Information Use
Introduction

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The following figures are controlled drawings and can be viewed and printed from the listed aperture card.

1. INTRODUCTION AND SUMMARY

1.1 Introduction

By letters dated June 24 and August 25, 2016, OPPD notified the NRC of its intention to permanently cease power operations at Fort Calhoun Station (FCS) pursuant to 10 CFR 50.82(a)(1)(i). On October 24, 2016, OPPD permanently ceased power operations at FCS (References 1-13, 1-14).

Pursuant to 10 CFR 50.82(a)(1)(ii), OPPD certified to the NRC that as of November 13, 2016, all fuel had been permanently removed from the FCS reactor vessel and had been placed into the spent fuel pool. The letter acknowledged that upon docketing the certifications for permanent cessation of operations and permanent removal of fuel from the reactor vessel, the 10 CFR Part 50 license no longer authorized operation of the reactor or emplacement or retention of fuel in the reactor vessel (Reference 1-15).

By letter from NRC (J. Kim) to OPPD (M. Fisher) “Fort Calhoun Station, Unit 1 – Issuance of Amendment Re: Revised Technical Specifications to Align to Those Requirements for Decommissioning” Dated March 6, 2018 (NRC-18-011), OPPD was granted Permanently Defueled Technical Specifications (PDTS). PDTS removed all sections of operating plant TS that no longer apply during the decommissioning process.

Based on the above, the DSAR was updated as the Defueled Safety Analysis Report, or DSAR. Prior to permanent removal of fuel, the revised Final Safety Analysis Report, referred to as USAR, was submitted as required under 10 CFR Part 50.71(e), effective July 22, 1980. The original Final Safety Analysis Report was submitted in support of the application by the Omaha Public Power District, (OPPD), for a license pursuant to Section 104b of the Atomic Energy Act, 1954, to operate the Fort Calhoun Station Unit No. 1, (AEC Docket 50 285, Construction Permit CPPR 41).

By letter from NRC (J. Parrott) to OPPD (M. Fisher) “Fort Calhoun Station, Unit 1 – Issuance of Amendment Re: Revised Fort Calhoun Station Permanently Defueled Technical Specifications to Align to Those Requirements for Permanent Removal of Spent Fuel from Spent Fuel Pool.”, Dated December 11, 2019 (NRC-19-026), OPPD was granted the amendment to the Permanently Defueled Technical Specifications (PDTS). This amendment removed all sections associated with the storage of fuel and relocated administrative requirements to appropriate documents. Based on the above, the DSAR has been revised to reflect the new license conditions and requirements.

This report provided pertinent technical information in accordance with the requirements set forth under Title 10 of the Code of Federal Regulations, Part 50, (10 CFR Part 50) and information and analyses submitted to the NRC or prepared as a result of NRC requirements. The plant began commercial operation on September 26, 1973. Prior to decommissioning, the nuclear steam supply system (NSSS) was of the pressurized water type. It was similar in design to several facilities which began operation or were under review by the U.S. Atomic Energy Commission at the time the plant was pursuing its original operating license. A license was requested to operate the facility at power levels up to and including 1420 core thermal megawatts (MWt) which corresponded to a turbine-generator output of 481 MWe. The license was then amended to allow operation at power levels up to and including 1500 core thermal megawatts (MWt) which corresponded to a turbine-generator output of nominal 533.7 MWe at 0.90 power factor.

1.0 INTRODUCTION AND SUMMARY

1.2 Summary Plant Description

1.2.1 Plant Site

The site for the Fort Calhoun Station contains approximately 540 acres on the west bank of the Missouri River, approximately 19.4 miles north of Omaha, Nebraska. OPPD has a perpetual easement on approximately 117 acres of land on the east bank of the river directly opposite the plant buildings. On the Western part of the site the ground rises sharply about 60 feet to a higher level area which is bounded on the west by U.S. Highway 75, formerly U.S. Highway 73.

The U.S. Corps of Engineers' river improvement program has led to the development of a stable, well defined river bank in the vicinity of the site. A partially filled-in area, about 450 feet wide, runs parallel to the bank.

The legacy station buildings are supported by a system of pipe piles which were driven to bedrock approximately 60 feet below the surface. Ground water level is close to existing grade and structures below grade are suitably water-proofed.

An Independent Spent Fuel Storage Installation (ISFSI) is located in the protected area designated for dry storage of spent fuel and greater than class C waste (GTCC). The ISFSI is licensed under Subpart K of 10 CFR Part 72.

The area adjoining the site is farmland and sparsely populated. The minimum exclusion distance is 1525 feet. The nearest population center area of more than 25,000 is formed by adjacent cities of Omaha, Nebraska and Council Bluffs, Iowa. The site vicinity plan is shown in Figure 1.2-2.

The exclusion zone consists of approximately 540 acres owned by Omaha Public Power District. The restricted area as defined in Section 20.3(a)(14) of 10 CFR Part 20 is shown on Figure 1.2-1.

A rail spur from the Chicago and Northwestern (CNW) Railway was constructed to serve the construction of the Fort Calhoun Station (FCS). The original CNW tracks and rail spur have since been removed. In 1994, a permanent easement was granted to allow the construction of a new rail spur in the approximate location of the old CNW railway to allow trains to serve the Cargill industrial facility located north of FCS. Road access to FCS is from U.S. Highway No. 75.

1.2.2 Station Arrangement

Station status is continually changing during decommissioning. Current information on systems, radiological conditions and demolition progress is maintained by the Radiation Protection and Decommissioning organizations respectively.

The principal station structures are the ISFSI Operating Facility (IOF) and ISFSI.

The site's legacy buildings include the turbine building, intake structure, technical support center, service building, maintenance shop, and the chemistry and radiation protection/locker facility including the office/cafeteria addition, and hazardous material storage building. All are located outside of the Protected Area.

Some specific system descriptions have been removed from the DSAR as all spent fuel has been removed from the Spent Fuel Pool to the ISFSI pad and these SSC no longer have a design function.

The reactor, steam generators, reactor coolant pumps and pressurizer are located in the containment, together with other nuclear steam supply system (NSSS) components which no longer have a design function.

A polar bridge crane is installed above the Containment operating floor, but no longer has a design function.

The reactor auxiliaries include, engineered safeguards components, the control room, radiation controlled area (RCA) protective clothing issue and dress area and laboratories, and fuel handling and storage facilities are located in the auxiliary building, but no longer have a design function. Reactor auxiliaries that retain a function include the waste treatment facilities. A traveling bridge crane is located over the fuel handling and storage area in the auxiliary building. The traveling bridge crane no longer has a design function.

The turbine building houses the turbine generator, condenser, and other turbine heat cycle components. These components no longer have a design function. The 150-ton traveling bridge crane no longer has a design function.

The service building houses the auxiliary boiler which no longer has a design function.

The condenser cooling circulating water and raw water pumps are located in the intake structure. They no longer have a design function.

Station Structures can contain provisions for dry active waste (DAW) processing, liquid radwaste filtration and ion exchange (FIX) equipment and radwaste solidification equipment.

1.2.3 Reactor and Reactor Coolant System

The reactor and reactor coolant system are located in containment but no longer have a design function.

1.2.4 Deleted

1.2.5 Engineered Safeguards Systems

The components which made up the engineered safeguards systems are located in the Auxiliary Building and Containment, but no longer have a design function.

1.2.6 Instrumentation and Control

A. Deleted.

B. Instrumentation

Local control of the remaining instrumentation monitoring system function to support the remaining functional portions of the waste disposal, radiation monitors, and HVAC systems. All other process instrumentation and monitoring systems remain installed, but no longer have a design function.

C. Plant Computer

The plant computer remains installed , but no longer has a design function.

1.2.7 Electrical Systems

The source of energy for the ISFSI loads are the 13.8 kV circuit from the OPPD Substation, and a diesel-generator set located in the IOF.

Power systems provide power to meet required remaining decommissioning support functions. Other legacy electrical systems remain installed, but no longer have a design function.

1.2.8 Auxiliary Systems

The following systems remain installed but no longer have a design function:

- Chemical Volume and Control System
- Shutdown Cooling System
- Component Cooling Water and Raw Water Systems
- Sampling Systems
- Circulating and Turbine Plant Cooling Water Systems
- Compressed Air System
- Spent Fuel Pool Cooling
- Auxiliary Boiler System
- Radioactive Waste Disposal System

A. Fuel Handling and Storage

Irradiated fuel bundles are not allowed to be stored in the SFP. The system remains installed, but no longer has a design function. The ISFSI contains all fuel for storage prior to off-site shipment.

OPPD has constructed an ISFSI, located in the Protected Area designated for dry storage of spent fuel. The ISFSI consists of the concrete basemat that was built on an elevated pad of compacted, engineered fill for flood protection, concrete horizontal storage modules, concrete shield walls, concrete approach slabs adjacent to the basemat, the ISFSI electrical equipment building, and the IOF. The ISFSI is designed for 42 horizontal storage modules arranged in a 2 x 21 back-to-back configuration. Each horizontal storage module holds one dry shielded canister for fuel storage or a canister containing greater than class C waste (GTCC) for storage. The HSM protects the canister(s) from natural phenomena such as tornado missiles, and is designed to provide for passive cooling of the canister by means of natural air circulation. The ISFSI basemat is 42 ft. wide by 211 ft. long, with its long dimension oriented in the east-west direction. The elevation of the top of the basemat is at 1009 ft-10 inches, above the level of the probable maximum flood. This DSAR for the Fort Calhoun Station does not assess the safety of the dry spent fuel storage system, which is licensed under Subpart K of 10 CFR Part 72 for general ISFSI licenses.

Transnuclear, Inc., the storage system vendor, maintains the Final Safety Analysis Report for the NUHOMS® Horizontal Modular Storage System (Reference 1-6). Certificate of Compliance No. 1004 (Reference 1-7) was issued by the NRC for the NUHOMS®- system, with the 32PT DSC used at the Fort Calhoun Station ISFSI. The Technical Specifications for the NUHOMS® storage system are included as Attachment A to Certificate of Compliance No. 1004.

B. Plant Ventilation Systems

Station Ventilation systems (serving the containment and part of the auxiliary building) handle airborne contaminants so that offsite concentrations and in plant doses (which are controlled by the ODCM and administrative procedures) are within 10 CFR Part 20 limits.

The remaining plant ventilation systems remains installed but no longer have a design function.

C. Plant Fire Protection

In November 2016, OPPD certified to the NRC per 10 CFR 50.82(a)(1) that fuel had been permanently removed from the reactor vessel. With this certification, 10 CFR 50.48(f) became applicable to the fire protection program. Subsequently, Amendment No. 290 to the Renewed Facility License DPR-40 deleted the fire protection program as a License Condition. The fire protection program is now maintained in accordance with 10 CFR 50.48(f). These programs address both the site and the ISFSI (CC-FC-211 and FCSI-FP-100).

1.2.9 Deleted

1.2.10 Radioactive Waste Disposal

Radioactive waste is managed during decommissioning through the use of permanent and temporary liquid, gaseous and solid treatment systems. These systems collect, process, monitor and regulate the discharge of potentially radioactive wastes from the site.

The waste equipment used for radioactive waste processing and disposal are designed to protect plant personnel and the public from exposure to radioactive wastes in accordance with 10 CFR Part 20; 10 CFR 50, Appendix I; 40 CFR Part 190; 10 CFR 50 Appendix A General Design Criterion 60, and Draft GDC Criteria 17 and 18.

This equipment along with approved procedures will provide the administrative controls to ensure that the radioactive releases are completed within the allowable concentrations and dose limitations defined in the Quality Assurance Topical Report (QATR), Appendix E and the Offsite Dose Calculation Manual (ODCM)

A. Liquid

Effluents shall be limited to less than ten times 10 CFR Part 20, Appendix B, Table 2, Column 2 concentrations at discharge as described within the ODCM.

B. Gaseous

The Five year average dispersion factor (χ/Q) for gaseous releases used to determine exposures in the unrestricted area is specified in the ODCM. The ODCM ensures that all releases are within applicable criteria.

C. Solid

The general types of radioactive solid wastes produced at the station are processed in accordance with radiological requirements in the ODCM and the Process Control Program (PC).

D. Shielding

Radiation shielding is designed to provide radiation protection for personnel inside and outside the plant, and for the general public.

Containment Building

The containment has one major shielding function: It shields adjacent auxiliary plant and yard areas from radiation originating from inside the containment.

Auxiliary Building

Adequate shielding is provided around equipment that carries radioactive liquid, slurry or gas.

Radioactive Waste Processing Building and CARP Building

Adequate shielding is provided for each room in the Radioactive Waste Processing and CARP buildings to permit continuous occupancy in general access areas.

E. Radiation Monitoring

Radiation monitors are provided for radiological controls and ODCM requirements

F. Miscellaneous Radioactive Material Sources

Miscellaneous radioactive material sources are controlled by Radiation Protection procedures.

G. Radiological Effluent Requirements

The QATR, Process Control Program (PCP), and the ODCM contain all the radiological effluent requirements.

H. Event Analysis

The PSDAR and FC08566, Dose Consequences of a High Integrity Container (HIC) Drop Event (Reference 1.4.1), provide quantity and design incidents for radiological solid (postulated gas) releases. This calculation supports the ISFSI Only Emergency Plan (IOEP) license, which assumes onsite deconstruction activities are administratively controlled.

The radioactive waste handling events have been postulated to be the limiting events for decommissioning activities and does not rely on any equipment for mitigation.

Therefore, there is no SSC required to meet 10 CFR 20 limits for these events.

1.2.11 Plant Design Characteristics

Amendment No. 283 to Renewed Facility Operating License No. DPR-40 allows the design and/or analysis of piping to be performed in accordance with ASME Section III, 1980 Edition (no Addenda) as an alternative to USAS B31.7, 1968 (DRAFT) Edition.

There is no longer any safety class components at the station.

1.0 INTRODUCTION AND SUMMARY

1.11 Specific References

1-1 Deleted

1-2 Deleted

1-3 Deleted

1-4 Deleted

1-5 Deleted

1-6 Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel (NUH-003), Transnuclear Inc., Revisions 9, 10, and 18.

1-7 Renewed Certificate of Compliance No. 1004, Amendments No. 8, 9, and 15, issued to Transnuclear, Inc. for Standardized NUHOMS-24P, -52B, -61BT, -24PHB and -32PT, including Attachment A, Technical Specifications, and NRC Safety Evaluation Report (SER).

1-8 Deleted

1-9 Deleted

1-10 Deleted

1-11 Deleted

1-12 Deleted

1-13 Letter from OPPD (T. Burke) to USNRC (Document Control Desk), "Certification of Permanent Cessation of Power Operations," dated June 24, 2016 (LIC-16-0043) (ML 16176A213).

1-14 Letter from OPPD (T. Burke) to USNRC (Document Control Desk), "Certification of Permanent Cessation of Power Operations," dated August 25, 2016 (LIC-16-0067) (ML 16242A127).

1-15 Letter from OPPD (T. Burke) to USNRC (Document Control Desk), "Certification of Permanent Removal of Fuel from the Reactor Vessel," dated November 13, 2016 (LIC-16-0074).

1-16 Letter from NRC (J. Kim) to OPPD (M. Fisher) “Fort Calhoun Station, Unit 1 – Issuance of Amendment Re: Revised Technical Specifications to Align to Those Requirements for Decommissioning” Dated March 6, 2018 (NRC-18-011).

1-17 Letter from NRC (J. Parrot) to OPPD (M. Fisher) “Fort Calhoun Station, Unit 1 – Issuance of Amendment to Revise Fort Calhoun Station Permanently Defueled Technical Specifications to Align to the Requirements for Permanent Removal of Spent Fuel from Spent Fuel Pool” Dated December 11, 2019 (NRC-19-026)

2. SITE AND ENVIRONS

ARCHIVED TEXT*

2.1 Introduction

This section outlines the bases for the remaining selection of design criteria for Fort Calhoun Station and provides the background data required to substantiate the proposed methods for controlling and assessing routine and accidental releases of radioactive liquids and gases to the environment. Field programs to investigate site geology, seismology, and subterranean hydrology have been completed.

The site of the power station is located at 96 degrees, 4 minutes and 39 seconds west longitude and 41 degrees, 31 minutes and 14 seconds north latitude in Washington County, Nebraska, on the southwest bank of the Missouri River at river mile 646.0, approximately 2.4 miles south-southeast of the Chicago and Northwestern Railway bridge at Blair, Nebraska. The site is 19.4 miles north-northwest of the intersection of 16th Street and Dodge Street in the city of Omaha. Meteorologically, hydrologically, geologically, and seismologically, this site is favorable for a nuclear power station.

The plant is designed, nevertheless, so that there will be no uncontrolled release of radioactive material during decommissioning operations. Radioactive effluents, both gases and liquids, will be released in a controlled manner to ensure that they are below allowable limits.

Dames and Moore, consulting engineers in the applied earth sciences, conducted investigations in site geology, seismology, subterranean hydrology and meteorology.

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2. SITE AND ENVIRONS

2.2 General Description of Site and Environs

The post permanent shutdown site extent is approximately 540 acres; approximately 445 acres of this area is on the alluvial flood plain of the Missouri River, and the remainder is part of the bluff system on the southwest side of the river. An additional exclusion area of approximately 117 acres is included on the northeast bank of the river directly opposite the industrial area.

This additional exclusion area is provided by means of perpetual easements which allows OPPD to restrict or prohibit access should evacuation be necessary. More specifically on October 28, 1969, the owners of property located across the Missouri River from OPPD's Fort Calhoun facility executed easements in perpetuity to the OPPD which consists of the following:

In consideration of the sum of One Dollar and other valuable consideration and of further agreements herein stated, the undersigned owners of real estate hereinafter described, their heirs, executors, administrators, successors and assigns, hereinafter called "Grantor" hereby grant and convey to the Omaha Public Power District, its successors and assigns, hereinafter called "District", a perpetual easement over, along and upon the following described accretion land owned by the Grantor and sometimes described as:

October 28, 1969 Agreement:

From the South 1/4 corner of Section 17, Township 18 North, Range 12 East of the 6th P.M., Washington County, Nebraska; thence North 00° 10'15" West along the ¼ line a distance of 2,088.27 feet to the point of beginning, said point being on the right bank of the designed channel of the Missouri River, thence continuing North 00° 10' 15" West a distance of 574.52 feet to intersect the 1943 Nebraska-Iowa compact line; thence along the compact line as follows:

South 42°52'	East a distance of	277.91 feet;
South 47°12'	East a distance of	476.86 feet;
South 51°42'	East a distance of	477.30 feet;
South 55°42'	East a distance of	479.83 feet;
South 59°24'	East a distance of	478.09 feet;
South 64°14'	East a distance of	481.84 feet;
South 68°56'20"	East a distance of	1,031.14 feet;
South 62°14'	East a distance of	468.62 feet;
South 56°54'	East a distance of	566.97 feet;
South 51°30'	East a distance of	366.47 feet;
South 46°48'	East a distance of	468.26 feet;
South 41°07'	East a distance of	282.40 feet;

To intersect the projected centerline of Broadway Street in Old DeSoto Townsite; thence South 32° 35' West along said center line a distance of 925.90 feet to intersect the right bank of the designed channel of the Missouri River, thence along said right bank as follows:

North 61°18'	West a distance of	299.23 feet;
North 59°40'	West a distance of	500.00 feet;
North 57°48'	West a distance of	500.00 feet;
North 56°20'	West a distance of	500.00 feet;
North 54°16'	West a distance of	500.00 feet;
North 52°30'	West a distance of	500.00 feet;
North 50°50'	West a distance of	500.00 feet;
North 49°00'	West a distance of	500.00 feet;
North 47°26'	West a distance of	500.00 feet;
North 44°50'	West a distance of	500.00 feet;
North 43°32'	West a distance of	500.00 feet;
North 41°30'	West a distance of	234.74 feet;

To the point of beginning, lying in Sections 16, 17, 20 and 21, Township 18 North, Range 12 East of the 6th P.M., Washington County, Nebraska, and containing 109.26 acres, more or less.

"1. District shall have the right of ingress and egress along the Grantor's property for any purpose necessary in maintaining the described property as an exclusion area, as later described."

"2. That part of the above described property is part of an exclusion area, now defined in the rules and regulations published by the United States Atomic Energy Commission, and more particularly by Title 10 - Atomic Energy, Part 100, 100.3 Definitions, (a) thereof, which exclusion area is an integral part of the District's nuclear power plant site, the balance of which lies on the Nebraska side of the Missouri River opposite said property and in said County.

"3. The Grantor may make any use of the above described property for their own benefit, except that the Grantor shall not make or permit any use or occupancy of said property, which shall be inconsistent with the maintenance of said property by District as such an exclusion area, or which shall be prohibited by any law or regulation now or hereafter enacted by proper public authority, either governing or applicable to the use and maintenance of said property as an exclusion area as now or hereafter defined, or otherwise.

"4. Grantor specifically covenants that no structure shall be built and that any structure now existing upon said land shall not be occupied at any time by any person or persons."

"5. The District shall have the right to post said land for the purpose of securing the area as a minimum exclusion as defined and required by the Atomic Energy Commission.

"6. In the event that an emergency should occur in connection with the operation of District's power plant, which in District's opinion would require such action in the interest of public health and safety, District may, without notice, take all necessary steps to exclude persons and property from within the posted area and to continue to exclude said persons and property until such time as said emergency has passed.

"7. The District shall reimburse the Grantor for any crop damage that might occur as a result of the District's personnel or any of its representatives entering upon the exclusion area property during an emergency.

"8. As further consideration for said easement, District shall, subject to the rights of the District created by this easement, quit-claim all right, title and interest of ownership of the above described property to Grantor herein.

"9. It is further agreed that Grantor has lawful possession of said real estate, good, right and lawful authority to make said conveyance and that their heirs, executors, administrators, successors and assigns shall warrant and defend same and will indemnify and hold harmless to the District forever against claims of all persons whomsoever in any way asserting any right, title or interest prior to or contrary to this conveyance.

In the opinion of counsel, paragraphs 3 and 6 of these agreements give OPPD ample legal authority to vacate said property in the event that an emergency should occur.

Figure 2.2-1 is an aerial photograph of the site and immediately surrounding area. A majority of the site is being farmed at the present time and it is planned that farming will continue. On-site farming consists primarily of grain. Approximately 354 acres of the total approximately 540 acres are under cultivation. The environmental monitoring program is performed in accordance with the ODCM. The area adjacent to the site is farm land and is sparsely populated. The nearest population area is the town of Blair, Nebraska, approximately 3.4 miles west northwest of the plant.

Figures 2.2-2 and 2.2-3 show the geographical features within 60 and 30 miles, respectively, of the site center; Figure 2.2-4 defines the metes and bounds of the site.

Both private and commercial traffic make use of U. S. Highway No. 75 which forms the southwest boundary of the site and of the Missouri River which forms the northeast boundary. The highway is located at least 3,200 feet away, therefore, it is unlikely that an accident on this route would affect the station. The river traffic handles few hazardous materials. The danger to the station from air traffic is considered minimal since the site is not located near landing patterns or runways of any large commercial or military airport facility.

2. SITE AND ENVIRONS

ARCHIVED TEXT*

2.3 Topography

Figure 2.3-1 shows the topography within the site boundaries. The surface of the land, starting from the Missouri River at about elevation 997 feet above mean sea level, falls to an old channel of the river before rising again to approximately 1,004 feet. Beyond this point, the land then gradually falls off to about 1,000 feet, rises again to approximately 1,020 feet, and then rises approximately 60 feet to a higher plateau at elevation 1,080 feet.

The Missouri River, which flows generally north to south, forms the northeast to southeast site boundary. This part of the river is referred to by the Corps of Engineers as the Blair Bend. The river limits are under control of the Corps who have established a structure azimuth line which acts as another site boundary.

The site drainage development program provides proper drainage of the plant site and upstream properties. This system controls runoff of local precipitation; drainage empties into the Missouri River above the plant.

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2. SITE AND ENVIRONS

ARCHIVED TEXT

2.4 Seismology

2.4.1 Seismic Geology and History

The site is underlain by 65 to 75 feet of unconsolidated alluvial and glacial deposits, largely loose to moderately compact silty sand and deeper sands and gravels resting on sedimentary bedrock. The bedrock is generally flat with a westward dip.

A study of the possible existence of faults was made during the geologic investigation of the area. No faulting is apparent in the unconsolidated Pleistocene and recent sediments of the Missouri River lowlands.

The closest known regional structures in the vicinity of the site are the Nehawka-Richfield Arch and the La Platte Fault. The Nehawka-Richfield Arch extends from near Omaha-Council Bluffs south and southwest for about 20 to 30 miles. There is no record of movement of the fault in historic times, or any indication of activity in recent geologic time.

One of the major structural features of the Nebraska-Iowa region is the Thurman-Wilson Fault which extends from south of Lincoln, Nebraska, northeast for about 150 miles, almost to Des Moines, Iowa. There is no record of movement of this fault in historic times.

2.4.2 Seismicity

The epicenters of several shocks in the region with a Modified Mercalli Intensity greater than V are located in a zone south of Omaha parallel to the Nemaha Uplift and the Abilene Arch. The epicenters fall between the Salina Basin on the west and the Forest City Basin on the east. Other activity is centered south and west of the Sioux Uplift, northwest of the site. Epicentral locations of all known earthquakes in the vicinity of the site with Modified Mercalli Intensity V were tabulated in the Dames and Moore study referenced in Appendix B.

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ARCHIVED TEXT

A number of smaller earthquakes have been experienced in the Nebraska-Iowa region. The epicenters of some of these shocks were along the Missouri, Platte and Solomon Rivers. Studies in Illinois indicate a possible relationship between river load and earthquake occurrence, but no similar studies have been performed for this area. In general, because of poor records and lack of damage associated with these smaller shocks, they are of little significance.

The significant shocks, i.e., those within 200 miles of the site, were tabulated. On the basis of this history, it is evident that the site lies in a region of infrequent seismic activity. Since the middle of the 19th century, from the first historical record of earthquake occurrence in the area, only 12 shocks with epicentral Modified Mercalli Intensities of V or greater have occurred within 200 miles of the plant site. These shocks were all of light to moderate intensity, with few of sufficient intensity to cause structural damage.

The largest earthquakes reported in the area had epicentral intensities of Modified Mercalli VII. Three shocks of this intensity originated within 200 miles of the site. Of these, the closest occurred in November 1877 near Lincoln, Nebraska, about 60 miles from the site. Two shocks were felt; the larger was felt over an elliptical area of approximately 140,000 square miles and was reported to have lasted 40 seconds. It is estimated that this shock had a magnitude of about 5 or slightly higher on the Richter Scale.

A shock of Modified Mercalli Intensity VII occurred in April 1867, near Manhattan, Kansas, about 170 miles from the site, and was felt over an area of 300,000 square miles. It is estimated that this shock had an intensity of about 5-1/2 on the Richter Scale. Another shock of Modified Mercalli Intensity VII occurred in the same area in January 1906, and was perceptible over an area of 10,000 square miles. The magnitude of this shock was probably not more than 5 on the Richter Scale.

Only one earthquake of Modified Mercalli Intensity VI has been reported within 200 miles of the site. It occurred in March 1935, near Tecumseh, Nebraska, and was felt in an area over 50,000 square miles.
Eight earthquakes of Modified Mercalli Intensity V have been reported within 200 miles of the site. The earthquake with its epicenter nearest the site occurred in February 1910, near Columbus, Nebraska, about 65 miles from the site. No significant structural damage occurred.

ARCHIVED TEXT

No damaging earthquakes have been reported within 50 miles of the site. While some of the regional shocks were undoubtedly felt in the locality of the site, no significant damage would be expected in even moderately well-built structures from a recurrence of these disturbances. It is probable that the earthquake of November 1877, was felt at the site with an intensity of about Modified Mercalli V.

No major earthquake has occurred near the site. The closest major shock was about 500 miles to the southeast. In 1811 and 1812 a series of large shocks were experienced near New Madrid, Missouri, but these shocks bore no relation to the structural geology surrounding the site.

Therefore, on a historical basis, it would appear that the site will not experience damaging earthquake motion.

2.4.3 Seismic Design Criteria

Although on the basis of the history of the region no significant earthquake ground motion is expected at the site, occasional shocks along the Missouri River and a continuation of shocks in the belt extending northward from the Abilene Arch to the Sioux Uplift could be postulated. For conservatism in the determination of appropriate seismic criteria the proximity of a fault to the site is considered. On this basis, and in accordance with the recommendations of the U.S. Coast and Geodetic Survey (USC&GS), site seismic criteria has been established.

2.4.4 Design and Maximum Hypothetical Earthquakes

The following criteria was applied to components, structures and equipment for the design earthquake and maximum hypothetical earthquake.

Design Earthquake (Operating Basis Earthquake)

All Class I components, systems and structures were designed so that the seismic stresses resulting from the response to a ground acceleration of 0.08g acting in the horizontal direction and two-thirds of 0.08g acting in the vertical direction simultaneously, in combination with the primary steady state stresses, are maintained within the allowable working stress limits accepted as good practice and, where applicable, set forth in the appropriate design standards; e.g., the ASME Boiler and Pressure Vessel Code, B31.1 (1967) and B31.7 (1968) Codes for Pressure Piping, ACI 318 Building Code Requirements for Reinforced Concrete, and AISC Specifications for the Design and Erection of Structural Steel for Buildings.

Maximum Hypothetical Earthquake (Design Basis Earthquake)

All Class I components, systems, structures (historic) and the ISFSI basemat (current) are designed so that seismic stresses resulting from the response to a ground acceleration of 0.17g acting in the horizontal direction and two-thirds of 0.17g acting in the vertical direction simultaneously, in combination with the primary steady state stresses, are limited so that the function of the component, system or structure is not impaired in such a manner that function is prevented.

Structures no longer have any design features that are credited in any event analysis.

2.4.5 Conclusions

The site is subject to infrequent slight ground motion from regional shocks.

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2.4.6 References

2.4.6.1 Dames and Moore letter, “Report, Site Environmental Studies, Fort Calhoun Station – Unit No. 1, Near Fort Calhoun, Nebraska, Omaha Public Power District,” dated March 30, 1967 (WIP8403)

2.4.6.2 Dames and Moore letter, “Recommendation for Response Spectra to be Used with Ground Acceleration of 8 Percent and 17 Percent of Gravity,” dated November 28, 1967 (WIP3618)

2.4.6.3 FCS-203087-USAR-2.4, Revision 1, USAR 2.4 Verification Summary Report (EC 67224)

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2. SITE AND ENVIRONS

2.5 Meteorology

2.5.1 General Climate

The general climate is classified as continental, i.e., hotter in summer and colder in winter than in lands near the ocean. Nebraska is located midway between two distinctive climatic zones, the humid east and the dry west[4]. Thus, cyclic weather conditions representative of either zone, or combinations of both occur. Changes in weather result from the invasion of large masses of air with dissimilar properties. These air masses tend to get their characteristics from either the warm and humid south-southeast, the warm and dry southwest, the cool and dry north-northwest, or the cold continental polar air of the north[6]. The region is also affected by many storms or cyclones (areas of low pressure) which travel across the country, generally from west to east. Thus, periodic and rapid changes in the weather are normal, especially in the winter[3].

2.5.2 Local Meteorology

Data from proximal long-term National Weather Service (NWS) Stations have been used to supplement the existing Fort Calhoun Station data in formulating the description of the local meteorology.

2.5.2.1 Wind Direction and Speeds

A comparison of the climatological normals for the North Omaha NWS and five years of data from the Fort Calhoun Station has been archived in Table 2.5-1. The elevation of the North Omaha NWS wind sensor was 20 feet above ground during the five-year period, while the elevation of the Fort Calhoun wind sensor was 10 meters above ground. Further discussion on the on-site data for wind direction and speed is presented below in Section 2.5.2.6.

The mean and maximum wind speeds recorded at Eppley Airfield and the North Omaha NWS for each month of the year are archived in Table 2.5-2.

2.5.2.2 Precipitation

Monthly and annual normal and extreme precipitation amounts for Eppley Airfield and the North Omaha NWS are archived in Table 2.5-3. Average monthly precipitation follows a seasonal trend, reaching a maximum in May and a minimum in January. The mean number of days with measurable precipitation varies between a 12-day maximum in May to a 5-day minimum in November. The normals and extremes for amounts of snow and ice pellets (including sleet) for Eppley Airfield and the North Omaha NWS are archived in Table 2.5-4.

2.5.2.3 Temperatures

The monthly temperatures at Eppley Airfield and the North Omaha NWS for the period 1961 through 1990 are archived in Table 2.5-5. This table also shows the record high and record low temperatures recorded at both locations through 1990. Annual extremes have been received at other locations in the Omaha vicinity as follows: a record high of 114°F in July, 1936, and a record low of -32°F in January, 1885[4].

Monthly and annual temperature normals for Eppley Airfield, North Omaha NWS and Blair are archived in Table 2.5-6[4]. These show close agreement.

2.5.2.4 Relative Humidity

The average relative humidity values for Eppley Airfield, the North Omaha NWS, and the Fort Calhoun Station for four times of the day are archived in Table 2.5-7. The mean number of days with heavy fog (visibility 3 mile or less) at Eppley Airfield and the North Omaha NWS are archived in Table 2.5-8.

2.5.2.5 Thunderstorms

The mean number of days with thunderstorms at Eppley Airfield and the North Omaha NWS are archived in Table 2.5-9. A maximum frequency of approximately 9.5 thunderstorms occur during the month of June. This decreases to a minimum of approximately 0.1 thunderstorms during the month of January.

2.5.2.6 Atmospheric Stability

Wind direction and speed data are presented in relative frequency distribution (in percent) by stability classes.

2.5.2.7 Topographical Description and Its Influence on Site Meteorology

The terrain in the vicinity of Fort Calhoun Station is generally flat from the north, northeast, east and southeast sectors, with an elevation of approximately 1000 feet above mean sea level (msl), for a radius of at least 10 miles. This terrain is generally the flood plain of the Missouri River. Terrain in the remaining sectors, south-southeast through west-northwest, show much greater relief from the low lying bluffs, cut by numerous ravines, with elevations of about 1300 feet above msl. These bluffs extend along the western bank of the Missouri River, which runs generally from the northwest to the southeast, and come within about one mile of the Fort Calhoun Station in the south through west-southwest sectors.

Two unusual effects in the site meteorology are: 1) under very light westerly wind flow there is a possibility of weak drainage flow off the bluffs to the west toward the river, and 2) there will possibly be a slowing down of weak winds as air flows across the river from east to west and meets the rising terrain to the west. However, neither of these effects are regarded as significant in their influence on site meteorology and should not, under most synoptic weather types, severely skew the strong measures of covariation (+0.75 to +1.00) which exist between the site and other meteorological stations.

2.5.2.8 Tornadoes

Amendment 272[37] revised the DBT and associated tornado missiles for Fort Calhoun Station (FCS) to that defined in Regulatory Guide (RG) 1.76, Revision 1[38]. This ensures that designated SSCs are adequately protected from the DBT and associated tornado missiles.

Tornado Missiles

The physical properties and velocities of tornado generated missiles are described in Regulatory Guide 1.76, Revision 1.

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Table 2.5-1 - Climatological Normals, Comparison of
North Omaha NWS with Fort Calhoun Station

	WIND DIRECTION (PERCENT)		**WIND SPEED (MPH)**	
Wind Direction	**North Omaha NWS (1985-1989)**	**Fort Calhoun (1985-1989)**	**North Omaha NWS (1985-1989)**	**Fort Calhoun (1985-1989)**
NNE	3.8	2.6	8.2	4.9
NE	3.3	2.4	6.9	4.6
ENE	3.2	2.4	6.5	4.5
E	3.1	3.1	6.7	5.0
ESE	5.4	5.7	6.8	5.4
SE	7.1	9.0	7.8	6.8
SSE	10.0	10.2	9.9	8.9
S	10.8	10.1	10.4	9.5
SSW	9.1	7.2	9.5	9.3
SW	4.3	3.7	8.5	7.5
WSW	2.4	3.0	7.2	5.5
W	3.9	4.5	7.7	4.4
WNW	5.3	7.6	10.1	4.6
NW	8.6	10.7	12.9	6.6
NNW	6.8	9.4	12.8	6.5
N	13.0	5.5	8.0	5.9
Missing	---	2.9	---	2.9
Average	---	---	8.7	6.3

NOTE: The wind speeds at the North Omaha NWS were recorded 20 feet above ground level, and the wind speeds at Fort Calhoun Station were recorded at 10 meters, above ground level. Data obtained from the Local Climatological Data; see References 4 and 5.

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Table 2.5-2 - Maximum Recorded and Mean Wind Speeds (MPH)

	EPPLEY AIRFIELD				NORTH OMAHA NWS			
Period	**Fastest Wind Speed (1949-1990)**	**Direction (Degrees)**	**Year**	**Mean (1936-1990)**	**Fastest Wind Speed (1979-1990)**	**Direction (Degrees)**	**Year**	**Mean (1985-1990)**
January	57	NW	1938	10.9	41	NW	1978	10.4
February	57	NW	1947	11.1	38	NW	1978	9.6
March	73	NW	1950	12.3	38	NW	1982	10.9
April	65	NW	1937	12.7	46	NW	1982	10.6
May	73	NW	1936	10.9	34	N	1983	8.9
June	72	N	1942	10.1	34	NW	1983	8.4
July	109	N	1936	8.9	46	NW	1980	7.5
August	66	N	1944	8.9	39	NW	1980	7.7
Septembe r	47	E	1948	9.5	35	NW	1980	8.4
October	62	NW	1966	9.8	34	NW	1979	8.9
November	56	NW	1951	10.9	38	NW	1982	9.9
December	52	NW	1938	10.7	37	NW	1981	9.9
Year	109	N	1936	10.6	46	NW	1982	9.3

NOTE: The wind speeds at Eppley Airfield were recorded at 70 feet above ground level (agl) until 1974; 20 feet agl since that time. The wind speeds at the North Omaha NWS were recorded at 20 feet agl. Data obtained from the Local Climatological Data; see References 4 and 5.

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Table 2.5-3 - Normal and Extreme Precipitation Amounts (Inches)

	EPPLEY AIRFIELD (1936-1990)							NORTH OMAHA (1954-1990)						
Period	**Monthly Normal**	**Monthly Maximum**	**Year**	**Monthly Minimum**	**Year**	**24-Hour Maximum (1942-1990)**	**Year**	**Monthly Normal**	**Monthly Maximum**	**Year**	**Monthly Minimum**	**Year**	**24-Hour Maximum (1977-1990)**	**Year**
January	0.77	3.70	1949	Trace	1986	1.52	1967	0.70	1.85	1975	Trace	1986	0.95	1982
February	0.91	2.97	1965	0.09	1981	2.24	1954	0.95	2.86	1965	0.09	1968	0.64	1978
March	1.91	5.96	1973	0.12	1956	1.45	1990	2.00	5.27	1983	0.06	1956	2.04	1982
April	2.94	6.45	1951	0.23	1936	2.56	1938	2.74	7.12	1984	0.15	1962	2.59	1986
May	4.33	10.33	1959	0.56	1948	4.16	1987	4.26	9.09	1959	0.55	1989	3.10	1987
June	4.08	10.81	1947	1.03	1972	3.48	1942	4.21	8.16	1984	0.95	1972	2.77	1988
July	3.62	9.60	1958	0.39	1983	3.37	1958	3.50	9.77	1958	0.29	1975	3.72	1977
August	4.10	10.16	1982	0.61	1984	5.27	1987	4.19	11.77	1960	0.63	1971	3.74	1987
September	3.50	13.75	1965	0.41	1953	6.47	1965	3.36	14.10	1965	0.96	1990	2.77	1989
October	2.09	4.99	1961	Trace	1952	3.13	1968	2.11	5.34	1986	0.06	1958	2.61	1986
November	1.32	4.70	1983	0.03	1976	2.53	1948	1.16	5.11	1983	0.03	1989	2.16	1983
December	0.77	5.42	1984	Trace	1943	3.03	1984	0.76	4.45	1984	0.02	1958	3.10	1984
Year	30.34	13.75	1965	Trace	1986	6.47	1965	29.94	14.10	1965	Trace	1986	3.74	1987

NOTE: Data obtained from the Local Climatological Data; see References 4 and 5.

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Table 2.5-4 - Normal and Extreme (Maximum) Snow and Ice Pellet Amounts (Inches)

	EPPLEY AIRFIELD (1936-1990)					NORTH OMAHA (1954-1990)				
Period	**Normal**	**Monthly Maximum**	**Year**	**24-Hour Maximum (1942-1990)**	**Year**	**Normal**	**Monthly Maximum**	**Year**	**24-Hour Maximum (1976-1990)**	**Year**
January	7.3	25.7	1936	13.1	1949	7.0	21.5	1975	6.0	1979
February	6.8	25.4	1965	18.3	1965	6.7	23.2	1965	10.0	1978
March	6.6	27.2	1948	13.0	1948	7.2	23.3	1960	13.3	1987
April	0.8	8.6	1945	8.6	1945	1.2	10.3	1983	4.8	1979
May	0.1	2.0	1945	2.0	1945	Trace	0.7	1967	0.0	---
June	Trace	Trace	1990	Trace	1990	0.0	0.0	---	0.0	---
July	0.0	0.0	---	0.0	---	0.0	0.0	---	0.0	---
August	0.0	0.0	---	0.0	---	0.0	0.0	---	0.0	---
September	Trace	Trace	1985	Trace	1985	Trace	0.3	1985	0.3	1985
October	0.3	7.2	1941	7.2	1941	0.4	5.2	1980	5.2	1980
November	2.5	12.0	1957	8.7	1957	3.2	13.9	1957	8.5	1983
December	5.7	19.9	1969	10.2	1969	5.5	19.3	1969	7.5	1984
Year	30.0	27.2	1948	18.3	1965	31.3	23.3	March 1960	13.3	March 1987

<u>**NOTE**</u>**:** Data obtained from the Local Climatological Data: see References 4 and 5.

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Table 2.5-5 - Normal and Extreme Temperatures (EF)

	EPPLEY AIRFIELD							NORTH OMAHA						
	(1961-1990)			(1936-1990)				(1961-1990)			(1954-1990)			
Period	**Daily Maximum**	**Daily Minimum**	**Monthly Normal**	**Record High**	**Year**	**Record Low**	**Year**	**Daily Maximum**	**Daily Minimum**	**Monthly Normal**	**Record High**	**Year**	**Record Low**	**Year**
January	31.1	12.7	21.9	69.0	1944	-23.0	1982	29.3	11.1	20.2	66	1981	-22	1982
February	35.8	17.1	26.5	78.0	1972	-21.0	1981	34.3	16.0	25.1	76	1972	-20	1981
March	47.5	27.8	37.7	89.0	1986	-16.0	1948	46.4	26.9	36.7	88	1986	-16	1960
April	62.4	41.1	51.8	97.0	1989	5.0	1975	60.2	38.6	49.4	96	1989	7	1975
May	73.0	52.2	62.6	99.0	1939	27.0	1980	70.6	50.0	60.3	100	1967	25	1967
June	82.5	61.9	72.2	105.0	1953	38.0	1983	81.6	60.9	71.3	104	1988	41	1956
July	87.7	67.1	77.4	114.0	1936	44.0	1972	85.9	66.0	76.0	107	1974	44	1971
August	85.2	64.9	75.1	110.0	1936	43.0	1967	83.8	63.8	73.8	106	1983	44	1986
September	76.9	55.6	66.3	104.0	1939	25.0	1984	74.9	54.3	64.6	103	1955	28	1984
October	65.5	43.7	54.6	96.0	1938	13.0	1972	64.0	42.7	53.4	93	1975	16	1972
November	48.6	29.6	39.1	80.0	1980	-9.0	1964	47.4	28.7	38.1	79	1980	-11	1964
December	35.6	18.4	27.0	72.0	1939	-23.0	1989	33.8	16.4	25.1	66	1976	-25	1989
Year	61.0	41.0	51.0	114.0	1936	-23.0	1989	59.3	39.6	49.5	107	1974	-25	1989

NOTES: 1. Data obtained from the Local Climatological Data; see References 4 and 5.

2. At the time of containment design/construction the lowest recorded temperature at Eppley Airfield was -22.0°F (January 1974).

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Table 2.5-6 - Monthly and Annual Temperature Normals (°F)

Period	Eppley Airfield (1936-1990)	North Omaha NWS (1954-1990)	Blair (1941-1970)
January	20.2	18.7	20.8
February	27.2	25.3	26.0
March	37.3	35.2	35.2
April	52.2	50.4	50.9
May	63.3	61.7	61.5
June	73.0	71.2	70.8
July	77.7	75.7	75.5
August	75.2	73.5	73.9
September	65.8	64.4	64.3
October	54.5	53.6	54.8
November	39.5	38.0	38.7
December	27.2	25.7	26.6
Year	51.1	49.5	49.9

NOTE: Data obtained from references 4 and 5.

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Table 2.5-7 - Comparative Relative Humidity Values for Eppley Airfield (1964-1990), North Omaha (N.O.) (1984-1990), and Fort Calhoun (1969-1975)

	0000*			0600*			1200*			1800*			24 Hour Average		
Period	**Eppley**	**N.O.**	**Ft. Calhoun**	**Eppley**	**N.O.**	**Ft. Calhoun**	**Eppley**	**N.O.**	**Ft. Calhoun**	**Eppley**	**N.O.**	**Ft. Calhoun**	**Eppley**	**N.O.**	**Ft. Calhoun**
January	75	70	82	78	74	83	65	60	71	66	60	76	70	66	78
February	76	71	82	79	75	84	63	61	70	63	62	72	70	67	77
March	72	69	80	78	77	84	57	57	66	54	54	65	65	64	74
April	68	65	72	77	75	80	52	51	59	48	46	54	62	60	66
May	72	69	75	80	78	83	54	54	61	51	51	54	64	63	68
June	75	68	75	82	77	83	55	54	59	52	50	52	66	62	67
July	78	75	77	84	83	83	57	60	60	55	57	56	69	69	69
August	80	79	82	86	87	88	59	62	65	58	61	58	71	72	75
September	81	77	82	87	84	88	59	60	65	59	60	60	72	70	74
October	76	69	79	82	78	87	55	55	65	56	56	63	67	65	74
November	76	72	85	81	77	88	62	61	72	65	64	77	71	69	80
December	78	73	84	80	76	87	67	66	74	71	69	80	74	71	81
Year	76	71	80	81	78	85	59	58	66	58	58	64	69	66	74

*Local Standard Time

NOTE: Data obtained from the Local Climatological Data; see References 4 and 5. Fort Calhoun data obtained from PSAR and archived meteorological data files.

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Table 2.5-8 - Mean Number of Days with Heavy Fog (Visibility 1/4 Mile or Less)

Period	Eppley Airfield (1935-1990)	North Omaha NWS (1975-1990)
January	1.8	1.2
February	1.9	2.1
March	1.4	2.5
April	0.5	0.6
May	0.8	0.8
June	0.4	0.6
July	0.5	0.3
August	1.5	1.1
September	1.4	0.9
October	1.5	1.1
November	1.6	1.9
December	2.1	2.7
Year	15.4	15.8

Table 2.5-9 - Mean Number of Days with Thunderstorms

Period	Eppley Airfield (1935-1990)	North Omaha NWS (1975-1990)
January	0.1	0.1
February	0.4	0.4
March	1.5	1.9
April	3.8	3.4
May	7.4	7.7
June	9.4	9.5
July	8.2	8.8
August	7.8	8.1
September	5.3	6.0
October	2.4	2.3
November	0.8	0.7
December	0.2	0.2
Year	47.2	49.0

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2. SITE AND ENVIRONS

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2.6 Geology

2.6.1 Physiography

Topographically, the site is part of the Missouri River bottom land, which is a nearly level plain about 15 miles wide at Blair, 8 miles wide at the site and narrowing to 3 miles wide in the vicinity of Omaha-Council Bluffs. The elevation of this plain averages about 1,000 feet above mean sea level at the site.

2.6.2 Regional Geology

The principal geologic features of the region include a 100 to 200 foot thickness of soil deposited by a glacial action, streams, and wind, underlain by sedimentary bedrock of 500 to 2,500 feet in thickness consisting primarily of limestone, shale, and sandstone. There are no bedrock outcrops on the site, but there are exposures within three and five miles from the site at two limestone quarries.

2.6.3 Regional Structure

With few exceptions, the bedrock formations of eastern Nebraska and western Iowa are nearly flat with a gradual westward dip. This regional attitude is modified by several well defined faults, basins, and arches. However, none of these structural features occurs in the vicinity of the site.

The dominant structural features of the Nebraska-Iowa region include the Thurman-Wilson Fault which extends from 12 miles southeast of Lincoln, Nebraska, northeast for approximately 150 miles, almost to Des Moines, Iowa. It lies approximately 55 miles southeast of the site; the upthrown side is on the northwest.

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The Forest City Basin which is approximately 100 miles southeast of the Omaha area lies along the downthrown east flank of the Nemaha Ridge, a very sharp buried uplift extending from near Lincoln, Nebraska, south southwest across Kansas and into northern Oklahoma. The depth to the Precambrian crystalline granite core is about 400 to 500 feet at the Nebraska-Kansas line, near the Missouri Border. The Salina Basin and its northern extension, the Central Nebraska Basin are approximately 150 to 200 miles southwest of Omaha. In northern Kansas, the Abilene Arch lies between the Salina Basin and Nemaha Uplift. In southeast South Dakota, approximately 125 miles north of the site, is the Sioux Uplift, and southwest of the Sioux Uplift, in Western Nebraska, are the Siouxana Arch and the Cambridge Arch.

2.6.4 Areal Structure

The structures nearest the site are the Nehawka-Richfield Arch and the La Platte Fault. The arch extends from near Omaha south about 20 to 30 miles into Sarpy and Cass Counties, Nebraska. Deep well records indicate that a limb of this uplift may extend northward into the Omaha area and possibly farther.

The closest known regional fault is the La Platte Fault which cuts across the Nehawka-Richfield Arch in the lower Platte River Valley. It apparently crosses the Thurman-Wilson Fault some 60 miles south of the site. This nearly vertical fault has a maximum upthrow of about 50 feet on the west. There is no record of movement of the fault in historic times, nor any indication of activity in recent geologic time.

2.6.5 Geologic History

The early Paleozoic Era in western Iowa and eastern Nebraska was marked by long periods of marine inundation which resulted in deposition of thick beds of limestone, dolomite, shale, and sandstone. In later Paleozoic time, shorter and more frequent periods of alternating marine and continental deposition occurred resulting in the production of thin coal beds and layers of shale, limestone, and some sandstones.

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The major tectonic features of the mid-continent region began to develop late in the Paleozoic Era, and probably most of the important structural features of the Nebraska Iowa Missouri River Valley area had already developed or were developing by the end of the Permian period. From the end of the Permian to the beginning of the Cretaceous, there is no depositional record to correlate with structural movements. The undisturbed beds of the Cretaceous Dakota formation indicate the lack of tectonic activity since that time.

During the Pleistocene period, when the interior of the continent was covered by continental glaciers, Nebraska was occupied by only the first two of four major ice sheets. The first of these resulted in a general leveling and deposition of till. This was followed by alluvial deposition during the inter-glacial stage, and deposition of additional till and outwash by subsequent glaciation. Ice damage to streams during this period resulted further in a deposition of lacustrine sands and gravels. Nebraska and western Iowa were not covered by later ice sheets, but during the retreat and advance of these ice sheets nearby, windblown deposits of fine sand and silt accumulated to thicknesses of as much as 100 feet. These deposits, known as loess, form the steep sided hills and bluffs of eastern Nebraska and western Iowa. Recent erosion and alluvial deposition have altered the landscape to its present form.

2.6.6 Glacial History of the Missouri Valley

At the beginning of the Pleistocene period, the Missouri River Valley and its main tributaries were established in their approximate present positions. Subsequently under successive glacial movements, the valleys were filled and re-opened several times. During this period, the Peorian loess was deposited on the terraces and adjacent uplands. It is probable that only the upper part of the alluvium in the Missouri River Valley is actually of recent age and that deeper deposits are mostly of Pleistocene age.

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2.6.7 Site Geology

Unconsolidated sediments at the plant site generally range from 65 to 75 feet in thickness. The soils are typically interstratified and cross-bedded. The beds change facies or grade laterally so rapidly that no bed lithologic correlation is possible from boring to boring. The boring data indicate that the upper 20 to 50 feet of soil are predominately silty sands, and the lower beds consist of fine sands with occasional interbedded lenses of gravel.

The bedrock beneath the site lies between 65 and 75 feet below the surface. The maximum relief of the bedrock surface in the site area is in the order of 13 feet. Some borings indicate a thin layer of clay on top of bedrock, others a soft to hard shale up to a thickness of seven feet. The bedrock consists of various types of limestone formations.

2.6.8 Conclusions

The bedrock beneath the site provides suitable support for the plant structures. There is no geologic feature of the site or surrounding area which adversely affects the use of the site for a nuclear power plant.

2. SITE AND ENVIRONS

2.7 Hydrology

2.7.1 Surface Drainage

2.7.1.1 General

The plant site is bounded on the northeast and southeast by a portion of Blair Bend of the Missouri River. The Corps maintains river structures to prevent further meandering of the channel within the alluvial flood plain; the structures take the form of pile dikes and bank revetments.

There are six dams upstream of the plant site that control the river flow. There are no dams, locks, or similar structures on the Missouri downstream of the plant site.

The Corps of Engineers has stated (Reference 12) that sedimentation will not affect the flood control capability of the reservoir system for 200 years or more.

2.7.1.2 River Stage and Flow

The site has the following flood levels (Reference 21 and 22).

Flood	Elevation (ft)	Notes
1% (100 yr.)	1001.3	Below site grade
0.1% (1000 yr.)	1004.2	Site Grade
1950 Actual Flood	1007	Top of water tight foundations
Maximum Probable Rainstorm below Gavins Point Dam	1009.3	
Oahe or Fort Randall Dam Failure + 1009.3’ flood	1014	

It is estimated that the large flows would take about two days to travel from Gavins Point to the Fort Calhoun site. Rainfall sufficient to cause an appreciable flood would have to be heavy and occur over an extensive area.

2.7.2 Ground Water

2.7.2.1 General

Ground water is from two sources. The first is the Missouri River Valley, where ample ground water is obtained from the Pleistocene Valley fill and alluvial sand and gravels. The water table ranges from 2 to 17 feet below the surface, and coincides with the elevation of the river in the bottom land adjacent to the river. The second source of ground water are the terraces and loess hill upland regions. In these areas, the majority of wells are drilled or dug and provide water mainly from the glacial sands and gravels.

The movement of ground water under the uplands is toward and into the Missouri River trench. The occurrence of springs along the base of the bluff confirms the movement of ground water from the hills to the river.

The development and use of ground water adjacent to the Missouri River and downstream of the plant will be monitored as a result of normal coordination with state and local authorities. The need for an evaluation of potential effects on these wells will be determined periodically.

2.7.2.2 Site Water Table and Transmissibility

Water levels taken in a series of borings drilled during July and August, 1966, reveal that the ground water levels at the site varied from elevations 993.7 to 992.4 feet, while the river levels recorded during this same period ranged from elevations 993.2 to 992.4 feet. Ground water levels vary with changes in the river level. The rate of ground water flow in the alluvial soils varies with the permeability. However, rate of flow is very low, because of the low gradients, and again, is toward the river. The coefficient of permeability varied from about one-half to three feet per day in the upper sandy silt and silty sand. In the lower fine-to-coarse sand and gravel, coefficients of permeability as high as 20 feet per day were measured.

A pumping test was conducted to evaluate the gross permeability and transmissibility characteristics of the alluvial deposits. At a pumping rate of about 700 gallons per minute, the maximum drawdown in the well was 21 feet. The ultimate radius of influence of the test well was between 1,300 and 1,800 feet. The gross permeability of the deep water bearing sands and gravels amounts to 1,100 gallons per day per square foot. The soils are in direct hydrologic connection with the Missouri River.

The hydrologic characteristics of the site and surrounding area and the pattern of the ground water are such that accidental discharge of radioactive fluids into the ground would have no adverse effects on existing or potential ground water users. Such fluids would percolate slowly in the direction of the Missouri River. Thus, hydrological conditions are favorable for the location and operation of a nuclear facility.

Thirteen groundwater monitoring wells (both shallow and deep) were installed at FCS from August 15 through August 27, 2007. Hydro geological information was collected and evaluated by Terracon Consultants Incorporated. A second review and evaluation was performed by Radiation Safety and Control Services incorporated. Soils observed during the advancement of the well borings consisted primarily of unconsolidated lean clay, silt, and sand. These materials appear to be representative of Missouri River alluvium, although some relatively shallow soils may represent construction fill. The unconsolidated sediments that underlie the plant site can be grouped into two units: an upper fine grained sandy clay with silt approximately 20 to 50 feet thick, and an underlying fine to coarse sand with some gravel. This lower unit extends to the relatively flat-lying carbonate bedrock surface at a depth of approximately 70 to 75 feet below grade. Both unconsolidated units are water bearing, but the deeper unit has higher hydraulic conductivity. The depth to ground water ranges about 15 to 20 feet below ground surface. The resulting hydraulic gradient within the unconsolidated sediments is relatively flat. This low hydraulic gradient, combined with moderate hydraulic conductivity of the fine grained alluvial material, results in relatively slow ground water velocity beneath the site. Water table and potentiometric surface contour maps constructed based upon water levels measured in the new wells indicate groundwater flow directions different from the directions presumed prior to construction of the wells. Initially two conditions at FCS produced groundwater flow gradients opposite to those originally presumed. The first condition that affected groundwater flow was the pumping of the ground water supply well located at the Northwest corner of the old warehouse pad however, this well no longer exists.

The second condition impacting groundwater flows, which remains applicable, is bank recharge. The Missouri River is in hydraulic connection with the groundwater in the alluvial aquifer. During periods of relatively high river stage, which occur generally from April through September when precipitation is greatest, river water recharges the nearby alluvial aquifer and induces groundwater flow gradients outward from the river channel. These gradients reverse seasonally, during periods of lower river stage. Groundwater flows at the landfill site were calculated at velocities of less than 0.8 ft day, toward or away from the river, based on river stage.

In summation, the setting of the plant appears to be within a dynamic groundwater environment influenced by pumping of the ground water supply well, river level, and seasonal amounts of precipitation. Consequently, the Site Groundwater Protection Program (ODCM) accounts for potential variations in flow directions present within the industrial area.

2.7.2.3 Well Water Analyses

Samples were taken from the test well on the plant site at eight-hour intervals during August, 1966. The chemical analyses of these samples are summarized in Table 2.7-4. Throughout the sampling period, the well-water temperature was 54°F; no large seasonal temperature variations can be expected. Other samples were taken at bore holes and subsequently analyzed. However, the analyses reported in Table 2.7-4 are typical and adequately describe the ground water.

Table 2.7-4 - Test Well Water Analysis

	Sample No. 1		Sample No. 2		Sample No. 3		Sample No. 4		Sample No. 5		Sample No. 6		Sample No. 8	
Analysis	**As $CaCO_3$**	**As Ion**	**As $CaCO_3$**	**As Ion**	**As $CaCO_3$**	**As Ion**	**As $CaCO_3$**	**As Ion**	**As $CaCO_3$**	**As Ion**	**As $CaCO_3$**	**As Ion**	**As $CaCO_3$**	**As Ion**
Fe, ppm	26.0	14.5	28.4	15.9	27.6	15.4	27.6	15.4	28.1	15.7	28.1	15.7	28.1	15.7
Mn, ppm	1.2	0.6	4.9	2.7	5.1	2.8	4.0	2.2	5.1	2.8	5.6	3.1	4.7	2.6
Na, ppm	118.0	54.3	106.9	49.2	104.5	48.1	104.2	47.9	96.0	44.2	96.0	44.2	91.5	42.1
K, ppm	4.5	3.5	4.4	3.4	4.4	3.4	4.4	3.4	4.1	3.2	5.1	4.0	4.4	3.4
Ca, ppm	420.0	168.0	408.0	163.2	398.8	159.5	399.6	159.8	401.0	160.4	394.0	157.6	406.0	162.4
Mg, ppm	220.0	52.8	212.0	50.9	214.4	51.5	237.8	57.1	203.0	48.7	274.0	65.7	248.0	59.5
Total Cations,ppm	**789.7**	**293.7**	**764.6**	**285.3**	**754.8**	**280.7**	**777.6**	**285.8**	**737.3**	**275.0**	**802.8**	**290.3**	**782.7**	**285.7**
SO_4, ppm	151.5	145.4	174.7	167.7	159.6	153.2	181.3	174.0	160.7	154.3	164.2	157.6	147.8	141.9
C1, ppm	183.9	130.6	14.1	10.0	8.5	6.0	11.3	8.0	8.5	6.0	5.6	4.0	8.5	6.0
HCO_3, ppm	454.0	553.9	575.4	702.0	586.4	715.4	584.8	713.5	568.0	693.0	632.9	772.1	626.2	764.0
NO_3 ppm	0.3	0.4	0.4	0.5	0.3	0.4	0.2	0.3	0.1	0.1	0.1	0.1	0.2	0.3
Total Anions, ppm	**789.7**	**830.3**	**764.6**	**880.2**	**754.8**	**875.0**	**777.6**	**895.8**	**737.3**	**853.4**	**802.8**	**933.8**	**782.7**	**912.2**
SiO_2 ppm		22.6		23.4		23.0		20.6		27.3	23.0			23.0
Total Dissolved Solids, ppm		1,146.0		1,188.9		1,178.7		1,202.2		1,155.7	1,247.1			1,220.9
Total Hardness, ppm, $CaCO_3$		640.0		620.0		613.2		637.4		604.0	668.0			654.0
Alkalinity, ppm $CaCO^3$		454.0		575.4		586.4		584.8		568.0	632.9			626.2
pH		7.0		7.0		7.4		7.4		7.3	7.4			7.5
Conductivity, mμmh		1,400		1,250		1,240		1,240		1,250	1,250			1,200

NOTES
1. Samples taken at 8-hour intervals, August 26 to 29, 1966.
2. Sample No. 7 was invalid.

2. SITE AND ENVIRONS

2.8 Demography

The plant site is located on the alluvial plain of the Missouri River in a predominantly agricultural region roughly ten miles north of the Omaha metropolitan area.

There are no residences within one-half mile of the reactor location. The seven nearest residences are from 3,000 to 4,000 feet distant. These are located generally along Highway 75, the western boundary of the site. There are no schools, hospitals, prisons, or motels/hotels in the immediate vicinity of the site. An industrial park is located north of the plant property. Industries include a large corn processing facility, agricultural fertilizer storage facilities and various other light industrial plants.

The DeSoto National Wildlife Refuge occupies approximately 7,821 acres east of the plant site. This area is open to the public for day use year round. Visitors to the refuge generally use areas from two to five miles from the plant. Estimates by the U.S. Fish and Wildlife Service place annual usage of the facility at approximately 120,000 for the Visitors Center and 400,000 for the refuge. The expected maximum daily usage of the facility has been placed at 2500 visitors for a Winter weekday and 5000 on a Summer weekend. The Boyer Chute Federal Recreation Area is a day use facility occupying approximately 2000 acres southeast of the plant site. Visitors to the recreation area generally use areas seven to ten miles from the plant. The estimates for annual usage of this facility is approximately 50,000 visitors.

The State of Nebraska operates the Fort Atkinson State Historic Park 5.5 miles southeast of the plant site. This day use facility is mostly seasonal and estimates place annual usage at 60,000. The State of Iowa maintains Wilson Island State Park with 275 camping spaces south of the DeSoto National Wildlife Refuge and four miles southeast of the plant site. The estimates for usage of this facility range from 500 on winter weekday to 1000 on a summer weekend.

Two private facilities lie to the north of the plant along the Missouri River. The Cottonwood Cove Marina & RV Resort is located approximately 4.5 miles from the plant. Estimates place summer weekend usage at 200 people. River View Park Resort & Marina is a private campground lying directly to the south of Cottonwood Marina and ranging from 4 to 4.5 miles from the plant. The campground has approximately 235 campsites and is open from April to October.

The nearest municipality is the city of Blair, about three miles northwest, with a population of 7,990 per the 2010 census.

Fort Calhoun is about five miles southeast of the facility. The 2010 census reported a population of 908 in Fort Calhoun and 167 in Kennard Village, about seven miles from the plant site. The 2010 population of Washington County is 20,234.

Missouri Valley, Iowa, about 11 miles east, has a 2010 population of 2,838 as compared to the 2000 population of 2,982. In St. Johns Township, of which the city is a part, population has steadily decreased.

The Omaha metropolitan area includes the cities of Omaha and Council Bluffs, Iowa, and the adjoining areas of Douglas, Washington, and Sarpy Counties, Nebraska, and Pottawattamie County, Iowa. The area lies 10 to 25 miles southeast of the site, with the main concentration of population beyond the 15-mile radius. Population studies have been undertaken by the Metropolitan Area Planning Agency. Population information is as follows:

	Omaha City	Metropolitan Area
1960 U.S. Census	301,598	457,873
1970 U.S. Census	346,929	542,646
1980 U.S. Census	313,911	569,614
1990 U.S. Census	335,795	618,262
2000 U.S. Census	390,007	707,211
2010 U.S. Census	408,958	789,342

Table 2.8-1 - Population Distribution as of 2010

Sector	Direction	Distance From Reactor In Miles/Square Miles of Sector Segment										TOTALS
		0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	
A	N	0	0	0	4	0	53	735	663	3,884	2,558	7,897
B	NNE	0	13	0	8	4	341	489	737	960	3,135	5,687
C	NE	0	0	0	5	21	116	1,163	2,199	1,771	2,350	7,625
D	ENE	0	0	0	0	11	908	4,875	1,007	4,192	5,017	16,010
E	E	0	0	0	0	0	121	907	2,461	3,225	1,733	8,447
F	ESE	0	0	8	0	18	52	1,420	2,626	3,367	1,064	8,555
G	SE	0	26	11	6	296	799	3,775	41,969	3,365	3,111	53,358
H	SSE	17	17	19	239	290	1,366	163,961	161,060	19,892	6,211	353,072
J	S	26	143	57	81	15	753	135,318	146,657	6,722	3,621	293,393
K	SSW	2	12	41	42	303	1,653	48,544	42,387	5,083	6,275	104,342
L	SW	20	49	61	38	80	249	2,182	4,958	6,148	3,915	17,700
M	WSW	0	56	16	353	87	546	1,939	30,475	1,443	1,538	36,453
N	W	10	137	104	139	78	246	682	1,654	1,951	919	5,920
P	WNW	0	2	310	3,361	2,183	290	484	1,798	5,563	2,067	16,058
Q	NW	0	0	245	1,510	203	194	745	1,948	1,678	2,174	6,983
R	NNW	0	0	86	3	34	60	1,972	455	938	3,435	8,697
TOTALS		75	445	958	5,789	3,623	7,747	369,191	443,054	70,182	49,123	950,197

* Based on 2010 U.S. Census Data
Sectors are assigned for 22.5 degree segments starting from 11.25 degrees East of North.

The U.S. Census data shows an increase in population in the Omaha metropolitan area and in most of the nearby cities but a decrease in the rural and farm population. While it is probable that the area around the plant site outside of the Omaha metropolitan area will remain largely agricultural and that the population will increase slowly, a general decline of the rural population will continue, reflecting the movement of people into towns and cities. The expansion of the Omaha metropolitan area has been generally south and westward, coinciding with the interstate highway. It is expected that future growth of the metropolitan area will continue south and west and also northwestward. Thus it is probable that the area surrounding the plant site will continue to remain largely agricultural.

2. SITE AND ENVIRONS

2.9 Land Use

2.9.1 General

The land within 40 miles of the plant site is used primarily for farming with the exception of the heavily industrialized cities of Omaha and Fremont, Nebraska, and Council Bluffs, Iowa.

2.9.2 Agronomy

Table 2.9-1 describes the use of agricultural land in Nebraska of counties within 10 miles of the plant site. Table 2.9-2 summarizes similar information for Iowa. The data are presented on a county basis for each of the two counties in Nebraska and the two counties in Iowa within 10 miles of the site. The data source for both tables is the United States Census of Agriculture, (2002) and the U.S. Census Bureau "State and County QuickFacts" (assorted years).

2.9.3 Industry

The major industrial centers within 40 miles of the plant site are Omaha and Fremont, Nebraska, and Council Bluffs, Iowa. The major industries within a 10 mile radius of the plant site are listed in Table 2.9-3 with firm name, product, number of employees, and direction and distance from the plant site. The sources for information presented in this table are the Nebraska Department of Economic Development Web Site, www.neded.org (Nebraska Manufacturers Arranged by Community, January 2004) and the Blair Area Chamber of Commerce, Blair, Nebraska (2006).

Table 2.9-1 - Agricultural Land Use in Nebraska of Counties Within 10 miles of the Fort Calhoun Station

County	Douglas	Washington
Number of Farms	361	760
Land Area in county, acres	211,827	249,914
Land Area in Farms, acres	94,613	242,419
Land Area in Farms, %	44.7	97.0
Land Use		
Total Cropland, acres	83,096	211,493
Total Harvested Cropland, acres	76,336	194,705
Principal Crops		
Corn for grain, acres	36,520	87,038
Wheat for Grain, acres	121	379
Oats for Grain, acres	233	479
Soybeans for Beans, acres	32,242	87,154
Forage, All Hay and Haylage, acres	5,233	18,689
Livestock		
Cattle and Calves Inventory, number	7,357	32,454
Hogs and Pigs Inventory, number	2,859	42,299
Value of Agricultural Products Sold		
Market Value of Products Sold, $	35,537,000	85,734,000
Crops, $	21,957,000	39,512,000
Livestock, Poultry, and Their Products, $	13,580,000	46,221,000

Table 2.9-2 - Agricultural Land Use In Iowa of Counties Within 10 Miles of the Fort Calhoun Station

County	Harrison	Pottawattamie
Number of Farms	828	1,255
Land Area in county, acres	445,901	610,726
Land Area in Farms, acres	428,235	540,288
Land Area in Farms, %	96.0	88.5
Land Use		
Total Cropland, acres	367,561	487,579
Total Harvested Cropland, acres	337,240	442,923
Principal Crops		
Corn for grain, acres	168,935	218,112
Wheat for Grain, acres	329	91
Oats for Grain, acres	328	1,220
Soybeans for Beans, acres	156,052	205,719
Forage, All Hay and Haylage, acres	10,269	16,632
Livestock		
Cattle and Calves Inventory, number	33,874	63,358
Hogs and Pigs Inventory, number	42,545	55,626
Value of Agricultural Products Sold		
Market Value of Products Sold, $	111,191,000	163,267,000
Crops, $	84,811,000	106,911,000
Livestock, Poultry, and Their Products, $	26,380,000	56,356,000

Table 2.9-3 - Industry Within 10 Miles of Fort Calhoun Station

Firm Name	Product(s)	Direction	Distance	No. of Employees
Ag-Bag Corporation	Plastic Bags for Agricultural Use	WNW	3-1/4	1 to 9
Blair Feed Mill, Inc.	Livestock Feed	WNW	3-1/2	1 to 9
Blair Manufacturing Company	Feed Wagon, Manure Spreader, Elevator, Stalk Chopper and Hay Rakes	WNW	3	100 to 199
Blair Readi-Mix	Ready-Mixed Concrete and Pre-cast Concrete Products	WNW	3-1/2	10 to 24
Carlson's Meats and Lockers	Custom Meat Processing	WNW	3-1/2	1 to 9
Cb Manufacturing, Inc.	Feed Wagons, Spreaders, Livestock Trailers and Rear Mounted Tractor Blades	WSW	7-1/4	1 to 9
Collins Mill	Commercial and Residential Oak Interior Mouldings and Doors	WSW	7-1/4	1 to 9
Concrete Equipment Company, Inc.	Concrete Plants, Bucket Elevators and Screw and Ball Conveyors	WNW	3-1/4	25 to 49
Desoto Engineering	Precision Swiss Automatic Screw Parts and Custom Centerless Grinding	WNW	2-3/4	1 to 9
Enterprise Company	Commercial Printing and Weekly Newspaper	WNW	3-1/2	10 to 24
G & G Manufacturing Company	Threaded Products, Bolts, Nuts, Powdered Metal Chain and Sprockets	ENE	10	1 to 20
Jebco	Truck Cranes, Personnel Lift Derricks, Aerial Platforms and Elevator Belt Conveyors	WNW	3-1/4	10 to 24
P-K Manufacturing Corporation	Lawn, Garden, Turf, Tree and Field Spraying and Fertilizer Application Equipment	SSE	9	25 to 49
Terra Chemicals/Pro-Sil Division	Liquid Silage Actuator, Liquid Clay and Zinc Complex for Fertilizers	WNW	2-3/4	1 to 9
Tri-Matic Equipment Company	Paint Spray Equipment and Booths	SSE	5-1/2	10 to 24
Valley Ready Mix Company	Ready Mixed Concrete	ENE	10	1 to 20
Wilkinson Manufacturing Company	Aluminum Foil Products and Swiss Screw Machine Parts	SSE	5-1/2	100 to 199

2.9.4 Wildlife

2.9.4.1 Fish

The Missouri River supports over fifty different species of fish. The more numerous fishes are minnows, carp, gizzard shad, goldeye and catfishes. There are approximately 160 licensed commercial fishermen who operate in the Sioux City to Platte River area of the Missouri River and their primary catch is in carp and catfish. There is an increasing number of sport fishermen on the river, their largest catch being in carp and catfish.

2.9.4.2 Animals and Birds

Deer, rabbits, squirrels, pheasants and quail are hunted in the area of the plant site. The Desoto National Wildlife Refuge is in a migratory waterfowl flyway and has maximum populations of mallard ducks, snow and blue geese, and Canada geese in the spring and fall. Fur-bearing animals such as the muskrat, beaver, and mink also inhabit the region of the site.

2. SITE AND ENVIRONS

2.10 Environmental Radiation Monitoring

2.10.1 General

The environmental monitoring program is designed to provide data concerning the types and amount of radioactivity present in the environment of the Fort Calhoun Station. The preoperational program was designed to assess environmental conditions before the arrival of fuel. Subsequent analysis during the decommissioning program is being used to demonstrate that plant decommissioning efforts do not have a significant effect on the environment. This program is described and implemented in accordance with the ODCM.

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2.10.2 Preoperational Survey Program

The purpose of the preoperational survey program was to determine the base level of existing radioactivity to which future analytical results can be compared; the program extended for four consecutive years. The monitoring program was developed in cooperation with the regulatory agencies of Nebraska and Iowa and the Fish and Wildlife Service of the United States Government Department of the Interior.

Specific radionuclide and/or gross radioactivity analyses were performed on the selected samples. Table 2.10-1 summarizes the types of samples and analyses included in the preoperational program.

Table 2.10-1 - Gross and Specific Radionuclide Analyses

	Gross α	Gross β-γ	γ-Spec	Sr-90	H-3	K-40	I-131	Cs-137
Surface Water	X	X	X	X		X		
Well Water	X	X	X	X		X		
Mud and Silt	X	X	X					
Aquatic Biota		X	X	X			X	
Milk		X	X	X		X	X	X
Vegetation		X	X	X		X	X	
Air Particulate	X	X	X					
Wildlife	X	X	X	X			X	

*DSAR pages labeled as “ARCHIVED TEXT” are pages with text which is not revised or updated. Information on “ARCHIVED TEXT” pages is A) of historical nature significant to the original licensing basis of the plant **OR** B) not meaningful to update.

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2.10.3 Preoperation Survey Results

2.10.3.1 Trial Monitoring Period

The first nine months of the program, starting in September 1968, was a trial period designed to verify the availability of adequate sample types and to select and test analytical procedures.

Results obtained during the trial period were preliminary. The trial period results are included in this report because they describe the background conditions and illustrated the preoperational surveillance program. No significant peaks were evident in any of the gamma scans performed on samples.

Water

Surface water samples were collected at six stations: one at the Desoto National Wildlife Refuge Lake area and five from the Missouri River at sampling stations located above and below the plant site, including the municipal water supplies at Omaha, Nebraska, and Council Bluffs, Iowa.

Well waters were sampled at eleven wells within a four-mile radius of the plant. Table 2.10-2 is a summary of the surface and well water data.

Table 2.10-2 - Average Radioactivity of Well and Surface Waters
November 1968 - June 1969

Activity Concentration, pc/liter		
	Well Water (11 Samples)	**Surface Water (6 Samples)**
Alpha	0.0	0.7
Beta-Gamma	10.9	26.2
Strontium 90	0.1	1.3
Tritium	550	1000

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Mud and Silt

Mud and silt samples were taken from the Missouri River downstream of the plant. No alpha radiation was detectable; the analysis for beta-gamma gross activity showed 18 picocuries per kilogram for the mud and silt.

Aquatic Biota

The basis for sampling aquatic biota was formulated from specific recommendations of the Nebraska Game, Forestation and Parks Commission. The fish species selected were chosen because their food habits include organisms within many of the lower trophic levels and because they are important from the standpoint of sport and commercial fishing.

The food habits and radioactivity of the fish samples, which were taken from the Missouri River, are shown in Table 2.10-3.

Table 2.10-3 - Food Habits and Radioactivity of Missouri River Fish
October 1968 - June 1969

Specie	Food Habits	(β-γ)-(K-40) nc/kg	K-40 nc/kg	Sr-90 pc/kg
Flathead Catfish #	Fish	3.2	2.6	0.0
Flathead Catfish *	Insects	7.8	10.6	0.0
Channel Catfish #	Fish	3.2	6.7	100.00
Channel Catfish *	Insects	1.6	6.5	0.0
Carp	Omnivorous	8.5	8.4	24.0
Paddlefish	Plankton	---	---	---
Buffalo	Algae and Insects	4.6	9.5	0.0
Shad	Plankton	---	---	---

Greater than 10 inches long
* Less than 10 inches long

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The paddlefish is difficult to collect but was included where possible because it feeds exclusively on plankton; the shad and buffalo with food habits similar to the paddlefish are acceptable substitutes. During its lifetime, the flathead catfish remains within approximately one mile of its origin and is therefore, sampled downstream of the plant site. Catfish and carp are the most abundant of the commercial fish varieties.

The Missouri River has a sand bottom which moves with the water flow; therefore, benthos and other bottom organisms are extremely scarce. Joint efforts with the Nebraska Game Commission to obtain sufficient samples for analysis of periphyton have failed; a cooperative study continues as a separate project.

Milk

Milk from large Grade A milk producers in the local milk shed was sampled in cooperation with the Omaha Douglas County Health Department. The dairy herds of these Grade A milk producers are located downwind of the plant site. Radioactivity levels in the milk samples analyzed are shown in Table 2.10-4.

Table 2.10-4 - Radioactivity in Milk January - March, 1969

	Fresh Milk		**Preserved Milk**		
	I-131 pc/1	**Cs-137 pc/1**	**(β-γ)-(K-40) nc/1**	**K-40 nc/1**	**Sr-90 pc/gm Calcium**
Farm A	0	0	0.53	0.73	1.0
Farm B	0	0	0.81	0.74	1.0
Farm C	0	0	0.71	0.78	0.9

*DSAR pages labeled as “ARCHIVED TEXT” are pages with text which is not revised or updated. Information on “ARCHIVED TEXT” pages is A) of historical nature significant to the original licensing basis of the plant **OR** B) not meaningful to update.

ARCHIVED TEXT

Vegetation

Foods normally consumed by the general population constitute the vegetation samples. Six stations with a total of ten varieties of food were sampled during the 1968 growing season. The variation in analytical results is shown in Table 2.10-5.

Table 2.10-5 - Radioactivity in Vegetation October, 1968

	Maximum nc/kg	**Minimum nc/kg**
Alpha	0.0	0.0
Beta-Gamma minus K-40	14.0	0.3
K-40	39.2	3.2
Sr-90	0.143	0.000
H-3	6	0

Air Particulate

Airborne particulate matter was collected at the plant site on 0.45 micron pore size filters; the filter was removed from the sampler and counted after the radioactivity had decayed for at least seventy-two hours. The air volume passed through the filter was approximately 1,000 cubic feet. None of the 32 samples analyzed showed any indication of alpha activity; the average beta-gamma concentration was 0.26 pc/m^3 with a maximum of 0.78 pc/m^3 and a minimum of 0.08 pc/m^3.

Background radiation readings measured with a Geiger-Mueller survey meter at sixteen stations around the plant site were all in the 0.00-0.02 mr/hr range. Results of the combination film badge-thermoluminescent dosimeters, at eleven stations, were all less than 30 mrem per quarter.

Wildlife

A wild rabbit sample was included to represent wildlife normally consumed in the area. These rabbits are free to wander, but they normally remain in the immediate vicinity. The radioactive content was 20 picocuries of Strontium-90 per gram of calcium in the femur and no iodine-131 was detectable in the thyroid.

ARCHIVED TEXT

2.10.3.2 Preoperational Monitoring Period

Following the trial period, the formal preoperational surveillance monitoring program was started in July, 1969, and continued for three years. This formal preoperational survey was an intensified continuation of the trial period already discussed. The program included soil samples and vegetation which are stored for possible future analyses.

The preoperational program results were documented for future reference and comparison; they defined the pre-operational background levels. Future background conditions may vary due to influences such as fallout from nuclear testing; however, the continuing environmental survey programs will provide adequate data to document changes in the background conditions.

*DSAR pages labeled as "ARCHIVED TEXT" are pages with text which is not revised or updated. Information on "ARCHIVED TEXT" pages is A) of historical nature significant to the original licensing basis of the plant **OR** B) not meaningful to update.

2.10.4 Radiological Environmental Monitoring Program (REMP)

The purpose of the REMP (ODCM Section 5.0) is to provide public assurance that the Fort Calhoun contribution to naturally existing radioactivity is negligible. The program verifies the effectiveness of the waste disposal systems and radiological safety procedures incorporated in the plant.

The Offsite Dose Calculation Manual contains a list of the current types of samples being taken, their location, and sampling frequency.

2. SITE AND ENVIRONS

2.11 Section 2 References

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22. DELETED

23. Safety Evaluation of the Omaha Public Power District Fort Calhoun Station, Unit No. 1, Issue Date: August 9, 1973, Suppl. 1 - April 23, 1973

24. DELETED

25. Environmental Statement Related to Operation of Fort Calhoun Station Unit 1, August 1972

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5. STRUCTURES

5.8 Missile Protection

5.8.1 External Missiles

5.8.1.1 Tornado Generated Missiles

The spectrum of hypothetical missiles used for the ISFSI design basis analysis are described below in Table 5.8-1. The associated design-basis tornado (DBT) characteristics are described below in Table 5.8-3. The criteria shown in Tables 5.8-1 and 5.8-2 are taken from Regulatory Guide (RG) 1.76, Revision 1. Per RG 1.76, Revision 1, Fort Calhoun Station is located in Region I of the United States where at the 10^{-7} per year probability level, the DBT is comprised of 230 mph winds with a concurrent pressure drop of 1.2 psi at a rate of 0.5 psi per second. The horizontal velocity component of tornado generated missiles is applied in all horizontal directions and where applicable, the vertical velocity component is equal to 67% of the horizontal velocity.

Table 5.8-1 - DBT Missile Spectrum and Maximum Horizontal Speeds

Item	Weight (lbs)	Horizontal Velocity (fps)
Sched 40 Pipe (6.625" dia x 15' lg)	287	135
Automobile (16.4'x6.6'x4.3')	4000	135
Solid Steel Sphere (1" dia.)	0.147	26

(Reference: Table 2 of RG 1.76, Revision 1)

Table 5.8-2 - Design Basis Tornado Characteristics

Region	Maximum Wind Speed (mph)	Translational Speed (mph)	Maximum Rotational Speed (mph)	Radius of Maximum Rotational Speed (ft)	Pressure drop (psi)	Rate of Pressure Drop (psi/s)
I	230	46	184	150	1.2	0.5

(Reference: Table 1 of RG 1.76 Revision 1)

The Atomic Energy Commission (AEC) approved Bechtel Topical Report BC-TOP-9A, "Design of Structures for Missile Impacts," Revision 2, which was used to evaluate the spectrum of missiles described in Table 5.8-1 against the SSCs to which they are being applied. (Reference 5-16)

RG 1.76 Revision 1 and Bechtel Topical Report BC-TOP-9A, Revision 2, comprise the methodology used to assess structures, systems and components for the DBT and associated missile impacts.

12. CONDUCT OF OPERATIONS

12.1 Organization and Responsibility

Station organization is described in NO-FC-10, Quality Assurance Topical Report (QATR) and in site administrative procedures and organizational charts.

12. CONDUCT OF OPERATIONS

12.2 Training

Station training requirements are located in NO-FC-10, Quality Assurance Topical Report (QATR) and in site administrative procedures.

12. CONDUCT OF OPERATIONS

12.3 Written Procedures

Station written procedures requirements are located in NO-FC-10, Quality Assurance Topical Report.

12. **CONDUCT OF OPERATIONS**

12.4 Records

Station records requirements are located in NO-FC-10, Quality Assurance Topical Report (QATR) and in site administrative procedures.

12. CONDUCT OF OPERATIONS

12.6 Site Emergency Plan

The ISFSI Only Emergency Plan (IOEP) requirements, as submitted to the NRC, are located in the IOEP.

12. CONDUCT OF OPERATIONS

12.7 Plant Security

The ISFSI Security Plan requirements, as submitted to the NRC, are located in the Security Plan.

APPENDIX A

1.0 INTRODUCTION

OPPD has ultimate responsibility for assuring that the Fort Calhoun Station is designed, maintained, tested, and operated in compliance with applicable regulations, codes, and standards and in a manner to protect the health and safety of the public. In meeting this responsibility, a Quality Assurance program has been established and implemented which complies with the provisions of:

a. Title 10, Code of Federal Regulations Part 50 Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants", and

b. Applicable sections of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.

CRITERION 5 - RECORDS REQUIREMENT

Records of the design, fabrication, and construction of essential components of the plant shall be maintained by the reactor operator or under its control throughout the life of the reactor.

This criterion is met [(2)]. The Omaha Public Power District (OPPD) is the owner and operator of Fort Calhoun Station, Unit No. 1 (FCS). The Omaha Public Power District will maintain records of the design, fabrication, and construction of essential components of FCS.

Due to Decommissioning OPPD has sought and received an exemption to records retention as follows:

The Commission hereby grants OPPD's partial exemptions from 10 CFR part 50, appendix B, Criterion XVII; 10 CFR 50.59(d)(3); and 10 CFR 50.71(c) to advance the schedule to remove records associated with Structure, System, or Components (SSC) that have been removed from the NRC's licensing basis documents by appropriate change mechanisms.

Records associated with residual radiological activity and with programmatic controls necessary to support decommissioning, such as security and quality assurance, are not affected by the exemption request because they will be retained as decommissioning records until the termination of the FCS license. Also, the licensee did not request an exemption associated with any other record keeping requirements for the storage of spent fuel at its ISFSI under 10 CFR 50 or the general license requirements of 10 CFR 72. No exemption was requested from the decommissioning records retention requirements of 10 CFR 50.75, or any other requirements of 10 CFR 50 applicable to decommissioning and dismantlement.

(2) Exemptions are from NRC-17-063, dated October 4, 2017.

CRITERION 17 - MONITORING RADIOACTIVITY RELEASES

Means shall be provided for monitoring the containment atmosphere, the facility effluent discharge paths, and the facility environs for radioactivity that could be released from normal operations, from anticipated transients and from accident conditions.

This criterion is met.

Plant gaseous effluents are vented to the atmosphere. Particulate monitoring of gaseous effluent is accomplished by filter air samplers.

Plant liquid effluents are monitored during release.

The above monitors are capable of detecting radioactivity released from the site to ensure the ODCM requirements are met.

CRITERION 18 - MONITORING FUEL AND WASTE STORAGE

Monitoring and alarm instrumentation shall be provided for fuel and waste storage and handling areas for conditions that might contribute to loss of continuity in decay heat removal and to radiation exposures.

This criterion is met. Area monitoring of dose rates is supplied in the waste storage areas as required by the Radiation Protection Program which includes the use of local alarms and indicators.

CRITERION 68 - FUEL AND WASTE STORAGE RADIATION SHIELDING

Shielding for radiation protection shall be provided in the design of spent fuel and waste storage facilities as required to meet the requirements of 10 CFR 20.

This criterion is met.

The liquid waste disposal equipment is built to industry code standards.

Solid wastes are collected and may be stored in a shielded area if radioactivity levels are high. Spent resins are placed in a shipping container and stored in a shielded area.

All spent fuel is stored in the ISFSI. All storage requirements are met as described in the 10 CFR 72.212 evaluation report. Station Greater Than Class “C” (GTCC) waste can also be stored in the ISFSI.

The shielding for radiation protection meets the requirements of 10 CFR 20 for all waste storage areas.

CRITERION 69 - PROTECTION AGAINST RADIOACTIVITY RELEASE FROM SPENT FUEL AND WASTE STORAGE

Containment of fuel and waste storage shall be provided if accidents could lead to release of undue amounts of radioactivity to the public environs.

This criterion is met.

There are no accidents or events remaining that could exceed offsite limits.

Other areas where waste is stored include the independent spent fuel storage installation (ISFSI), which is located at the north end of the site, in the ISFSI Protected Area.

All spent fuel is stored in the ISFSI. All storage requirements are met as described in the 10 CFR 72.212 evaluation report. Station GTCC waste can also be stored in the ISFSI.

Waste processing equipment is designed for packaging, storage and transport of low-level radioactive wastes. This provides control to maintain releases within ODCM and PCP requirements.

CRITERION 70 - CONTROL OF RELEASE OF RADIOACTIVITY TO THE ENVIRONMENT

The facility design shall include those means necessary to maintain control over the plant radioactive effluents, whether gaseous, liquid, or solid. Appropriate holdup capacity shall be provided for retention of gaseous, liquid, or solid effluents, particularly where unfavorable environmental conditions can be expected to require operational limitations upon the release of radioactive effluents to the environment. In all cases the design for radioactivity control shall be justified (a) on the basis of 10 CFR 20 requirements for normal operations and for any transient situation that might reasonably be anticipated to occur and (b) on the basis of 10 CFR 100 dosage level guidelines for potential reactor accidents of exceedingly low probability of occurrence except that reduction of the recommended dosage levels may be required where high population densities or very large cities can be affected by the radioactive effluents.

This criterion is met [(3)].

All release events are bounded within 10 CFR 20 limits with reliance on SSCs.

The liquid wastes are collected, treated (filtration or demineralization) as appropriate, and analyzed prior to release. A radiation monitor, monitors all liquid discharges of radioactive waste. The effluent discharge, when diluted, will not exceed requirements of 10 CFR 20 as described in the ODCM.

Space for storage of the solid wastes is provided so that packaging, handling and shipping can be carried out under favorable environmental conditions. All solid waste will be monitored, labeled, packaged and handled according to applicable regulations.

Gaseous wastes are no longer stored. All waste gas is vented and monitored during release.

(3) Amendment No. 299 removed the requirements of 10 CFR 100 for reactor accident dose analysis at the decommissioning site.