

# Long-Term Surveillance Plan for the Hallam, Nebraska, Decommissioned Reactor Site

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U.S. DEPARTMENT OF  
**ENERGY**

Legacy  
Management

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## Abbreviations

AEC	U.S Atomic Energy Commission
CFR	<i>Code of Federal Regulations</i>
DHHS	Department of Health and Human Services
DOE	U.S. Department of Energy
ft	feet
HNPF	Hallam Nuclear Power Facility
IHX	intermediate heat exchanger
JSA	job safety analysis
LM	Office of Legacy Management
LTSP	Long-Term Surveillance Plan
NDH	Nebraska Department of Health
NPPD	Nebraska Public Power District
pCi/L	picocuries per liter
USC	<i>United States Code</i>

# 1.0 Introduction

## 1.1 Purpose and Scope

This Long-Term Surveillance Plan (LTSP) explains how the U.S. Department of Energy (DOE) Office of Legacy Management (LM) will fulfill its responsibilities as the long-term custodian of the Hallam, Nebraska, Decommissioned Reactor Site, which is the location of the former Hallam Nuclear Power Facility (HNPF). The LM support contractor is responsible for the preparation, revision, and implementation of this LTSP, which specifies procedures for inspecting, monitoring, custodial maintenance, reporting, and records maintenance pertaining to the site.

## 1.2 Legal and Regulatory Requirements

As part of its Power Demonstration Program, the U.S. Atomic Energy Commission (AEC), a predecessor agency of DOE, operated the Hallam reactor from 1962 to 1964. The radiological surveillance of the Hallam site was established when the operating agreement between AEC and the Nebraska Public Power District (NPPD) was terminated. The DOE Chicago Operations Office (now the Office of Science) and the Nebraska Department of Health (NDH) agreed to install a shallow groundwater monitoring system as part of the environmental surveillance program. Surveillance at the site was scheduled to end in fiscal year 2005, with no further activities planned afterward. At that time, the plan was to transition the site to NPPD with future use of the facility to remain restricted. DOE has title to and responsibility for the entombed radioactive materials (AEC 1971).

In compliance with the above agreement to end the environmental surveillance program at the site in 2005, DOE prepared a report in 2006, *Summary of Ground Water Monitoring Results and Recommendation to Discontinue Monitoring at the Decommissioned Hallam Nuclear Power Facility, Hallam, Nebraska* (DOE 2006), providing an assessment of groundwater monitoring results at the site since 1970 and through the June 2006 sampling event. This assessment indicated that there had been no impact on shallow perched groundwater in the immediate vicinity of the entombed reactor. Based on evaluation of hydrogeologic conditions in the vicinity of the site, there was no compelling evidence that there would be potential for impact to the shallow perched groundwater system or connected water resources in the future. Also, there was no use of shallow perched groundwater as a drinking water source near the site, and the area surrounding the site was restricted because of land ownership by NPPD. Consequently, there was no current or anticipated unacceptable risk to human health or the environment related to the decommissioned HNPF. Thus it was determined that monitoring of shallow groundwater had been effective in demonstrating no impact to the shallow perched groundwater 37 years after entombment of the reactor, and that the monitoring objectives set forth between the parties had been achieved.

Based on the assessment issued in 2006 (DOE 2006), no further groundwater monitoring activities were recommended or deemed necessary at the Hallam site. DOE recommended that monitoring of shallow perched groundwater in the vicinity of the site be discontinued and that the monitoring wells be decommissioned. The State of Nebraska response to this DOE report said they did not concur with DOE recommendations to stop monitoring but they would accept reducing sampling and analysis frequency to once every 2 years (State of Nebraska 2007). DOE accepted the State of Nebraska position and continued sampling every 2 years.



In 2016, with an additional 9 years of data collected, DOE issued another groundwater monitoring assessment (DOE 2016). The 2016 assessment further supported the results of the 2006 assessment, reporting that the entire body of data collected at the site demonstrated that there had been no negative impacts to the shallow perched groundwater from the radioactive material entombed at the site after 46 years. Based on that fact, coupled with the low probability for the potential for contamination migration at the site, the DOE report proposed that the sampling frequency could be reduced without adversely impacting the protectiveness of human health and the environment at the site.

DOE implemented a sampling frequency reduction following the 2016 sampling event, as outlined below:

- Once every 5 years for the next 20 years (2021 through 2041).
- Once every 10 years from 2041 through 2071. It is estimated that by 2071 groundwater monitoring requirements will no longer be warranted and monitoring will be discontinued.

It was further proposed that a total uranium analysis be included in future sampling events so that uranium results can be compared with the gross alpha results and the relationship between the two types of samples can be evaluated.

### **1.3 The Role of DOE**

In 1988, DOE designated the Grand Junction Projects Office as the program office for managing (1) DOE sites that contain regulated low-level radioactive materials, (2) the portions of DOE sites that do not have a DOE mission after cleanup, and (3) other sites as assigned. The DOE facility at Grand Junction also was to serve as a common office for the security, surveillance, monitoring, and maintenance of these sites. DOE established the Long-Term Surveillance and Maintenance Program to fulfill these responsibilities.

In December 2003, DOE formally established LM. The LM mission includes “...implementing long-term surveillance and maintenance projects at sites transferred to LM to ensure sustainable protection of human health and the environment.” LM is responsible for implementing the LTSP for the Hallam site.

## **2.0 Site Background**

### **2.1 Description of Site Area**

#### **2.1.1 Location and Property Ownership**

The Hallam site is in Lancaster County in southeastern Nebraska, approximately 19 miles south of Lincoln and 1.5 miles northeast of the village of Hallam (Figure 1). The site is in Section 19, Township 7 North, Range 6 East, which is owned by NPPD. Section 19 is also the location of the operational coal-fired NPPD generating plant called the Sheldon Station. The entombed reactor occupies approximately 1.4 acres within the 18-acre Hallam site, which is inside the 640-acre Sheldon Station property.

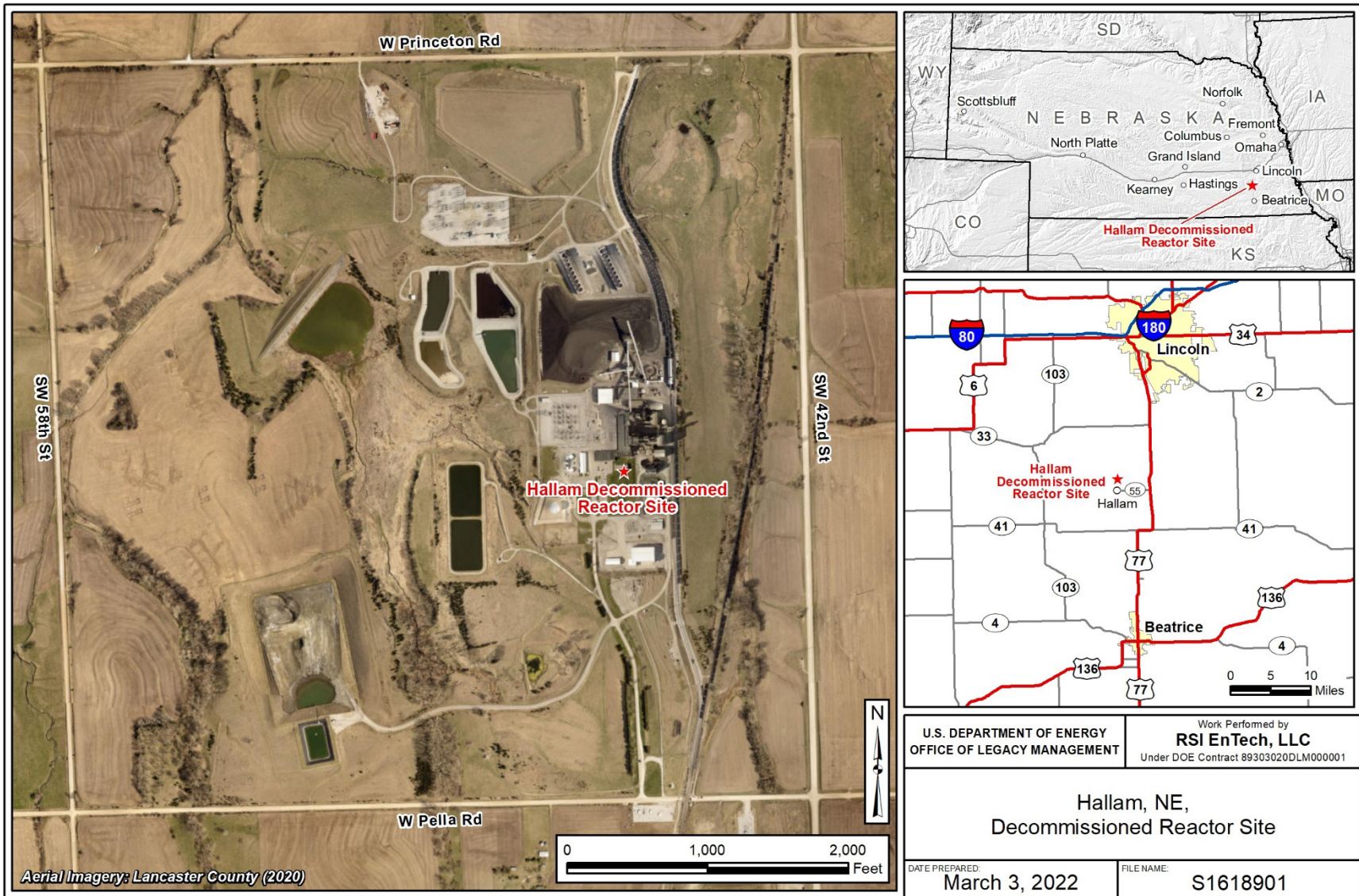


Figure 1. Hallam Site Location Map

The Lancaster County, Nebraska, land and title records have been annotated appropriately regarding the remainder of the dismantled facility (AEC 1971). A copy of the lease agreement between the Consumers Public Power District and AEC, which includes the legal description of the 18-acre Hallam site, is included in Appendix A.

Directions and mileage to the site from the Lincoln Municipal Airport are as follows:

- Take U.S. Interstate Highway 80 west to the first exit (the bypass).
- Proceed south on U.S. Highway 77 for 20 miles to the Hallam exit (2.5 miles south of Princeton).
- After exiting, drive 2 miles toward the village of Hallam.
- Just before Hallam (0.5 mile), turn north on the gravel road and proceed 1 mile, then turn west for 1 mile.
- The Sheldon Station power plant is visible from the gravel road.

### **2.1.2 Hydrogeology**

The Hallam site lies within glacial-drift hills near the upper end of the Olive Branch drainage basin, which is a tributary to Salt Creek. The site is on a topographic high, at approximately 1440 feet (ft) above mean sea level, and is well drained. Water from precipitation moves overland or underground toward points of discharge along Olive Branch, which flows into Salt Creek, and then into the Platte River. Surface water from Salt Creek is not used for drinking purposes and is rarely diverted for irrigation.

The site is underlain by unconsolidated Pleistocene deposits as much as 400 ft thick, consisting of clay, silt, sand, and gravel. These deposits overlie Permian limestone and shale bedrock. The preexisting valley in the bedrock beneath the site was filled with large quantities of clay, silt, sand, and gravel transported by the glacial ice sheets during Quaternary time. The vast quantities of sand and gravel that were laid down during the Kansan glacial epoch constitute the most important (regional) aquifer in the area. Groundwater also occurs in intermittent shallow perched zones beneath the site.

Saturated unconsolidated sand and gravel glacial deposits lie on top of the bedrock and form the regional aquifer. These deposits are generally treated as a single aquifer because they have ample permeability and are generally interconnected. Groundwater from the regional aquifer is used to supply domestic, stock, irrigation, industrial, and public-supply wells, and the aquifer is a prolific producer. The saturated thickness ranges from only a few feet to more than 200 ft. Depth to the regional water table ranges from less than 10 ft in the valley of Olive Branch to more than 180 ft below the highest hills. Groundwater flow in the regional aquifer is generally to the east beneath the site. Recharge to the regional aquifer is by underflow from areas to the west. The amount of local recharge from precipitation to the regional aquifer is very small because glacial till serves as a barrier to downward migration of water. Groundwater from the regional aquifer discharges along Olive Branch and its tributaries.

A series of production wells were installed in the regional aquifer beneath the site in 1959 and range in depth from 255 to 288 ft. The thickness of clay and fine-grained materials overlying transmissive zones ranged from approximately 70 to 160 ft. Initial static water levels ranged from 120 to 150 ft, and sustained yield from the wells during initial testing was in the range of 900 gallons per minute.

A perched aquifer beneath the site is created by intermittent shallow perched groundwater zones in small bodies of sand and gravel and by surficial loess deposits that rest on compact deposits of relatively impermeable glacial till. Depth to the perched groundwater beneath the site ranges from about 5 to 20 ft. Water levels and the extent of perched water are variable and dependent on precipitation. Groundwater flow is also variable, depending on the degree of interconnection between the perched zones. Flow in the perched aquifer is generally to the north and northwest beneath the site following surface drainage patterns to discharge areas. Much of the recharge from precipitation within the area becomes soil moisture and is lost to evapotranspiration. Perched groundwater is present in some places in amounts sufficient to supply small yields of water to shallow wells; however, groundwater from the shallow perched aquifer is not used at the Hallam site.

Aquifer tests (slug tests and flexible wall permeameter tests) conducted on wells completed in the perched aquifer indicate that aquifer conductivity is generally low and variable. Data gathered during the purging of monitoring wells prior to collection of groundwater samples provide an additional estimate of the yield and continuity of the perched aquifer. This indicates the aquifer yield is generally poor and that zones that are marginally productive are few and discontinuous. This assessment is in agreement with the lithologic logs produced during well drilling.

The clay and fine-grained material (70 to 160 ft thick) beneath the sandy zones at the site causes perching of the shallow groundwater and inhibits vertical migration of the shallow groundwater to the regional aquifer. This natural flow barrier essentially eliminates the potential for groundwater adjacent to the entombed reactor to migrate to the regional aquifer. In addition, if the isolation structure ever failed, contaminant transport would likely be minimal because of the low hydraulic conductivity and the favorable ion-exchange capacity of the soils and sediments underlying the site. As percolation occurs through the considerable thickness of clay and silt soils and sediments, there is ample opportunity for adsorption, ion exchange (with sodium and calcium), and, because of long travel times, radioactive decay.

### **2.1.3 Climate**

The Hallam area in southeastern Nebraska is characterized by a continental climate subject to a wide seasonal range in temperature. Light rainfall, hot summers, and severe winters are typical in the area. Average annual precipitation in the area is 27.5 inches. The mean daily summer temperature is 76 °F, while the mean daily winter temperature is 28 °F. Maximum seasonal temperatures range from 110 to -29 °F. Prevailing winds are from the north during February, March, and April, and from the south during the rest of the year. Strong winds are common, with an average annual wind velocity of 10.5 miles per hour. Nebraska is on the western edge of the tornado belt, with rare tornados most often in the spring.

## **2.2 Site History**

The HNPF was a 240-megawatt (thermal), sodium-cooled, graphite-moderated demonstration nuclear reactor built and operated by AEC between 1962 and 1964 (Appendix A). Testing of the reactor began in August 1961. Failure of the moderator elements occurred in February 1964 and the reactor was shut down in September 1964. The AEC contract for operating the HNPF was terminated due to technical problems associated with the reactor core in August 1965, and AEC

announced the HNPF would be decommissioned in June 1966. NPPD was authorized to decommission and dismantle the facility in 1967. The facility was dismantled and placed in a safe condition (entombment) between 1967 and 1969 and retired by AEC in 1971. DOE is responsible for the radioactive materials remaining at the site.

Following its shutdown, reactor fuel and most radioactive materials were removed from the site. The final dismantled condition of the HNPF consists of a massive below-grade reinforced concrete and steel structure that is encapsulated and sealed. The isolation structure was originally designed as containment for an operational nuclear power plant and thus can be expected to retain its integrity for an indefinite period of time (DOE 1993). Radioactive materials are stored in steel-lined cavities that are surrounded by several feet of concrete and other structural shielding materials. Most of the radioactive material is immobile since it is in the form of neutron-activation products dispersed in metallic components. The inventory of significant radionuclides remaining at the site includes iron-55, cobalt-60, nickel-63, and samarium-151. Levels of activity in the storage areas have been significantly reduced since entombment due to radioactive decay. Of the radionuclides present at significant activity levels at the time of entombment, only nickel-63 (with a half-life of approximately 100 years) and samarium-151 (with a half-life of approximately 90 years) would still be present at 80% to 90% of their original activity levels (ORISE 1994a, 1994b). The inventory of radioactive materials at the time of decommissioning is appended as part of Docket 115-3 between NPPD and AEC (Appendix B). Decay and dose calculations indicate that DOE can release the decommissioned reactor for unrestricted use about 100 years after decommissioning (AEC 1971). Based on a start year of 1971, this equates to the year 2071. It is estimated that by 2071 groundwater monitoring requirements would no longer be warranted and will be discontinued.

Based on activity inventories provided in the *Final Status Report and Safety Analysis for the Hallam Nuclear Power Facility Site and Remaining Structures* (AEC 1969), material remaining below ground in the year 2071 will still be too radioactive to meet the U.S. Department of Transportation exempt status for shipping under current regulations found in Title 49 *Code of Federal Regulations* Section 173.436 (49 CFR 173.436). Additional calculations based on the decay equation  $A_f = A_0 e^{-\lambda t}$  indicates that nickel-63 (the longest half-life activity material at the site) will not meet the U.S. Department of Transportation exempt status for shipping until the year 4189 (Table 1).

Table 1. Hallam Reactor Radiological Decay Calculations (Curies)

Year	Elapsed Years	Iron-55	Cobalt-60	Samarium-151	Nickel-63	Total	Additional Information
1974	0	205,200	89,060	6300	12,370	<b>312,930</b>	Isotope concentrations 5 years after the facility shutdown in 1969.
2017	43	4	312	4524	9185	<b>14,025</b>	Present.
2021	47	1	184	4387	8934	<b>13,506</b>	From 2021 to 2041, groundwater is scheduled to be sampled once every 5 years.
2041	67	0	13	3761	7779	<b>11,553</b>	From 2041 to 2071, groundwater is scheduled to be sampled once every 10 years.
2071	97	0	0	2985	6320	<b>9305</b>	No additional groundwater monitoring is required after 2071 so long as the entombment remains undisturbed.

**Notes:**

In 49 CFR 173.436, the shipping exempt consignment activity level for samarium-151 is 0.0027 curies. For the Hallam site that level is forecast to be reached in the year 3878.

In 49 CFR 173.436, shipping exempt consignment activity level for nickel-63 is 0.0027 curies. For the Hallam site that level is forecast to be reached in the year 4189.

### 2.3 Stabilization/Isolation Approach

The final dismantled condition of the HNPF consists of a massive, below-grade reinforced concrete structure. The reactor building was razed, and the surface of the remaining structure was weatherproofed by a covering of sand, waterproof polyvinyl membrane, and soil. This cover was sloped for positive drainage and drain tile was installed at the periphery.

The intermediate heat exchanger (IHX) structure, which protrudes above grade, was weatherproofed by a layer of polyvinyl membrane and a protective cover of concrete. This approach is designed to preclude the ingress of water to interior portions of the structure. Human access to the entombed structure can be gained only by extensive effort utilizing a combination of explosives, air hammers, and cutting tools.

Prior to the final sealing of the facility, all nuclear fuels and all bulk sodium were removed from the site. Residual sodium was reacted with steam to form sodium hydroxide, thus removing any potential for hydrogen formation at some later date should water enter the facility.

Within the structure that housed the reactor, three principal locations were utilized for long-term storage of most of the radioactive materials that remained at the site. These locations are the reactor cavity, the fuel storage location in pit 3, and the moderator element storage cells. Each of these cavities is steel-lined and surrounded by several feet of concrete and other structural material that were provided for shielding in the operational plant. Approximately 300,000 curies of radioactive material were stored at these locations, with more than 99% of it located in the reactor cavity. Most of this activity is immobile since it is in the form of neutron activation products dispersed in metallic components.

The former radioactive waste disposal building remains onsite. No significant amount of radioactive material remains in this building. The below-grade portions of this building and a connecting pipe tunnel have been sealed to prevent access. All cavities in which radioactive components are stored have been sealed by welded closures to isolate them from the rest of the structure. All other cavities, pipe ways, and stairwells were sealed by welding existing closures or providing a closure constructed of reinforced expanding concrete (AEC 1971).

## 2.4 Site Information

The Hallam site plan is shown in Figure 2.

Documents describing the contents and construction of the isolation structure were sealed in two capsules (i.e., 24 × 19 × 4-inch stainless-steel boxes) that were secured at two accessible locations in the isolation structures: (1) in a niche cut into the IHX vaults superstructure and (2) at the center of the steel plate covering the reactor vessel loading face shield. The documents in the capsules and the construction and mounting of the capsules were described in detail by the Atomics International organization (Paulett 1969).

The first capsule (in the IHX vaults superstructure) was set into a niche in the south face of the superstructure at a point due north of the center of the reactor vessel loading face shield. The capsule was covered by a stainless-steel plaque engraved with a warning notice providing information on the location of the structures containing radioactivity and the location of documents pertaining to the structures. The second capsule (in the reactor centerline) is buried beneath the isolation structure protective covering and provides a warning regarding the presence of radioactive material that is not to be disturbed unless authorized.

## 2.5 Groundwater Conditions

Groundwater conditions at the site have been well characterized (DOE 2006, DOE 2016). Surveillance and monitoring has been in place since 1970, including monitoring for radionuclides in shallow groundwater by the U.S. Geological Survey in Lincoln and the DOE Chicago Operations Office. The ongoing monitoring program evolved from an agreement between and the DOE Chicago Operations Office and the State of Nebraska to conduct monitoring through 2005.

Over the past 46 years (1970 to 2016), nickel-63 and gamma-emitting radionuclide activities have not been detected in any sample above their respective detection limit. Tritium activity has been below the detection limit in the majority of samples. In the few samples that had detectable tritium, the activity was near the detection limit; therefore, these detections are considered a product of the uncertainty in the analytical method (counting statistics) rather than an actual contaminant in the groundwater.

Gross alpha and gross beta activities have been consistently detected in groundwater samples collected at the Hallam site. However, because gross alpha and gross beta activities have been low and consistent over time, these activities are attributed to naturally occurring radionuclides (e.g., uranium and uranium decay chain products) in the groundwater.



Some analytical results from 2006 had elevated gross alpha activity exceeding 15 picocuries per liter (pCi/L). The U.S. Environmental Protection Agency standard for gross alpha-particle activity (excluding radon and uranium) is 15 pCi/L. Radon and uranium had not been subtracted from the 2006 gross alpha results reported for the Hallam site. DOE reanalyzed a subset of the 2006 samples for gross alpha and also for total uranium. The results of the reanalysis confirm the original gross alpha values. When the total uranium contribution is subtracted from the gross alpha activities, all gross alpha measurements from 2006 are well below 15 pCi/L.

Analytical results of groundwater samples through 2016 have revealed no detectable radiological release from the Hallam site and no evidence of any impact to groundwater in the shallow perched zones. Results have been consistently at or near detection limits for all analytes over the period of time DOE has been monitoring groundwater. Analytical results through 2016 are available on the [Hallam Site page](#) of the DOE website.

Water level data demonstrate that there have been no negative radiological impacts to the shallow groundwater zones, neither during periods of relative drought nor when precipitation levels were above normal (DOE 2016).

## 2.6 Specific Site Surveillance Features

Since the Hallam site is on property owned and institutionally controlled by NPPD, fencing, signs, and property markers all fall under the jurisdiction of NPPD. DOE will inspect the following specific features:

- The IHX structure, which protrudes above grade
- 19 monitoring wells
- The 1.4-acre, grass-covered, mounded reactor entombment area

DOE has installed boundary monuments to formally establish the perimeter of the 1.4-acre reactor entombment area. There is a permanent plaque on the side of the IHX structure that provides some information about the reactor entombment. Encased behind the plaque is information regarding the entombment of the HNPF.



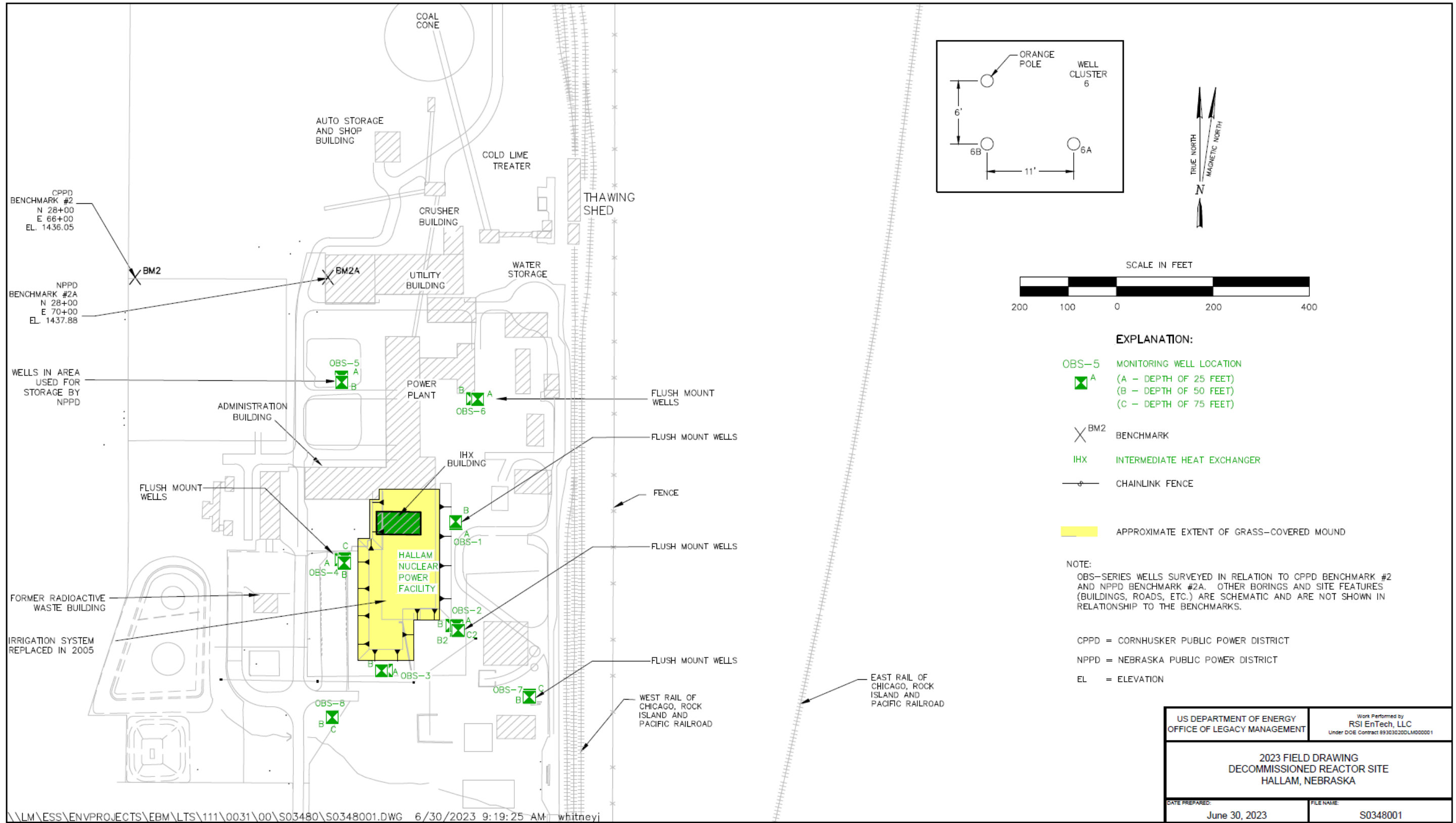


Figure 2. Hallam Site Plan

## 3.0 Long-Term Surveillance Program

### 3.1 Environmental Monitoring and Inspection

#### 3.1.1 Groundwater Monitoring

Although the potential for transport of radioactive materials stored in the isolation structure to the environment is insignificant, AEC made arrangements with NDH to conduct environmental radiological surveillance to verify that no radionuclides are released to the environment (DOE 1993). After entombment, a surveillance and monitoring program was initiated in 1970 by NDH and was funded by AEC, which included analyzing groundwater samples from the deep production wells (groundwater from the regional aquifer at depths greater than 180 ft) at the Sheldon Station power plant. NDH was concerned in 1990 about the possibility of shallow groundwater coming in contact with buried radiological materials along the buried walls of the reactor. Subsequently, DOE and NDH agreed to further characterize hydrologic conditions and establish a monitoring program in the shallow perched groundwater zones in the vicinity of the HNPF.

Groundwater monitoring was conducted on an annual basis at the Hallam site through June 2007. In 2006 a DOE report (DOE 2006) recommended that groundwater monitoring be discontinued because analytical results since 1970 had demonstrated no impact to shallow perched groundwater and there was no current or anticipated unacceptable risk to human health and the environment. The State of Nebraska Department of Health and Human Services (DHHS) responded to DOE in a letter dated February 2, 2007, indicating they did not concur with DOE recommendations to stop monitoring but they would accept reducing the sampling and analysis frequency to once every 2 years (State of Nebraska 2007). DOE agreed to the reduced sampling frequency in a letter dated March 14, 2007 (Appendix C). Consequently, from 2007 through 2016, groundwater monitoring was conducted once every 2 years. The correspondence described above is available in Appendix C.

In 2016 DOE issued a second groundwater monitoring assessment. Based on that assessment, DOE is proceeding with the following sampling frequency:

- Once every 5 years for the next 20 years (2021 through 2041).
- Once every 10 years from 2041 through 2071. It is estimated that by 2071 groundwater monitoring requirements will no longer be warranted and monitoring will be discontinued.

The groundwater monitoring program involves collection of groundwater samples from 17 monitoring wells and measurement of groundwater levels from 19 monitoring wells (Figure 2). (Two monitoring wells are only used for measuring water levels because of very slow recovery rates.) The 19 monitoring wells are completed in the perched aquifer in eight clusters surrounding the facility and are screened at depths of approximately 25 ft (“A” series), 50 ft (“B” series), and 75 ft (“C” series) (Figure 2). Samples are analyzed for gross alpha, gross beta, nickel-63, tritium, gamma-emitting radionuclides, and total uranium. Total uranium was added to the program following the 2016 assessment so that uranium results can be compared with the gross alpha results and the relationship between the two types of samples can be evaluated. Analytical results from monitoring are evaluated and reported following each sampling event.

### **3.1.2 Visual Site Inspection**

- The concrete-encased IHX structure that protrudes above ground is inspected for signs of deterioration or other damage.
- The 1.4-acre, grass-covered, mounded reactor entombment area is checked to determine whether the grass is healthy and whether any erosion is occurring on the side slopes.
- Monitoring wells are examined for damage or deterioration that might require repair.

DOE has installed boundary monuments to formally establish the perimeter of the 1.4-acre reactor entombment area. Future inspections will check on the ongoing condition of the monuments.

## **3.2 Monitoring and Inspection Report**

DOE compiles a periodic inspection and status report following physical site inspections and groundwater sampling events. The reports are posted on the [LM public website](#). The reports discuss inspection results (including the status of the IHX structure), the status of the buried concrete structure, monitoring wells, results of groundwater monitoring, and any long-term surveillance and maintenance issues. The reports also include any recommendations for site maintenance.

## **3.3 Maintenance and Emergency Measures**

### **3.3.1 Custodial Maintenance**

DOE is responsible for making any necessary repairs to the concrete encasing the IHX structure (AEC 1971). This can require periodic sealing and other concrete repairs to maintain integrity.

### **3.3.2 Emergency Measures**

Emergency measures are the actions that DOE will take in response to “unusual damage or disruption” that threaten or compromise site safety, security, or integrity. DOE will contain or prevent dispersal of radioactive materials in the unlikely event of a breach in site containment materials.

## **3.4 Records**

To support long-term surveillance of the Hallam site, LM maintains records at the LM Field Support Center at Grand Junction, Colorado, and at the LM Business Center in Morgantown, West Virginia. These records contain important information required to protect human health and the environment, manage land and assets, protect the legal interests of DOE and the public, and mitigate community impacts resulting from the cleanup of legacy waste. Site historical records about the environmental remediation and stewardship are included in the collection.

All LM records are managed in accordance with the following requirements:

- Title 44 *United States Code* Section 29 (44 USC 29), “[Records Management by the Archivist of the United States](#)”
- 44 USC 31, “[Records Management by Federal Agencies](#)”
- 44 USC 33, “[Disposal of Records](#)”
- 36 CFR 1220–1239, “[Records Management](#)”
- DOE Order 243.1B, *Records Management Program*
- LM Records Management Program procedures

### 3.5 Quality Assurance

The long-term custody of the Hallam site and all activities related to the surveillance and maintenance of the site will comply with DOE Order 414.1D Chg 1, *Quality Assurance*. Quality assurance requirements are routinely fulfilled through a work planning process, standard operating procedures, trained personnel, documents and records maintenance, and assessment activities. Requirements are transmitted through procurement documents to subcontractors when appropriate.

### 3.6 Safety and Health

Safety and health requirements and procedures for LM activities are consistent with DOE orders, federal regulations, and applicable codes and standards. The DOE Integrated Safety Management process serves as the basis for the contractor’s Safety and Health program.

Specific guidance is contained in a job safety analysis (JSA) prepared for any field work performed at the HNPF. This JSA identifies specific hazards associated with the anticipated scope of work and provides direction for the control of these hazards. During the preinspection briefing, personnel are required to review the JSA to ensure that they have an understanding of the potential hazards and the safety and health requirements associated with the work to be performed.

## 4.0 References

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**Appendix A**

**Lease Agreement**

14  
CONSUMERS PUBLIC POWER DISTRICT  
Approved by Board of Directors  
Date JUL 24 1959

LEASE OF LAND  
BETWEEN  
CONSUMERS PUBLIC POWER DISTRICT  
AND  
THE U. S. ATOMIC ENERGY COMMISSION

This LEASE is entered into this 24th day of July, 1959, effective as of January 16, 1959, between the UNITED STATES OF AMERICA (called the "Government"), acting through the UNITED STATES ATOMIC ENERGY COMMISSION (called the "Commission"), and CONSUMERS PUBLIC POWER DISTRICT, a public corporation and political subdivision of the State of Nebraska, with its principal office located at Columbus, Nebraska (called "Consumers").

Recitals

On September 20, 1957 the Government and Consumers entered into a contract identified as Contract No. AT(11-1)-513 (hereinafter called the "contract") pursuant to which, inter alia, the Commission has undertaken to furnish a nuclear reactor plant (utilizing certain facilities provided by Consumers) for the production of steam for the generation of electricity in Consumers' turbogenerator and related conventional type power facilities, the Lessor to furnish the site for the overall plant. The contract is in connection with and in furtherance of the Commission's civilian reactor program. Under the contract Consumers agrees to lease to the Government, rent-free and for a term of forty years, the parcel of land on which the reactor and related facilities are to be located, together with rights of ingress and egress over the adjacent tracts of land to which Consumers holds title.

The land hereby leased has been acquired by Consumers for the purpose of leasing it to the Government and is not otherwise necessary for use by Consumers in its operations; therefore, this lease is permitted under the terms of Consumers' Bond Resolution.

NOW THEREFORE, the parties agree as follows:

In consideration of the commitments and obligations of the parties under the contract and of One Dollar (\$1.00) and other good and valuable considerations, the receipt and sufficiency of which are hereby acknowledged, Consumers does hereby lease and demise to the Government the following described tract of land located in Section 19, T-7-N, R-6-E, Lancaster County, State of Nebraska;

From the south east corner of said Section 19, T-7-N, R-6-E, thence 2479.6 feet north and 957 feet west to the point of beginning; thence west 920 feet; thence south 850 feet; thence east 920 feet; and thence north 850 feet to the point of beginning,

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together with a right of ingress and egress over and along a roadway to be provided by Consumers to and from an existing public road;

This lease shall be for a term commencing on the 16th day of January, 1959 and ending on the 15th day of January, 1999, unless sooner terminated as herein provided or by consummation of a sale of the nuclear facilities to Consumers resulting from exercise of its option therefor under the contract.

The Government shall have no obligation to pay rent for the demised land. Consumers' title in fee simple to the demised premises is hereby warranted by Consumers.

The parties further agree to the following terms and conditions:

#### ARTICLE I

In accordance with the provisions of the contract and for the purpose of performance of the work thereunder, Consumers shall have the right, during the term of the contract and any extensions thereof, to occupy and use jointly with the Government the property covered by this lease. Subsequent to the expiration or termination of the contract, the Government, acting directly or through contractors of its choice, shall have the right, during the existence of this lease, to utilize the demised land.

#### ARTICLE II

The Government shall have the right, during the existence of this lease, to erect structures, install equipment, attach fixtures and make any other changes beneficial to the operation of the facilities to, in, or upon the leased property. Subject to Consumers' rights under the contract such structures, equipment, fixtures, or other devices provided by the Government shall be and remain the property of the Government and may be removed or otherwise disposed of by the Government.

#### ARTICLE III

The Government may terminate this lease at any time by giving Consumers a six-months written notice in advance.

#### ARTICLE IV

Upon expiration or termination of this lease, subject to Consumers' rights under the contract the Commission shall at its expense make the premises safe from a radiation standpoint and may, but will be under no obligation to restore the leased land to its original condition or remove any or all Government-owned portions of the nuclear plant, facilities, components or equipment.

#### ARTICLE V

Consumers owns premises known as the Hallam Site, of which the demised premises are a part, consisting of approximately 640 acres, to the north



of Hallam, Nebraska. Said Hallam Site consists of Section 19 (except existing right-of-way of Chicago, Rock Island, and Pacific Railway Co.), T-7-N, R-6-E, located in Lancaster County, the deeds thereto being recorded in the office of the Register of Deeds in said Lancaster County, reference being made thereto for a more particular description of said tract. Consumers agrees that so long as the project defined in the contract continues and for any additional period required to make the property safe for other uses, it will retain title to and control of said Hallam Site and will not permit activities thereon or uses thereof which, under Commission reactor safeguard criteria, are inconsistent with nuclear reactor operations.

#### ARTICLE VI

Consumers reserves out of this lease a right-of-way over, across, and under the demised premises of sufficient width and at an appropriate location (so as not to interfere with the Commission's use of the premises) for any facilities required during the existence of this lease in connection with the operation of the turbine generator portion of the plant for the generation, transmission, and sale of power.

#### ARTICLE VII

Consumers also reserves the right on the expiration or termination of this lease to leave on the premises equipment or facilities supplied by Consumers for the nuclear facilities.

#### ARTICLE VIII

In the event that the contract expires without renewal, or is sooner terminated, Consumers agrees to grant, without charge, to the Government at the Commission's request (a) a right of access to and a right to use, in connection with its activities on the demised premises, any railroad siding or sidings which may be built by Consumers on that part of the site not included in this lease, and (b) rights of way over, across, and under that part of Consumers' site not included in this lease, of sufficient width and at an appropriate location for any facilities required during the existence of this lease in connection with the operation of the nuclear portion of the plant, and (c) a right of user for the nuclear facilities to the system of wells to be constructed by Consumers. Any such grant to the Government shall limit the Government's use to that generally contemplated for a nuclear reactor having requirements similar to those contemplated by the project.

#### ARTICLE IX

It is agreed that neither party during the existence of this lease will assign this lease or sell or assign its interest in the demised premises or in any improvements remaining thereon or make any subleases thereof to any person or persons without the previous written consent of the other party hereto. Both parties recognize that utilization of radiation may make it desirable for others to build and operate facilities on the demised land, in which case the approval of both the Government and Consumers will be required.

ARTICLE X

Consumers warrants that no person or selling agency has been employed or retained to solicit or secure this lease upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by Consumers for the purpose of securing business. For breach or violation of this warranty, the Government shall have the right to annul this lease without liability or in its discretion to deduct from the contract price or consideration the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE XI

No member of or delegate to Congress or resident commissioner shall be admitted to any share or part of this lease or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this lease if made with a corporation for its general benefit.

ARTICLE XII

Consumers agrees that the Comptroller General of the United States or any of his duly authorized representatives shall until the expiration of three years after final payment of the agreed rental, have access to and the right to examine any directly pertinent books, documents, papers and records of Consumers involving transactions related to this lease.

ARTICLE XIII

Any notices required hereunder shall be sufficient if sent to the appropriate party at the addresses indicated below:

Manager, Chicago Operations Office  
U. S. Atomic Energy Commission  
P. O. Box 59  
Lemont, Illinois

General Manager  
Consumers Public Power District  
Columbus, Nebraska

IN WITNESS WHEREOF, the parties hereto have executed this lease on the date first above written.

THE UNITED STATES OF AMERICA

By Kenneth A. Dunbar  
Kenneth A. Dunbar, Manager  
Chicago Operations Office  
U. S. Atomic Energy Commission

CONSUMERS PUBLIC POWER DISTRICT  
By Walter A. Becker  
President



Walter A. Becker  
Assistant Secretary

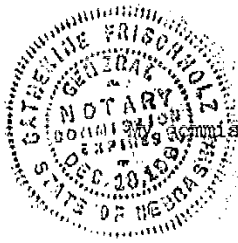
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STATE OF NEBRASKA )  
                          ) SS.  
PLATTE COUNTY      )

On this 7<sup>th</sup> day of July, 1959 before me, the undersigned, a Notary Public in and for said County, personally came Wayne E. Barber, President of Consumers Public Power District, to me known to be the President and the identical person whose name is affixed to the above Lease, and acknowledged the execution thereof to be his voluntary act and deed as such officer and the voluntary act and deed of said District and that the seal of said District was thereto affixed by its authority.

WITNESS my hand and Notarial Seal the day and year last above written.



Katherine Frischnolz  
Notary Public

Commission expires Dec. 18, 1961

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## **Appendix B**

### **Agreement Between NPPD and AEC**



**Department of Energy**  
**Office of Legacy Management**

Washington, D C 20585

SEP 16 2004

OLM-SRS-2004- 12

Mr. Robert A. Green  
Nebraska Public Power District  
P.O. Box 499  
Columbus, NE 68602-0499

Subject: Department of Energy Access to the Hallam, Nebraska, Decommissioned Reactor

Dear Mr. Green:

In 1993, The U.S. Department of Energy (DOE), Chicago Operations Office, signed a license agreement with the Nebraska Public Power District (NPPD) to conduct remedial activities and to ensure access to the decommissioned Hallam Nuclear Power Facility at the Sheldon Power Station near Hallam, Nebraska. The agreement allows DOE to fulfill its obligation under U.S. Atomic Energy Commission (DOE) Docket 115-3, dated July 20, 1971, to ensure the radiological safety of the facility. The agreement has undergone two modifications to the term and expired in 2000. DOE has completed the installation of monitoring wells needed to monitor the ground water around the site as required in the license agreement.

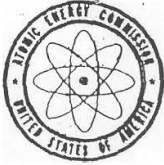
As stated in the docket, the right of access to the facility for monitoring purposes was reserved for the DOE. Therefore, it has been determined that DOE currently has access to the facility and does not need to renew the 1993 license agreement.

Thank you for your continued support. If you have questions or concern, please contact Charles W. (Bill) Montana, Jr., Realty Officer, at (702) 295-1899 or (702) 630-0379.

Sincerely,

Steven R. Schiesswohl  
Realty Officer

cc: C. Montana, DOE/LM-30  
M. Tucker, DOELM-50  
C. Bahrke, Stoller (e)  
C. Carpenter, Stoller (e)  
M. Widdop, Stoller (e)  
Project File HAL015.10 (DOE)



UNITED STATES  
ATOMIC ENERGY COMMISSION  
WASHINGTON, D.C. 20545

NEBRASKA PUBLIC POWER DISTRICT  
(FORMERLY CONSUMERS PUBLIC POWER DISTRICT)

DOCKET NO. 115-3

HALLAM NUCLEAR POWER FACILITY

ORDER TERMINATING OPERATING AUTHORIZATION

The Atomic Energy Commission has found that the Hallam Nuclear Power Facility located in Hallam, Nebraska, has been dismantled and disposition has been made of the component parts in accordance with the regulations of the Commission in 10 CFR Chapter I, and in a manner not inimical to the common defense and security or to the health and safety of the public. Therefore, in accordance with the December 15, 1969 application by Nebraska (formerly Consumers) Public Power District and supplements dated February 9 and June 26, 1970, Operating Authorization No. DPRA-1 is hereby terminated as of the date of this order.

FOR THE ATOMIC ENERGY COMMISSION

*Peter A. Morris*

Peter A. Morris, Director  
Division of Reactor Licensing

Date of Issuance: July 20, 1971

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UNITED STATES ATOMIC ENERGY COMMISSION

DOCKET NO. 115-3

NEBRASKA PUBLIC POWER DISTRICT

(FORMERLY CONSUMERS PUBLIC POWER DISTRICT)

HALLAM NUCLEAR POWER FACILITY

NOTICE OF TERMINATION OF OPERATING AUTHORIZATION

The Atomic Energy Commission has terminated Operating Authorization No. DPRA-1 which authorized the Consumers Public Power District (CPPD), now the Nebraska Public Power District, to operate the Hallam Nuclear Power Facility (HNPF) located in Hallam, Nebraska. On November 3, 1967, the Commission issued an order authorizing CPPD to dismantle the HNPF and decontaminate the facility in accordance with the HNPF Retirement Plan (Revised) and the Final Summary Safeguards Report, Supplement 5.

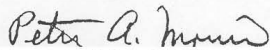
Representatives of the Commission have inspected the HNPF and have verified that it has been dismantled and disposition made of its component parts as described in the HNPF Retirement Plan (Revised). The Commission inspectors have further verified that the premises are safe from a radiation standpoint for unrestricted occupancy in accordance with the requirements of 10 CFR Part 20. In addition, an appropriate notice regarding the remainder of the dismantled facility has been placed in the land title records of Lancaster County, Nebraska. The HNPF was Commission-owned; consequently, the Commission has title ~~to and responsibility~~ for the entombed radioactive materials.

Accordingly, the Commission has found that termination of Operating Authorization No. DPRA-1 for the HNPF will not be inimical to the common defense and security or to the health and safety of the public.

Copies of (1) the Commission's Order Terminating Operating Authorization (2) a related Safety Evaluation by the Commission's Division of Reactor Licensing, and (3) the CPD application for termination dated December 15, 1969, and supplements dated February 9 and June 26, 1970, are available for inspection at the Commission's Public Document Room, 1717 H Street, N.W., Washington, D. C. A copy of each of items (1) and (2) may be obtained upon request sent to the U. S. Atomic Energy Commission, Washington, D. C. 20545, Attention: Director, Division of Reactor Licensing.

Dated at Bethesda, Maryland, this 20th day of July, 1971.

FOR THE ATOMIC ENERGY COMMISSION

  
Peter A. Morris, Director  
Division of Reactor Licensing



UNITED STATES ATOMIC ENERGY COMMISSION  
SAFETY EVALUATION BY THE DIVISION OF REACTOR LICENSING  
RETIREMENT OF THE HALLAM NUCLEAR POWER FACILITY

DOCKET NO. 115-3

INTRODUCTION

By order of the Atomic Energy Commission dated November 3, 1967, Nebraska Public Power District<sup>1</sup> (NPPD) was authorized to retire and dismantle the Hallam Nuclear Power Facility (HNPF) in accordance with a "Retirement Plan" approved by the Commission.

The HNPF was a Commission-owned sodium-cooled, graphite-moderated reactor operated by NPPD at its Sheldon Station near Hallam, Nebraska, in accordance with an operating authorization issued under the Commission's regulation, 10 CFR 115. The Commission concluded in June 1966 that the HNPF had fulfilled its objectives in the Power Demonstration Program, and at that time began plans for retirement of the facility. The dismantling activities have now been completed, and NPPD has requested that Operating Authorization No. DPRA-1 be terminated. In support of this request, NPPD submitted "Final Status Report and Safety Analysis of the Hallam Nuclear Power Facility and Remaining Structures" (AL-AEC-MEMO-12794 - Revised) dated September 30, 1969, and a letter dated June 26, 1970, which amplifies and corrects this report. These documents describe the activities undertaken to retire the facility, set forth the condition of the dismantled facility, provide an inventory of the remaining radioactive materials and assess the safety aspects related to long-term storage of such materials at the site.

Facility Status after Dismantlement

In its dismantled condition, the HNPF consists of a massive, below-grade reinforced concrete structure, within which a number of cavities are located. These cavities formerly housed the reactor, those portions of the heat transfer and auxiliary systems that contained radioactive sodium or other radioactive fluids, and storage locations for radioactive materials. All of these cavities have been sealed. The reactor building has been razed, and the surface of the remaining structure has been weatherproofed by covering with sand, a waterproof polyvinyl membrane and earth. This

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<sup>1</sup>Nebraska Public Power District was formerly named Consumers Public Power District.

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cover is sloped for proper drainage and drain tile is installed at the periphery. The intermediate heat exchanger (IHX) structure, which protrudes above grade, has been weatherproofed by a layer of polyvinyl sheet and a protective cover of concrete. In this condition, interior portions of the structure are sealed against ingress of water and access can be gained only by extensive effort utilizing a combination of explosives, air hammers and cutting tools. The only other HNPf structure remaining at the site is the radioactive waste disposal building, a relatively small structure previously used in connection with storage and handling of wastes.

Prior to final sealing of the facility, all nuclear fuel and all bulk sodium were removed from the site. Residual sodium was reacted with steam to form sodium hydroxide, thus removing any potential for hydrogen formation at some later date should water enter the facility. Equipment that could be salvaged economically was decontaminated, where necessary, and shipped from the site for utilization elsewhere.

Within the structure that housed the reactor, three principal locations were utilized for long-term storage of most of the radioactive materials that will remain at the site. These are the reactor cavity, Fuel Storage Pit No. 3, and the moderator element storage cells. Each of these cavities is steel lined and surrounded by several feet of concrete and other structural materials that were provided for shielding in the operational plant. Approximately 300,000 curies of radioactive material are stored in these locations with over 99% of it being located in the reactor cavity. Most of this activity is immobilized since it is in the form of neutron activation products dispersed in metallic components. A small amount of activation products is immobilized in the shielding concrete surrounding the reactor cavity. In addition to the activity stored in these principal storage locations, eight other locations within the structure contain a total of approximately 1/4 curie of activity in the form of activation products dispersed in metallic components. No significant amount of radioactive material remains in the radioactive waste disposal building. However, the below-grade portions of this building and a connecting pipe tunnel have been sealed to prevent access.

All of the cavities in which radioactive components are stored have been sealed by welded closures in such a manner that they are isolated from the rest of the structure. In addition, all other cavities, pipe ways and stair wells have been sealed by welding existing closures or providing a closure constructed of reinforced expanding concrete.

### Radiological Status of Accessible Locations

After the retirement activities were completed, a radiation survey was performed to verify that radiation levels would not be high enough to present a hazard even if it were assumed that the general public could have unlimited access to the site. This survey showed that in all but one location the radiation levels are at background. The AEC Division of Compliance (CO) has noted from its independent survey that small amounts of activity remain in the silt of the primary and secondary retention ponds which were provided to hold up discharges from the plant. No significant activity was found in the tertiary pond to which the secondary pond drains. Water samples from these ponds were all within the concentrations permitted by 10 CFR Part 20, Column 2, Table II, of Appendix B and Note 1 thereto.

Some silt samples contained concentrations of radioactive materials several times that which would be permitted in an equal weight of water as stated in 10 CFR 20. The fact that such concentrations exist in the silts indicates either that the radioactive material is in very insoluble form or that it is strongly adsorbed by the silt. There is no potential for pond water exceeding 10 CFR 20 limits. The potential for transport of sediments downstream by run-off is very small as indicated by the absence of radioactive material in the tertiary pond. However, should such transport occur as a result of storm run-off, the small total quantity of radioactive material in the pond bottom would be further dispersed and diluted, and it is unlikely that subsequent measurements could detect radiation levels in excess of background beyond the tertiary pond.

The beta-gamma external radiation measurements made by CO indicate some locations in the pond bottom (with water absent) with radiation levels between 0.3 and 0.5 mR/hr at 1 cm from the surface. While these indicated levels are slightly higher than the 0.2 mR/hr average gamma radiation level which the decontamination effort was to achieve, as specified in the HNPFF deactivation procedures, these levels are still well within Section 20.105(b) of 10 CFR 20 limits. Because the radiation monitoring instrument used by CO was equipped with a 2.5 mg/cm<sup>2</sup> GM tube, it was sensitive to both gamma radiation and low energy beta radiation, and the measurements made at 1 cm above the silt would include beta radiation as well as the gamma radiation. The licensee's consultant, Isotopes, Inc., when making the final survey of the pond, used a 35 mg/cm<sup>2</sup> GM tube, which is insensitive to beta radiation with energies less than about 0.2 Mev. The results of the licensee's survey indicated radiation levels of less than 0.2 mR/hr. Silt and vegetation samples gathered by CO and analyzed by the Commission's Idaho Operations Office showed

radioactivity concentrations of Co-60, Ni-63, Fe-55, Mn-54 and Na-22. The major contributor to the silt concentration (50 to 90 percent) was Ni-63 which decays only by beta emission ( $E_{\max} = 0.066$  Mev). Therefore, comparative evaluation of the radiation survey results of the licensee and CO indicate that a high percentage of the radiation level may be due to the low energy beta radiation from Ni-63. The limits for unrestricted areas specified in Section 20.105 of 10 CFR 20 are applicable to whole body doses and, therefore, compliance with them should be determined for gamma radiation only at a radiation measuring height of 30 to 36 inches above the source.

Based upon our analysis and evaluation, we have concluded that the licensee has achieved satisfactory decontamination levels and that such levels do not represent an undue risk to the health and safety of the public.

#### STORAGE OF RADIOACTIVE MATERIALS

##### Storage Areas

The three principal locations in which radioactive materials will remain stored are the reactor cavity, fuel and storage pit No. 3, and the moderator storage cells. These storage locations (designated Storage Areas 1, 2, and 3, respectively) are all situated within the below-grade portions of the remaining structure; as previously noted, a small amount of radioactive material, principally in the form of activation products in miscellaneous small parts, is stored within other volumes located in the below-grade structure.

Over 99% of the activity stored at the site is located within the reactor cavity (Area No. 1). This cavity is lined with carbon-steel plate with a minimum thickness of 1/2 inch. The liner represents a high integrity envelope for the cavity since it was designed to be gas tight to retain a helium atmosphere and to exclude in-leakage of water which would have posed a hazard during reactor operation. Remaining within the cavity are the reactor vessel and surrounding guard vessel, with associated double-walled piping, and most of the reactor vessel internals. The cavity closure consists of a massive shield plug which was formerly the loading face of the reactor. In connection with the retirement activities, all sodium piping and vent lines were cut and sealed with welded caps at the diaphragm seals separating the reactor cavity from the adjoining pipeways, thus isolating the reactor cavity

from the remainder of the structure. All small plugs penetrating the loading face shield have been sealed in place, and the entire shield has been covered by two 1/2-inch-thick steel plates, welded in place to provide a secondary permanent seal.

Substantially all of the radioactive material stored in the reactor cavity consists of activation products dispersed in the stainless steel materials that constitute the reactor vessel and its internals. Lesser amounts of activation products are dispersed in the carbon steel thermal shield and guard vessel which surround the reactor vessel and in the cavity liner itself. The small amount of radioactive material contained in the reinforcing bar and the concrete outside the reactor cavity is too low in concentration to present a potential radiological problem. The following table summarizes the inventory of significant radionuclides remaining in the reactor vessel and outside the reactor vessel as of late 1969 (5 years after reactor shutdown).

Significant Radionuclides in Reactor Cavity (Area No. 1)

Isotope	Reactor Vessel & Internals	External to Reactor Vessel
	Curies	Curies
Fe-55	190,000	10,000
Co-60	73,000	3,000
Ni-63	12,000	Negligible
Sm-151	6,300*	Negligible

\*Located in control elements stored in reactor vessel.

Fuel Storage Pit No. 2, which was used for storage of spent nuclear fuel when the facility was operational, has been designated Storage Area No. 2. This pit is lined by 1/4-inch-thick stainless steel plate, and has suspended in it a number of stainless steel thimbles 40 feet long with 1/4-inch wall thickness. Each of these thimbles was formerly used to store a spent fuel element that had a film of sodium on it; hence they were of leak tight construction to preclude cooling water in the pool from entering the thimbles. The pool has been drained and these thimbles now contain process tubes, control rod tubes, dummy elements and a spent neutron source element, all of which contain induced radioactivity from having been located in the reactor during operation. The

thimbles have been welded to the steel sleeves through which they are hung in the concrete shield structure constituting the roof of the fuel pit. The upper side constitutes part of the grade level floor of the remaining structure. Closures and dust covers for each thimble have been welded in place to assure water tightness and the interspace has been filled with expanding concrete.

In 1969, five years after shutdown, the inventory of significant radio-nuclides in the fuel storage pit consisted of 2,900 curies of Fe-55, 4,400 curies of Co-60, and 230 curies of Ni-63.

Storage Area No. 3 consists of the 12 moderator-element storage cells which are 20-ft-long cylinders, each 2 ft in diameter, cast in the concrete structure of the main floor of the plant; These cells have steel-encased, concrete shield plugs as closures. The radioactive components stored in them consist primarily of three canistered moderator-elements that had experienced cladding failures during reactor operation. A number of parts such as pumps, valves and segments of piping are stored in these cells. The moderator cells were sealed by welding the plug casings to the cell liners and filling the space above the plugs with expanding concrete. Five years after shutdown (1969), the miscellaneous parts stored in these cells contained about 0.008 curies of activity, and the total inventory, most of it in the form of activation products in the moderator element cladding, consisted of 2,300 curies of Fe-55, 660 curies of Co-60 and 140 curies of Ni-63.

#### Integrity of Storage Structure

The selected storage areas are within a below-grade reinforced concrete structure that was originally designed as containment for an operational nuclear power plant. Thicknesses of concrete, steel and other materials in the vicinity of the storage locations were dictated primarily by shielding considerations for the operational plant. Similarly, the design, in terms of structural strength, took into account combinations of normal structural design loads with loadings that were presumed possible as the result of various hypothetical reactor accidents. Because of these original design considerations, the structure can be expected to retain its integrity for an indefinite period of time. The minimum design-life objective of the various seals, supplementary closures and weatherproofing measures, installed during the dismantling of the facility, is 100 years. Based on our review of the design details of these features, and the design details of the original facility, we conclude that this objective has been met.

The Division of Compliance (CO) has conducted inspections at the facility and has verified that all of the steps necessary to sealing and weatherproofing the storage structure had been carried out in conformance with the requirements of the approved retirement plan. CO noted that the one-foot-thick concrete slab placed on the roof of the IHX structure had suffered cracking, apparently caused by expansion and contraction that occurred because of changes in temperature. These cracks have been repaired; however, the slab is exposed to weather and some deterioration may be expected to occur in the future. Further cracking of this slab would be of little significance since its purpose is solely to give physical protection to the polyvinyl waterproofing membrane placed on the IHX roof as an additional precaution against inleakage of rainwater. The IHX structure itself, with its 6-112-ft-thick reinforced concrete roof and shield plugs, sealed in place, is inherently leak-tight.

Various conditions have been considered that conceivably could affect the integrity of the structure. These include natural events and conditions that might arise as the result of hydrogen accumulation or corrosion within the structure.

It was determined through evaluation of the structure prior to operation of the plant that tornado wind loadings and tornado-borne missiles could not affect the integrity of the structure because of its location at or below grade elevation and because of the strength of the reinforced concrete. Differential pressures across the structure in excess of those considered possible as a result of the passage of a tornado were found to be incapable of lifting any of the plugs used as closures in the floor of the structure. Additional margin against the possibility of tornado damage has been provided by seal welding of these plugs and by application of a cover of sand and earth after the structure was sealed.

The site is located in Zone 1 of the Uniform Building Code Map of Seismic Probability. Thus, the area is expected to experience earthquakes only infrequently and at magnitudes that would not affect the integrity of the Structure. If an unexpectedly severe earthquake were to occur, it is conceivable that some damage, in the form of cracking, might occur to the concrete. It would be highly unlikely, however, that the integrity of the three designated storage areas would be affected since the steel liners should be sufficiently strong to withstand the forces of an earthquake and sufficiently ductile to accommodate without failure any dimensional

changes induced by cracking of the concrete. Even if the storage areas were breached, there would be no significant potential for release of radioactivity because most of it is in the form of activation products distributed through and immobilized within metallic structural materials. Any necessary repairs to the structure, to restore its weathertightness, could be made easily, long before corrosion of these materials could lead to the spread of activity.

Flooding at the site is not considered possible because of its elevation and location away from streams. However, the possibility of water invasion from the surface and from ground water was considered in the design of the original facility, as well as in the design of the added sealing features. We have determined that the upper surface of the structure has been sealed to the extent that inleakage of water could not occur unless a small leak path had been left, for example, because of an undetected weld defect. Even if such a defect existed, invasion of water from the upper surface would be minor because of the provisions made for drainage of storm water. The potential for water invasion below grade is somewhat greater because of the frequent existence of high ground water levels at the site. It appears possible that water could enter some of the below-grade cavities in small amounts because of seepage through construction joints or existing cracks in the concrete. Water could not enter the designated storage areas, however, because of the water-tight steel liners that have been provided. It is conceivable, though unlikely, that after prolonged immersion the liner materials could corrode to the point of developing leaks. The consequences of such postulated leakage are discussed in the following section.

Hydrogen evolution owing to sodium-water reaction or radiolytic dissociation of water would be the only potential mechanism through which a condition within the storage structure could threaten its integrity. The potential for hydrogen production by a sodium-water reaction has been eliminated by reacting residual sodium with a purge flow of steam followed by a purge of nitrogen. Sampling of the purge gases verified that the reaction was complete and that all hydrogen evolved during the process had been purged from the system. After the final purge with nitrogen, the system was dry except for combined water associated with the sodium hydroxide residue left in the system. Radiolytic decomposition of water, owing to gamma ray emissions from the decay of activation products, would produce only a negligible quantity of hydrogen, in terms of the potential for creating a combustible mixture or building up a gas pressure, even if it is arbitrarily assumed that no diffusion of hydrogen occurred from the system.



Radiological Safety of Stored Materials

As noted previously, radiation levels at all accessible points of the retired facility are approximately at background levels. Consequently, there would be no radiological hazard associated with allowing general public access to the site. Entry into the storage areas could pose a possible radiological hazard to the person(s) involved, unless such entry was accomplished with awareness that radioactive materials existed therein. Such entry would require deliberate extended effort, however, and it is exceedingly unlikely that it would be attempted.

To preclude the possibility that at some future date entry into the storage areas might be attempted under uncontrolled conditions, a description of the facility, its contents and a notice that entry into the facility requires permission of the appropriate governmental authority has been placed in the Deed for the property, thus becoming part of the permanent Lancaster County, Nebraska, land records. In addition, two sealed stainless steel capsules, containing a description of the contents of the facility and details of its construction, have been installed at the facility. One of these is located in a niche on the face of the IHX structure and the other at the center of the steel plate covering Storage Area No. 1. Engraved notices at each of these capsules warn that entry is prohibited unless appropriate authority has been obtained. We conclude that the foregoing measures are adequate to prevent uncontrolled entry into the Storage areas.

The only way in which the stored radioactive materials could conceivably reach the environment would be, through corrosion of the barriers surrounding the storage areas followed by corrosion of the materials containing the activation products and subsequent transport into the surrounding soil in water solution. In order to assess the possible consequences of such corrosion, an extremely conservative corrosion model was developed in which it was arbitrarily assumed that water invaded the facility five years after shutdown and promoted continuous general corrosion of the materials involved.

Taking into account the time rate of dissolution of the materials involved and the competing process of radioactive decay, the calculated maximum concentrations of the significant isotopes in water confined in the structure would be 1.3 times the allowable Concentrations for water specified in 10 CFR 20 for Fe-55, 23 times allowable for Co-60 and 27 times allowable for Ni-63. Iron and cobalt activities come primarily

from corrosion of carbon steel materials surrounding the reactor vessel, and the nickel activity concentration comes from the arbitrary assumptions that the stainless steel liner and thimbles of Area 2 have lost their integrity so that corrosion is initiated immediately. Should this confined water be released to the soil at the time the peak concentrations for each isotope exist, the ground water in immediate contact with the structure would exceed allowable concentrations. Considering the ion exchange capacity of the soil, however, these concentrations would be reduced several orders of magnitude in only a few meters of ground water travel. Thus, there would be negligible potential, even in this extreme case, for movement of significant amounts of activity into potable water supplies.

If this potential for corrosion of materials were considered more realistically, by assuming that wafer does not invade the facility until the 100-year design life of the structure is reached, radioactive decay would have reduced the Fe-55 activity to less than 4 microcuries and the Co-60 activity to less than 0.2 curies, most of which would be dispersed in corrosion resistant stainless steel components. About 5,900 curies of Ni-63 and 2,900 curies of Sm-151 would still be present, both dispersed in stainless steel. A potential hazard would still exist for direct handling of such materials; however, the potential for release by corrosion in significant quantities would be very slight. Analyses show that corrosion rates of the stainless steel barriers, e.g., the reactor vessel and the thimbles in storage Area No. 2, would take place at such slow rates that concentrations in water could not exceed the allowable level specified in 10 CFR 20 unless it were arbitrarily assumed that the vessel or the thimbles were breached early in the life of the structure so as to allow corrosion of the interior members and subsequent outleakage of contaminated water to occur. In such an event, the concentration of Ni-63 would be only slightly above permissible levels and the activity would be retained in soils adjacent to the structure. We conclude, therefore, that storage of activity at the Hallam site will not pose an undue risk to the health and safety of the public owing to contamination of ground water.

#### Surveillance

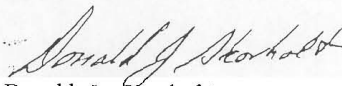
Although the potential for transport of radioactive materials stored in the isolation structure to the environment is insignificant, under the terms of its contract termination agreement with NPPD, the Commission nevertheless has made arrangements with the State of Nebraska Department of Health to conduct radiological surveillance semiannually to verify that

no radioactivity is being released. The results of surveillance conducted to date by the State verify that there has been no detectable release from the retired facility. Under the terms of the agreement with NPPD, the Commission will be responsible for instituting any remedial measures should activity be detected outside the facility and for making any necessary repairs to the structure to preserve its integrity should unanticipated damage or deterioration make this necessary. For these reasons, the Commission has retained the right of access to the facility.

CONCLUSION

Based on our review of the retirement activities performed, verification of an adequate degree of compliance with the criteria specified for securing the facility, and assessment of the present and future radiological status of the retired facility and its environs, we conclude:

1. that the facility and the site have been placed in a safe condition that will permit unlimited access to the site without danger of exposure of individuals to radiation levels significantly above background;
2. that the manner in which radioactive materials are stored will preclude transport of radionuclides into ground water in any significant amount;
3. that adequate control provisions have been made to prevent unauthorized access to storage areas within the retired facility; and
4. that the existence of stored radioactive material at the Hallam Nuclear Power Facility is not inimical to the common defense and security or to the health and safety of the public.

  
Donald J. Skovholt  
Assistant Director for  
Reactor Operations  
Division of Reactor Licensing

Date: July 20, 1971

## **Appendix C**

### **Correspondence Between DOE and Nebraska DHHS**



February 2, 2007

Department of Energy  
Office of Legacy management  
19901 Germantown Road  
Germantown, ND 20874

Subject: USDOE Recommends Discontinuing Monitoring at the Hallam Nuclear Power Facility (HNPF), Hallam, Nebraska.

Dear Ms. Powell, Site Manager

This office has reviewed your letter and the submitted report no. DOE-LLM/1319-206 dated September 26, 2006. The Department does not concur with your recommendation. The Department recommends reducing the sampling and analysis frequency to once every two years.

Abnormally dry to severe drought conditions have existed during most of the monitoring of the HNPF. The report neither mentions the drought of 2000 through the present nor discusses its effects on the ground water monitoring and the applicability of the monitoring to years with normal or above normal precipitation.

From your report, nickel-63 and samarium-151 remain of significant activity levels. The two nuclides have half-lives at 100 years and 90 years respectively. As stated in your report, DOE can not release the decommissioned reactor for unrestricted use for about 100 years after decommissioning, and should be committed to continue periodic monitoring during that time period.

We would encourage a follow up discussion with you and Nebraska Public Power District on this matter. I may be reached at (402) 471-0171 or E-mail at [jim.defrain@hhss.ne.gov](mailto:jim.defrain@hhss.ne.gov).

Sincerely,

Jim DeFrain, Health Physicist  
Radiation Control Program

Cc: Russ Neffeler, Environmental Compliance Auditor, Nebraska Public Power District  
Marty Link, Associate Program Director, Nebraska Department of Environmental Quality



**Department of Energy  
Office of Legacy Management**

March 14, 2007

Mr. Jim DeFrain  
Department of Health and Human Services  
Regulations and Licensure  
P.O. Box 95007  
Lincoln, NE 68509-5007

Subject: USDOE Recommends Discontinuing Monitoring at the Hallam Nuclear Power Facility (HNPF), Hallam, Nebraska

Dear Mr. DeFrain:

In response to your letter dated February 2, 2007, the U.S. Department of Energy (DOE) Office of Legacy Management is pleased that the State of Nebraska would endorse a biennial monitoring frequency at the decommissioned Hallam Nuclear Power Facility. As documented in our September 2006 report, there have been no impacts on shallow perched ground water in the immediate vicinity of the entombed reactor. Assuming that future monitoring results continue to demonstrate no impact, we would expect that continued reductions in monitoring frequency and possibly monitoring points would be justified, and these could ultimately lead to an abandonment of ground water monitoring altogether. However, in the near-term we expect that the next two ground water monitoring events would be in June 2008 and June 2010.

In reference to your letter, we did not mention the drought conditions you describe because the ground water levels in the shallow wells have not changed appreciably since the wells were installed. Based on an examination of precipitation data (1948 – 2006) for the neighboring towns of Crete, Hickman, and Beatrice, we recognize that the past six years may have been drier than normal; however, the wells were installed during a period of above normal precipitation. The hydrographs presented in our report show that shallow ground water levels, and concentrations of dissolved chemical constituents, remained relatively constant between 1998 and 2006.

You also referred to the nickel-63 and samarium-151, which remained in the reactor cavity after the power plant was decommissioned. Notwithstanding that nickel-63 was never detected in ground water monitoring at the site, we propose to continue analyzing the ground water samples for nickel-63 and to continue the gamma spectrometry scans that target 19 additional analytes. We also propose to continue monitoring for tritium because greatly elevated activities of tritium

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3610 Collins Ferry Road, P.O. Box 880, Morgantown, WV 26507	626 Cochrans Mill Road, P.O. Box 10940, Pittsburgh, PA 15236
1000 Independence Ave., S.W., Washington, DC 20585	12101 Airport Way, Unit C, Broomfield, CO 80021-2583
<b>11003 Hamilton-Cleves Hwy., Harrison, OH 45030</b> X	955 Mound Road, Miamisburg, OH
232 Energy Way, N. Las Vegas, NV 89030	7295 Hwy 94 South, St. Charles, MO 63304

Mr. Jim DeFrain  
March 14, 2007

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could be an indicator of a failure in the decommissioned reactor core. However, in future monitoring we may consider dropping gross alpha from the list of analytes because it is normally an indicator of radium (and uranium) decay and may occur naturally in the glacial till.

During the April 2006 inspection, and previous inspections of the Hallam site, it was noted that some of the DOE wells are in or along traffic patterns established by operators of the Sheldon Power Station. In particular, it is a matter of time before plant operators collide with well pair OBS 2B and 2C; therefore, DOE plans to reconfigure these two wells, and potentially other wells at the site, into flush mounted completions.

I may be reached at either 513-648-3148 or via email at [jane.powell@lm.doe.gov](mailto:jane.powell@lm.doe.gov)

We would welcome a discussion with you concerning these topics and other topics of mutual interest. I will be contacting you shortly regarding a suitable time to begin that discussion.

Sincerely,  
  
Jane Powell  
LM Site Manager

JP/dp

c:  
Robert Ransbottom, Stoller (e)  
Project Files (Thru D. Roberts)