be determined within 60 days of the completion (approximately 2010) of additional site characterization during Phase 3 of the DP, and will take into account additional information obtained as the site is decontaminated.

The licensee's financial assurance covers the estimated cost of decommissioning, and provides a mechanism to cover increases in costs, if necessary. Therefore, the amount of financial assurance is acceptable.

14.3.1 Evaluation Criteria for Financial Assurance Instruments

The Notes promise payment from Fansteel, Inc., the licensee's parent company, to FMRI Inc., the licensee, which is a wholly owned subsidiary of Fansteel, Inc. FMRI Inc. was formed solely to perform decommissioning of the Muskogee site. In addition, the licensee provided a Pledge Agreement assigning its rights to payment under the Notes to the NRC or its designee, and an Indemnification Agreement to indemnify NRC in the event that action was required to compel payment under the Notes.

However, the licensee's Promissory Notes do not meet the requirements of 10 CFR 40.36(e).

14.3.1.1 Exemption Request for Financial Assurance

The licensee stated in its July 24, 2003 letter that it cannot emerge from bankruptcy if it must meet the requirements of 10 CFR 40.36(e). Therefore, the licensee requested an exemption from the regulation to obtain authorization to use a combination of Promissory Notes, the Decommissioning Trust, a Pledge Agreement, and an Indemnity Letter as financial assurance.

The licensee submitted drafts of the Notes as a method to maximize the funds available for decommissioning while also meeting its obligations to its creditors in bankruptcy. The Primary Note will provide $30.6 million over ten years. Under the Primary Note, the licensee's parent company promised to pay a minimum of $1.4 million per year from future increases in cash balances produced by the parent company. Additional payments up to $4 million per year will be made, in accordance with a formula stated in Section 15 of the DP, depending on the amount of the increase in cash balance, for an annual maximum of $5.4 million per year. If the increase in cash balance is insufficient to fund the budgeted amount of remediation for the year, up to one-half of the previous year's total cash balance will be used to fund the decommissioning. If insurance proceeds or asset sales produce cash, such amounts would be paid to FMRI Inc. in addition to the annual maximum. The Secondary Note will pay $282,000

per year for up to 14 years, beginning in 2009. Payments under the Secondary Note do not provide for variation according to cash flow, but, when groundwater remediation is completed, no further payments will be made under the Secondary Note. The licensee will have access to the Decommissioning Trust funds, up to a maximum of $2,000,000, with amounts withdrawn subject to replenishment. If insurance proceeds or assets sales produce payments to FMRI Inc., the funds will be used first to replenish the Decommissioning Trust and second to reduce the principal of the Primary Note. The Contingent Note will be used to fund increases in costs, if the initial estimate of costs proves insufficient. The amount of the Contingent Note will be determined by estimating the costs remaining to complete the decommissioning after additional site characterization is performed. The NRC is a third party beneficiary to all the Notes, which provides enforceable rights under contract law to compel payment.

In addition to the Notes, the licensee submitted in draft form a Pledge Agreement which creates a security interest in all of the licensee's rights under the Notes which can be used to transfer funds to an appropriate trustee in the event the licensee does not meet its obligations. An Indemnity Letter was submitted in draft form, which indemnifies the NRC against costs incurred in connection with the exercise or enforcement of rights under the Pledge Agreement.

In a meeting arranged by the Department of Justice as the NRC's legal counsel, on October 28, 2003, the licensee committed to revising the drafts in accordance with comments from the staff.

The staff finds the revised drafts of the financial assurance instruments acceptable, therefore, the exemption request to 10 CFR 40.36(e) is granted, and the licensee may submit original signed versions of the revised drafts of the financial instruments as financial assurance.

15 Conclusions and Recommendations

The DP submitted was characterized by the licensee as "conceptual in nature". Therefore information on some aspects of decommissioning was not presented. The Licensee has agreed to provide the additional information as described in the proposed license conditions identified in Attachment 1, to which the Licensee agrees.

15.1 Proposed License Conditions

Based on the information described in this SER, the staff recommends the license conditions shown in Attachment 1 be implemented as part of the approval of the licensee's DP:

15.2 Recommendations

The staff recommends approval of the decommissioning plan with the addition of the license conditions identified.

PROPOSED LICENSE CONDITIONS

1. In accordance with provisions of 10 CFR 40.42(g)(4)(i) Licensee shall, not later than May 31, 2004, provide a physical description - dimensions, types of liners, etc. - of Pond 1, Pond 1S and 1N, and Pond 4, the time during which each [of] the ponds were used, what process-related materials and how much was placed in each of the ponds, and how and where those materials were disposed when the ponds were closed.

2. At the time Ponds 2 and 3 are emptied, Licensee shall undertake to excavate and dispose of any identified WIP material that migrated from the ponds For the purpose of this paragraph, WIP that migrated from ponds 2 and 3 shall be defined as material that exhibits the same physical characteristics as the sludge-like material contained in the ponds.

3. Licensee shall conduct an additional characterization of any additional contaminants at the site, as contemplated by Section III.E.4.(c) ii. of Fansteel's Plan of Reorganization, VI.C.5.a of the Reorganization Plan of Fansteel. Inc., et al of September 18, 2003, including: all soils, buildings and groundwater on the site, using guidance in NUREG-1757, Vol. 2. Upon agreement by NRC that any additional contamination is adequately characterized, Licensee shall identify the cost to remediate all contamination identified in this study. Work shall be performed according to the following schedule:

   a. Submit a site characterization plan not later than February 28, 2011.

   b. Submit a site characterization report (SCR) not later than December 29, 2011.

   c. Develop detailed work plans to be submitted with the SCR, including cost and schedule, for any additional work identified in the SCR.

4. The licensee shall not have a removable fraction of residual radioactivity on any specific building surface that exceeds 3%.

5. Before release of any equipment, Licensee shall characterize all surfaces, interior and exterior, and shall remediate all contaminated equipment to the limits of RG 1.86.

6. Licensee shall verify the conditions used in its dose analyses (secular equilibrium, ratio of decay chains, etc.) for each area of remediation not later than the date of submission of the FSSR for Phases 3 and 4.

7. Licensee shall remediate the site to residual radioactive levels to ensure that exposure to residual radiation in all media from applicable pathways will not result in a dose exceeding 25 mrem/y, as specified in 10 CFR 20.1402. Licensee will establish remediation levels (DCGLs) as part of the Phase 3 Workplan, approved by NRC, that demonstrate the 25 mrem/y dose limit will not be exceeded.

8. Licensee shall use the sum of fractions rule, as shown below, to fraction the concentration when multiple radionuclides are present so that the total dose will not exceed 25 mrem/y.

$$\sum_{i=1}^{N} \frac{Conc_i}{DCGL_i} \leq 1$$

where:

$Conc_i \equiv$ concentration of radionuclide i

$DCGL_i \equiv$ derived concentration guideline level for radionuclide i

$N \equiv$ total number of radionuclides

9. In accordance with 10 CFR 40.42(g)(4)(ii), Licensee shall provide to NRC the following detailed plans, including work to be performed by contractors and the qualifications of all contractors, for remediating contamination at the site identified in the July 24, 2003 DP:

   a. WIP (Phase 1) not later than August 2, 2004.

   b. CaF (Phase 2) not later than January 2, 2007

   c. all contaminated soil, buildings and equipment not later than August 1, 2011.

   d. groundwater remediation (Phase 4) not later than January 5, 2012.

10. Licensee shall obtain NRC approval of survey and sampling methods prior to reuse of any materials. NRC will be notified 30 days before the survey is performed. NRC or its contractor will be given the opportunity to observe the licensee[']s survey and perform an independent confirmatory survey. NRC will review the results to determine if the material meets release criteria.

11. Licensee shall, prior to application for license termination or any partial site release, describe the nature of the permanent surface water and E&S controls identified in §8.3.2.6 of the DP, and why they are consistent with the unrestricted release criteria of 10 CFR 20.1402.

12. Licensee shall update the DP not later than December 31, 2003 to describe current activities to remediate radioactive contamination in groundwater.

13. Licensee shall develop a method not later than January 15, 2012, to be approved by NRC, to demonstrate compliance with radioactive release criteria for groundwater.

14. Licensee shall update Figure 8-3 of the January, 2003 DP submittal annually, and submit the revised figure to NRC not later than January 15 of each year until license termination.

15. FMRI shall submit, by March 31st of each year, an accounting of expenses that shall include:

    a. the same line items as provided in Table 15-11 of the Decommissioning Plan,

    b. the amount spent on each line item during the reporting period,

    c. the cumulative amount spent for each line item through the end of the reporting period,

    d. identification of variances (both positive and negative) between the planned expense and the actual expense for each line item during the reporting period,

    e. an explanation of the reasons for variances that exceed 5% of the planned expense for a line item during the reporting period,

    f. a comparison of the cost of work remaining to the funding remaining under the assurances provided to the NRC, where

        i. the cost of work remaining must be determined by estimating the amount and cost of labor, materials, services, etc., required to complete the work, and not by simply subtracting the cost of work performed from the amount budgeted for decommissioning, and
        ii. if the cost of remaining activities exceeds the remaining amounts assured to the NRC, then the accounting, to the extent possible, must include a detailed plan to adjust the work plan to the available funding.

    g. all expenses not covered by the line items of Table 15-11, if any, and an explanation of the reason for such expenses

16. FMRI shall submit, by March 31st of each year, an accounting of income from Reorganized Fansteel that shall include amounts paid to FMRI:

    a. annual mandatory prepayments,

    b. minimum semi-annual payment,

    c. additional annual prepayment (1) insurance proceeds, and (2) reorganized debtor asset sale proceeds,

    d. payments under the secondary promissory note,

    e. payments under the contingent promissory note, and

    f. any other payments received.

17. FMRI shall submit, by March 31st of each year, updated versions of Tables 15-11 and 15-12, showing actual figures for previous periods, and updated projections using current information.

18. FMRI shall maintain, for inspection at its facility, monthly updates of its accounting of expenses and income.

19. FMRI shall provide annual financial statements of FMRI and Reorganized Fansteel to NRC within 30 days of the issuance of such statements.

20. If any payment due to FMRI under the Notes from Reorganized Fansteel has not been paid on the date it is due, and if such payment default is not cured within three working days following the due date, FMRI shall, within three additional working days, notify Reorganized Fansteel in writing, initiate appropriate action to collect the payment, and notify the NRC in writing of the late payment and the actions initiated to collect the payments below:

    a. Payment Due Date Under Primary Promissory Note

        i. April 10 - annual mandatory prepayments
        ii. June 30 - first minimum semi-annual payment
        iii. December 31 - second minimum semi-annual payment

    b. Payment Due Date under the Primary Promissory Note for additional annual prepayment (insurance proceeds and reorganized debtor asset sale proceeds), if any, within 30 days after receipt by Reorganized Fansteel

    c. Payment Due Date for Secondary Promissory Note by January 1 of each year, commencing in 2009

    d. Payment Due Date under the Contingent Promissory Note as determined at the time the principal amount of the note is established

21. FMRI shall, up to the amount available from the payments or proceeds identified below, replenish any withdrawal from the Decommissioning Trust Fund within 30 days of receipt of any payments or proceeds intended to provide for replenishment, as provided in the Decommissioning Plan or the terms and conditions of the Joint Reorganization Plan as approved the United States Bankruptcy Court.

22. Licensee shall provide to NRC not later than August 2, 2004 the experience and education requirements for the HPS [Health Physics Supervisor], the CS [Construction Supervisor], and the QCO [Quality Control Officer].

23. Not later than August 2, 2004, Licensee shall define changes to the FSSP [Final Status Survey Plan] that may be made without prior approval of NRC.

24. Not later than August 1, 2004, Licensee shall make available at the site for review by NRC a revised RWMP and QA Plan, for Phase 1 of decommissioning activities. Thereafter, Fansteel shall update and have available at the site the RHSP, EMP, RWMP and QA Plan prior to the beginning of each phase of decommissioning.

25. Licensee shall conduct the following final status surveys and submit reports to NRC to demonstrate compliance with decommissioning criteria. NRC will be notified 30 days before a survey is performed, and NRC or its contractor will be given the opportunity to observe the licensee's survey and perform an independent confirmatory survey. If NRC does not approve a survey, additional remediation and resurvey shall be promptly conducted.

    a. Immediately following completion of remediation of all soils, buildings and equipment, but not later than 9 months after approval of the FSSP, Licensee shall conduct a final status survey of all areas remediated and submit a Phase 3 FSSR
    b. Immediately following completion of remediation of the groundwater, Licensee shall conduct a final status survey of site groundwater and submit a Phase 4 FSSR.

26. Not later than February 28, 2011, Licensee shall submit, applicable FSSPs for Phases 3 and 4, for prior NRC approval, which shall include measures to evaluate volumetric, subsurface, and groundwater contamination that are beyond the scope of MARSSIM (NUREG-1575, Table 1.1).