NEXTera ENERGY
DUANE ARNOLD

February 5, 2021

NG-21-0004
10 CFR 50.82

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Duane Arnold Energy Center
Renewed Facility Operating License No. DPR-49
Docket No. 50-331

Response to Request for Additional Information Related to Post Shutdown Decommissioning Activities Report

References:
1. Letter from NEDA (D. Curtland) to USNRC, " Post Shutdown Decommissioning Activities Report," NG-20-0027, dated April 2, 2020 (ML20094F603)
2. FINAL RAI – Duane Arnold – Post-Shutdown Decommissioning Activities Report (EPID No. L-2020-LLL-0005), dated January 6, 2021 (ML21006A405)

NextEra Energy Duane Arnold, LLC (NEDA) submitted a Post Shutdown Decommissioning Activities Report (PSDAR) for the Duane Arnold Energy Center (Reference 1). Subsequently, the NRC Staff requested additional information regarding that submittal (Reference 2). The enclosure to this letter contains the requested information.

This letter makes no changes to existing commitments and makes no new commitments. If you have any questions regarding this matter, please contact Michael Davis, Licensing Manager at 319-851-7032.

P Hansen

Paul Hansen
Decommissioning Director, Duane Arnold Energy Center
NextEra Energy Duane Arnold, LLC

Enclosure

cc: Regional Administrator, USNRC, Region III
Project Manager, USNRC, Duane Arnold Energy Center
Inspector, USNRC, Duane Arnold Energy Center
A. Leek (State of Iowa)

REQUEST FOR ADDITIONAL INFORMATION

RELATED TO POST-SHUTDOWN DECOMMISSIONING ACTIVITIES REPORT

NEXTERA ENERGY DUANE ARNOLD, LLC

DUANE ARNOLD ENERGY CENTER

DOCKET NO. 50-331

INTRODUCTION

By letter dated April 2, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20094F603), NextEra Energy Duane Arnold, LLC (NEDA), submitted a Post-Shutdown Decommissioning Activities Report (PSDAR) for Duane Arnold Energy Center (DAEC). NEDA submitted the PSDAR pursuant to Title 10 of the Code of Federal Regulations (10 CFR), Section 50.82(a)(4). NEDA developed the DAEC PSDAR using the Regulatory Guide 1.185, Revision 1, "Standard Format and Content for Post-Shutdown Decommissioning Activities Report" (ADAMS Accession No. ML13140A038). The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing the PSDAR and has determined that the following additional information is required in order to complete the review.

**RAI-NMSS**

Applicable Regulation and Guidance

The regulation 10 CFR 50.82(a)(4)(i) states that the licensee shall submit a PSDAR to the NRC that includes "a discussion that provides the reasons for concluding that the environmental impacts associated with site-specific decommissioning activities will be bounded by appropriate previously issued environmental impact statements." The regulation 10 CFR 50.82(a)(6) states, in part, that "[l]icensees shall not perform any decommissioning activities ... that ... [r]esult in significant environmental impacts not previously reviewed ...." In NUREG-0586, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors," the NRC evaluated the environmental impacts during the decommissioning of nuclear power reactors. The Decommissioning GEIS (NRC 2002) concludes that:

> For those issues that have been determined to be generic, licensees may proceed with the decommissioning activity without further analysis provided that the impacts resulting from those activities fall within the range of impacts as described in Chapter 4. However, if the impacts of an activity fall outside the range predicted in Chapter 4, or if the activity results in impacts to environmental issues not considered in this Supplement, or if the impact involves an environmental issue determined to be conditionally site-specific as defined above, then the activity cannot be performed until a further site-specific analysis is completed along with a license-amendment request and NRC has approved the license amendment (the license amendment request will provide an opportunity for a public hearing).

**Environmental Justice (EJ)**

**RAI-NMSS-EJ-1**

The environmental justice impact analysis, in the DAEC PSDAR, does not adequately explain the reason for concluding the impacts of decommissioning activities would be bounded by the Decommissioning GEIS, NUREG-0586 (NRC 2002). In PSDAR Section 5.1.13 "Environmental Justice," the licensee concludes

"...that the impacts of DAEC decommissioning on environmental justice are small and are bounded by the GEIS." Unfortunately, the Decommissioning GEIS does not provide a generic impact determination for the environmental justice issue. The evaluation of environmental justice impacts in the Decommissioning GEIS, states that "the adverse impacts and associated significance of the impacts must be determined on a site-specific basis." (See Decommissioning GEIS Section 4.3.13.4, Conclusions, page 4-65). The Decommissioning GEIS also states, "Subsequent to the submittal of the PSDAR, the NRC staff will consider the impacts related to environmental justice from decommissioning activities."

The licensee's PSDAR Section 5.1.13, "Environmental Justice," provides a few brief statements regarding potential impacts to minority and low-income populations, including land use, human health, environmental, and socioeconomic effects. The analysis relies on radiological environmental monitoring program data and environmental justice impact conclusions for the continued operation of DAEC from the October 2010 license renewal SEIS (NUREG-1437, Supplement 42, Duane Arnold Energy Center, October 2010). However, the normal reactor operations activities at DAEC addressed in the October 2010 license renewal SEIS do not consider the effects of major decommissioning activities (i.e., dismantlement and decontamination of the containment structure).

In addition, Section 4.3.13.2, "Potential Impacts of Decommissioning Activities on Environmental Justice," (page 4-64) of the Decommissioning GEIS states:

> [D]ecommissioning activities that may affect environmental justice are related to organizational or staffing changes and offsite transportation issues.... Any decommissioning activity that results in a disproportionate share of the negative environmental consequences to minority or low-income groups has the potential to be an adverse environmental justice impact.

The Decommissioning GEIS goes on to state:

> Detectability and destabilization, as they relate to environmental justice, must be defined in proportion to the minority and low-income populations that reside in the area of the power plant. Proportionment must be determined at each site at the time of decommissioning.

The licensee's analysis in the PSDAR does not address proportionment at the time of decommissioning and is silent on the potential impacts of dismantlement and decontamination activities on minority and low-income populations living near DAEC.

a. In accordance with 10 CFR 50.82(a)(4)(i) and 10 CFR 50.82(a)(6)(ii), explain the reasons for concluding that the environmental justice impacts associated with site-specific decommissioning activities will (or will not) be bounded by appropriate previously issued environmental impact statements.

b. In addition, provide a more up-to-date environmental justice demographic analysis (i.e., using data from the 2010 census) on site-specific human health and environmental effects from dismantlement and decontamination activities, including offsite transportation issues associated with the delivery of dismantlement equipment and the removal of waste material, on minority and low-income populations living near DAEC.

DAEC Response

DAEC has revised the Section 5.1.13 to include a summary statement for the 2019 REMP Report, and to remove the statement of being bounded by the GEIS and replace it with a reference to the SEIS analysis and conclusions. Additional explanation was added to support the conclusion that the SEIS would bound decommissioning activities.

A discussion of how the 2010 census data compared to the 2000 census data was added to show the conclusions of the SEIS were still valid in determining the effects of decommissioning. The revised PSDAR is attached.

**Historic and Cultural Resources (HC)**

**RAI-NMSS-HC-1**

Section 5.1.14 of the PSDAR provides an analysis of potential impacts to cultural, historic, and archeological resources. In the PSDAR, NEDA indicates that decommissioning activities at DAEC would be confined to the operational area, and because this area was degraded during site construction, no impact to cultural, historical, or archeological resources would be anticipated. NEDA further acknowledges that the SEIS for DAEC license renewal (NUREG-1437, Supplement 42) determined that potential impacts to historic and archaeological resources were possible due to the potential richness of archaeological resources on the DAEC property. The PSDAR states that NEDA has, accordingly, coordinated with the Iowa State Historic Preservation Officer (SHPO) to develop and maintain excavation and trenching procedures for the DAEC which address potential impacts to both known and undiscovered resources.

However, NEDA did not indicate in the PSDAR whether they considered the DAEC nuclear facility itself eligible for inclusion on the National Register of Historic Places or Historic American Engineering Record. There is also no indication that NEDA had contacted the SHPO regarding this matter.

Section 4.3.14.2 of the decommissioning GEIS (page 4-67) states:

> In a few situations, the nuclear facility itself could be potentially eligible for inclusion in the National Register of Historic Places, especially if it is older than 50 years and represents a significant historic or engineering achievement. In this case, appropriate mitigation would be developed in consultation with the SHPO [State Historic Preservation Officer]. Even for buildings that are less than 50 years old, the processes and engineering that were employed may be of interest and may be eligible for the Historic American Engineering Record.

In order to remain in compliance with the National Historic Preservation Act, the NRC is required to take into account the effects of its undertakings on historic properties (see "Protection of Historic Properties" regulations, 36 CFR 800). Under these regulations, the NRC staff's review of the PSDAR may be considered an undertaking "activity" (see 36 CFR 800.16(y)).

According to Protection of Historic Properties regulations in 36 CFR 800.4(a)(2), Identification of historic properties, in consultation with the SHPO, the NRC is required to "Review existing information on historic properties within the area of potential effects, including any data concerning possible historic properties not yet identified." In addition, according to 36 CFR 800.4(a)(3), the NRC must "Seek

information, as appropriate, from consulting parties, and other individuals and organizations likely to have knowledge of, or concerns with, historic properties in the area, and identify issues relating to the undertaking's potential effects on historic properties...."

Regulations in 36 CFR 800.4(c)(1) state:

> In consultation with the SHPO...the agency official shall apply the National Register criteria (36 CFR part 63) to properties identified within the area of potential effects that have not been previously evaluated for National Register eligibility.

If requested by the Iowa SHPO, an eligibility determination for NRHP listing status would need to be conducted by a professional that meets the Secretary of the Interior's standards in 36 CFR 61. A professional, experienced in conducting Historic American Building Surveys, would also be needed to determine the eligibility of listing DAEC in the Historic American Engineering Record.

- In light of these considerations, does NEDA plan to determine, in consultation with the Iowa SHPO, the current eligibility status of the DAEC facility itself for inclusion in the National Register of Historic Places or Historic American Engineering Record, and, if required, identify appropriate mitigation measures (e.g., preservation of historic information and data) potentially resulting from this consultation?

DAEC Response

DAEC will determine, in consultation with the Iowa SHPO, the eligibility status of the DAEC facility for inclusion in the National Register of Historic Places or Historic American Engineering Record identify appropriate mitigation measure, if required. DAEC has added a discussion in Section 5.1.14 stating that it will consult with the Iowa SHPO to determine any historical impacts of decommissioning.

**Special Status Species and Habitats (SSSH)**

**RAI-NMSS-SSSH-1**

Table 5.1, "State and Federally Listed Species Potentially Occurring in the Vicinity of DAEC," of the PSDAR identifies several federally listed species that occur within the vicinity of DAEC, including the Higgin's-eye pearly mussel (*Lampsilis higginsii*) and northern long-eared bat (*Myotis septentrionalis*). However, Section 5.1.7, "Threatened and Endangered Species," does not sufficiently analyze how or whether these species would be affected by decommissioning activities.

a. Explain more fully how decommissioning activities may affect northern long-eared bats in the area by assessing all possible effects and forms of take that may occur during the decommissioning period. For instance, impacts to bats may result from:
   - mortality or injury from collisions with plant structures, equipment, or vehicles;
   - habitat loss, degradation, disturbance, or fragmentation, and associated effects; and
   - behavioral changes resulting from noise, lighting, and other factors associated with decommissioning activities.

   The above list is not comprehensive, and other effects may be relevant for the assessment.

b. Explain more fully how decommissioning activities may affect Higgin's-eye pearly mussels in the area by assessing all possible effects and forms of take that may occur during the decommissioning period. For instance, impacts to mussels may result from:
   - mortality or injury during cooling water intake and discharge structure dismantlement;
   - habitat loss, degradation, or disturbance, or fragmentation associated with in-water work; and
   - mortality, injury, or habitat effects resulting from dredging.

   The above list is not comprehensive, and other effects may be relevant for the assessment.

c. Has NEDA identified any known occurrences of the three federally listed plants—prairie bush clover (*Lespedeza leptostachya*), eastern prairie fringed orchid (*Platanthera leucophaea*), and western prairie fringed orchid (*Platanthera praeclara*)—on the DAEC site? If so, provide a species-specific assessment of the potential effects of decommissioning.

d. If adverse effects or incidental take of any federally listed species is possible, explain how NEDA would obtain the necessary permits under either the Endangered Species Act (ESA) Section 7 or ESA Section 10 to exempt such take during the decommissioning period.

DAEC Response

NEDA has revised section 5.1.7, "Threatened and Endangered Species", to include a discussion of how DAEC decommissioning will affect these species. During the dormancy period, there will be little impact to species, given the activity at the site will be much less than that during plant operation. Prior to conducting any significant dismantling or disassembly, NEDA will assess threatened and endangered species at that time to ensure a contemporary status of species that could be impacted is considered. NEDA will comply with regulations on threatened and endangered species when conducting decommissioning activities.

**Water Resources (WR)**

**RAI-NMSS-WR-1**

Neither the PSDAR's discussion of decommissioning costs summarized in Table 2.2 (and discussed in Section 4) nor the Decommissioning Cost Estimate (DCE) included as Attachment 1 to the PSDAR appear to account for costs associated with groundwater remediation during the decommissioning period. Section 5.0 of the DCE states that "No known areas of radiologically contaminated soil have been identified...documented tritium levels in groundwater are below drinking water standards. Therefore, no soil or groundwater remediation costs will be assumed." However, NEDA states in Section 2.3.6 (pages 17-18) of the PSDAR that "[i]n 2012, measurable amounts of tritium began to be detected in some of the groundwater monitoring wells in an area immediately adjacent to the south side of the Turbine and Reactor buildings, continuing for a short distance to the southeast on the plant property. This area has been and continues to be mitigated through mitigation wells." The PSDAR further states that tritium mitigation is not expected to be required at the end of the SAFSTOR period. Still, the PSDAR provides no timeframe when groundwater remediation would be completed.

In addition, NEDA's 2018 Annual Radiological Environmental Operating Report (NEDA 2019) includes sampling results from the groundwater protection program where seven (7) on-site wells completed in

the shallow aquifer exceeded the drinking water standard for tritium (20,000 pCi/L). Samples that exceeded the standard for tritium, ranged in concentration from 20,346 to 290,512 pCi/L. NEDA's 2019 annual report (NEDA 2020a) indicates that tritium concentrations continued to exceed the standard in several monitoring wells in 2019, up to a maximum of 95,396 pCi/L. As discussed in the 2019 Annual Radioactive Material Release Report (Section 2.8, p. 15), since early February 2017, NEDA has operated groundwater extraction wells to continuously remove tritiated groundwater from the shallow aquifer. The extracted groundwater is diluted and then discharged to the Cedar River as a permitted release (NEDA 2020b).

During decommissioning, the NRC will need to evaluate on-site and any off-site groundwater contamination against drinking water standards (Maximum Contaminant Levels – MCLs), as prescribed in the Memorandum of Understanding between the EPA and NRC (EPA and NRC 2002). The NRC's regulations at 10 CFR 20.1406(c), "Minimization of Contamination," and 10 CFR 20.1501(a), "General," prescribe additional requirements with respect to the disposition of radiological releases at decommissioning sites.

- Consider providing an update to the DCE and associated summary that accounts for the costs for ongoing remediation of the shallow aquifer to MCLs, or below. Otherwise, provide an explanation beyond the current statements in the PSDAR for why such costs should not be considered.

DAEC Response

NEDA installed the current tritium monitoring and mitigation system in 2016 during plant operation. Therefore, the significant financial outlay of installation did not affect the DCE. The costs going forward of maintaining the system during decommissioning are relatively insignificant and are reflected in the DCE as part of energy and maintenance costs. Therefore, NEDA does not plan to update the DCE with ongoing maintenance costs of the system.

**RAI-NMSS-WR-2**

As referenced in RAI-NMSS-WR-1, NEDA's PSDAR states that tritium was detected in shallow groundwater in the 2012 timeframe. The most recent available groundwater protection program monitoring data indicate the presence of a contaminant plume (tritium) in the shallow aquifer (less than 25 feet deep) and moving toward the Cedar River. This plume was reportedly first identified in February 2016, as indicated in the 2019 annual report (NEDA 2020a) (see Section 4.3 and Appendix D). Since February 2017, NEDA has operated a groundwater extraction, treatment (dilution), and disposal system to address tritiated groundwater in the shallow aquifer.

Two near surface aquifers underlie most of the site area, an upper water table aquifer and a lower artesian aquifer in weathered rock. These aquifers are separated by a relatively impervious clay aquiclude (FPL Energy 2008). As has been seen with other reactor sites with groundwater contamination, the potential exists for the engineered backfill beneath the DAEC nuclear island and other engineered structures to provide a preferential flow path for groundwater contamination from the shallow (water table) aquifer to the underlying artesian aquifer.

The environmental impact of the inadvertent release of radionuclides at the DAEC site and ongoing groundwater remediation activities during decommissioning on water quality (surface and groundwater) and water use have not previously been considered.

The Decommissioning GEIS (NRC 2002) does not generically consider the environmental impacts of inadvertent releases of radionuclides to groundwater and the associated operational impacts of groundwater remediation systems during the decommissioning of a nuclear reactor site. Additionally, the inadvertent release from DAEC was discovered after the NRC prepared its license renewal SEIS in 2010 (NRC 2010). NEDA initiated groundwater remediation in 2017. The staff does not know of any environmental impacts statements that have evaluated these activities and impacts. Therefore, the environmental impacts of the inadvertent release of radionuclides have not been previously been considered and further that the PSDAR does not show that site-specific decommissioning activities with respect to ongoing groundwater remediation will be bounded, as specified in 10 CFR 50.82(a)(4)(i).

Address or provide the following, and include or reference supporting analyses in the response:

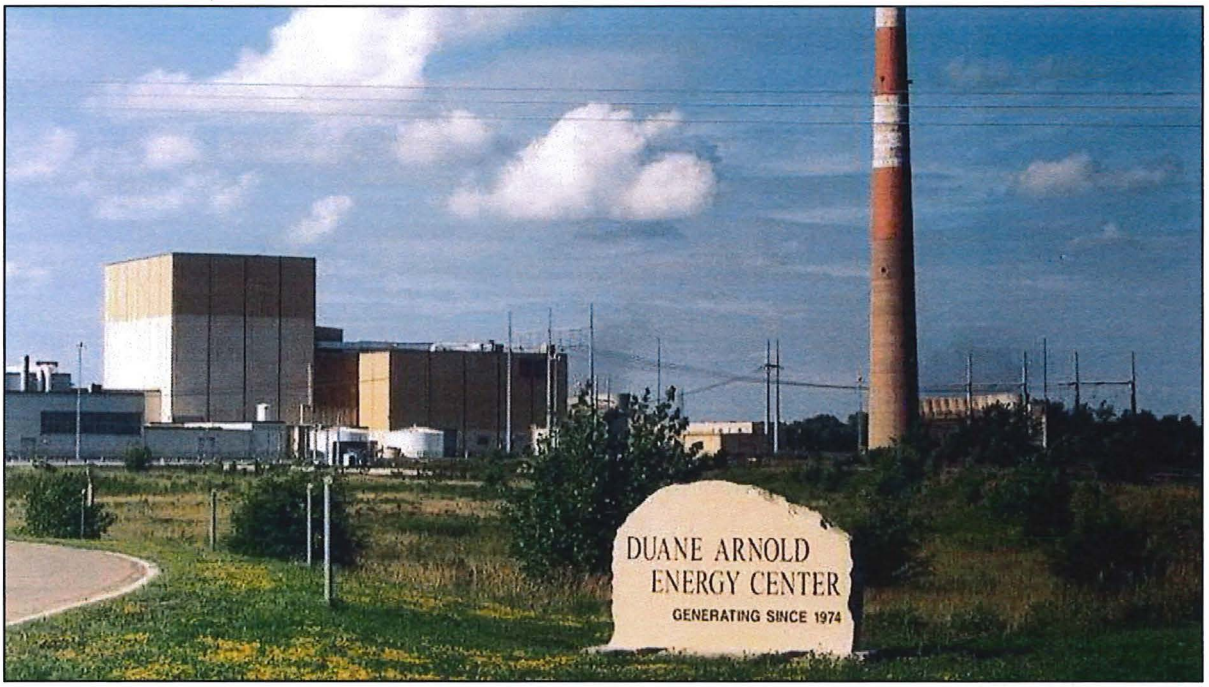
a. Identify the source(s) of the inadvertent releases of radionuclides to site groundwater;
b. Address whether the releases have been stopped and, if so, describe the corrective actions taken (include dates);
c. If the source(s) of the inadvertent releases have not been stopped, describe whether and for how long such releases may be likely to continue into the decommissioning period;
d. Provide an analysis of the impacts of the inadvertent release of radionuclides from DAEC on the shallow aquifer and underlying artesian aquifer. This analysis should characterize the extent and magnitude of current contamination in the water table aquifer and in the underlying artesian aquifer, if any.
e. Provide an evaluation of the impacts of ongoing groundwater plume remediation on groundwater and surface water quality and use (i.e., extraction system withdrawals); and
f. Provide an estimate or projection of when groundwater remediation will be completed and describe the cleanup standards to be achieved.

DAEC Response

NEDA has revised Section 2.3.6 of the PSDAR to include the specific information requested for ongoing groundwater remediation. The revision includes statements that the source of radionuclides was identified and stopped. The releases have also been confined to the shallow aquifer on-site with no impacts to ground or surface water offsite. The cleanup standards will be that for unrestricted use under 10 CFR 20.1402. The supporting analysis for the information in this section is contained in Apparent Cause Evaluation 2116760, "Entry into ODAM LCO" and Radiation Safety & Control Services Technical Support Document No. 16-046, "DAEC Numerical Fate and Transport Groundwater Modeling to Support Tritium Contamination Remediation".

Additional Revisions

Due to permanently shutting down the DAEC earlier than the originally planned date of October 30, 2020, NEDA has revised the decommissioning schedule in Table 2.1. This reflects the actual shutdown date of August 10, 2020 and completion of defueling in October 2020. The subsequent schedule milestone dates were revised to reflect the actual shutdown and defueling dates that have occurred. References to the decommissioning timeline in Sections 1.2 and 2.1 were also revised to correspond with the schedule changes. The PSDAR, Revision 1, dated February 2, 2021 is attached.




# POST-SHUTDOWN DECOMMISSIONING ACTIVITIES REPORT

DUANE ARNOLD ENERGY CENTER

Revision 1, February 2, 2021

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**List of Attachments**

# ACRONYMS

| | |
|---|---|
| ALARA | As Low As Reasonably Achievable |
| D&D | Decontamination and Dismantlement activities |
| DAEC | Duane Arnold Energy Center. Also see NEDA. |
| DCE | Decommissioning Cost Estimate |
| DOE | Department of Energy |
| DTF | Decommissioning Trust Fund |
| EPA | Environmental Protection Agency |
| FSS | Final Status Survey, also referred to as Final Status (radiation) Survey |
| GEIS | Generic Environmental Impact Statement (NUREG-0586) |
| GTCC | Greater Than Class C (waste) |
| GW | Ground Water |
| ISFSI | Independent Spent Fuel Storage Installation |
| LLRW | Low Level Radioactive Waste |
| LLRWSF | Low Level Radioactive Waste Storage Facility |
| LTP | License Termination Plan |
| MARSSIM | Multi-Agency Radiation Survey and Site Investigation Manual |
| NEDA | NextEra Energy Duane Arnold, LLC. Also see DAEC. |
| NEI | Nuclear Energy Institute |
| NRC | Nuclear Regulatory Commission |
| ODAM | Offsite Dose Assessment Manual |
| OSHA | Occupational Safety and Health Administration |
| REMP | Radiological Environmental Monitoring Program |
| SAFSTOR | Safe Storage |
| SEIS | Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437), Supplement 42, "Regarding Duane Arnold Energy Center" (referred to as the "Supplemental Environmental Impact Statement") |
| SHPO | State Historical Preservation Office |
| TS | Technical Specifications |
| UFSAR | Updated Final Safety Analysis Report |

# 1.0 INTRODUCTION AND SUMMARY

## 1.1 INTRODUCTION

In accordance with the requirements of Title 10 of the Code of Federal Regulations (CFR) 50.82, "Termination of license," paragraph (a)(4)(i), this report constitutes the Post-Shutdown Decommissioning Activities Report (PSDAR) for the Duane Arnold Energy Center (DAEC). This PSDAR contains the following:

1. A description of the planned decommissioning activities along with a schedule for their accomplishment.

2. A discussion that provides the reasons for concluding that the environmental impacts associated with site-specific decommissioning activities will be bounded by appropriate previously issued environmental impact statements.

3. A site-specific decommissioning cost estimate (DCE), including the projected cost of managing irradiated fuel and the post-decommissioning site restoration cost.

The PSDAR has been developed consistent with Regulatory Guide 1.185, "Standard Format and Content for Post-Shutdown Decommissioning Activities Report," (Reference 1). This report is based on currently available information and the plans discussed herein may be modified as additional information becomes available or conditions change. As required by 10 CFR 50.82(a)(7), NextEra Energy Duane Arnold (NEDA) will notify the Nuclear Regulatory Commission (NRC) in writing, with copies sent to the State of Iowa, before performing any decommissioning activity inconsistent with, or making any significant schedule change from, those actions and schedules described in the PSDAR, including changes that significantly increase the decommissioning cost.

## 1.2 BACKGROUND

DAEC is located adjacent to the Cedar River approximately 2.5 miles northeast of the town of Palo, Iowa. The closest major city is Cedar Rapids with its outer boundary 8 miles to the southeast. The site, containing approximately 500 acres, is entirely owned by NEDA.

DAEC employs a General Electric boiling water reactor nuclear steam supply system licensed to generate 1,912 megawatts - thermal (MWth). The principal structures of DAEC are the reactor and turbine buildings, radwaste building, low-level radwaste storage facility, intake structure, switchyard, offgas stack, pump house, cooling towers, and administration buildings.

On January 27, 2006, FPL Energy Duane Arnold, LLC (a wholly owned subsidiary of FPL Energy) purchased 70% ownership of DAEC from Interstate Power & Light company. Operating authority was also transferred from Nuclear Management Company to FPL Duane Arnold, LLC. On April 16, 2009, the name "FPL Energy Duane Arnold, LLC" was legally changed to "NextEra Energy Duane Arnold, LLC." The current operating license for DAEC will expire on midnight February 21, 2034.

On July 27, 2018, NextEra Energy Duane Arnold (NEDA) announced its plans to cease operation of DAEC in the fourth quarter of 2020. On January 18, 2019, NEDA formally notified the Nuclear Regulatory Commission of its intent to cease operation (Reference 2). The shutdown schedule was later revised to a permanent shutdown date of August 10, 2020 due to storm damage incurred at the site.

## 1.3 SUMMARY OF DECOMMISSIONING ALTERNATIVES

The NRC has evaluated the environmental impacts of three general methods for decommissioning power reactor facilities in NUREG-0586, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors," (GEIS) (Reference 3). The three general methods evaluated are summarized as follows:

- DECON: The equipment, structures and portions of the facility and site that contain radioactive contaminants are promptly removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.

- SAFSTOR: After the plant is shut down and defueled, the facility is placed in a safe, stable condition and maintained in that state (safe storage). The facility is decontaminated and dismantled at the end of the storage period to levels that permit license termination. During SAFSTOR, a facility is left intact or may be partially dismantled, but the fuel is removed from the reactor vessel and radioactive liquids are drained from systems and components and then processed. Radioactive decay occurs during the SAFSTOR period, thereby reducing the quantity of contamination and radioactivity that must be disposed of during decontamination and dismantlement.

- ENTOMB: Radioactive structures, systems and components (SSCs) are encased in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level that permits termination of the license.

# 2.0 DESCRIPTION OF PLANNED DECOMMISSIONING ACTIVITIES

## 2.1 DETAILED DESCRIPTION

NEDA commenced decommissioning of the DAEC after final plant shutdown on August 10, 2020. A list of milestone events in the decommissioning process is shown in Table 2.1. NEDA currently plans to decommission the DAEC using the SAFSTOR method. SAFSTOR is broadly defined in Section 1.3 of this report. Use of the SAFSTOR method will include management of the spent fuel on site. This is necessary because the DOE has not, yet, met its obligations to remove and take possession of the spent fuel. To explain the basis for projecting the cost of managing spent nuclear fuel, a discussion of spent fuel management activities for the site is included herein.

The initial decommissioning activities to be performed after plant shutdown will entail preparing the plant for a period of safe-storage (also referred to as dormancy). This will include de-fueling the reactor and transferring the fuel into the Spent Fuel Pool; draining fluids and de-energizing systems; reconfiguring the electrical distribution, ventilation, heating, and fire protection systems; and minor deconstruction activities. Systems needed for continued operation of the Spent Fuel Pool may be reconfigured for operational efficiency. The dormancy period will begin when the buildings and systems have been sufficiently prepared for long-term safe storage and all spent fuel has been transferred to the Independent Spent Fuel Storage Installation (ISFSI) for dry storage.

During dormancy, the DAEC will be staffed with personnel that will monitor, maintain, and provide security for the ISFSI and plant facilities. Staffing and configuration requirements are expected to change during the phases of the decommissioning process for transitioning to dormancy. The required staffing levels during this transition period are principally dependent upon the status of the spent fuel being stored on-site. This can be characterized as one of three spent fuel conditions, as follows:

- Wet and dry storage of spent fuel
- On-site dry storage of all spent fuel
- No fuel on site

Spent fuel will remain in the Spent Fuel Pool until it meets the criteria for transfer, and the spent fuel can be transferred in an efficient manner to the ISFSI. After all fuel has been transferred to the ISFSI, the pool and supporting systems will be drained and de-energized for the remainder of the dormancy period. The spent fuel will be stored in the ISFSI until transfer to the DOE.

Decontamination and dismantlement (D&D) activities will be scheduled to enable the license to be terminated within 60 years after permanent cessation of operations. Following completion of the D&D activities and termination of the NRC license, site restoration will be performed to a condition such that the site may be re-used for beneficial purposes.

For the purposes of a current decommissioning cost estimate, it is assumed that remaining structures are to be demolished and the site restored to an appropriately graded and vegetated condition (green field).

Decommissioning activities will be performed in accordance with written, reviewed, and approved site procedures. There are no identified or anticipated decommissioning activities that are unique to the DAEC site outside the bounds considered in the GEIS.

Radiological and environmental programs will be maintained throughout the decommissioning process to ensure occupational, public health and safety, and environmental compliance. Radiological programs will be conducted in accordance with the facility's revised Technical Specifications, Facility Operating License, Updated Final Safety Analysis Report (UFSAR), Radiological Environmental Monitoring Program (REMP), and the Offsite Dose Assessment Manual (ODAM). Non-radiological Environmental Programs will be conducted in accordance with applicable requirements and permits.

Tables 2.1 and 2.2 provide summaries of the schedule/plant status and costs for decommissioning the DAEC. The major decommissioning activities and the general sequence of activities are discussed in more detail in the sections that follow.

## Table 2.1

## Decommissioning Schedule and Plant Status Summary

| Plant Status/Decommissioning Activities | Start | End | Approximate Duration (Years) |
|---|---|---|---|
| **Pre-Shutdown** | | | |
| Pre-Shutdown Planning | Early 2019 | August 2020 | |
| **Preparations for Dormancy** | | | |
| Plant Shutdown/Defueling Outage | August 2020 | October 2020 | 0.17 |
| Preparations for Dormancy (completion of SAFSTOR preparations) | January 2020 | August 2022 | 2.58 |
| **Fuel Status** | | | |
| Wet and Dry Fuel Storage | August 2020 | April 2022 | 1.67 |
| Dry Fuel Storage | April 2022 | October 2059 | 37.5 |
| Dormancy With No Fuel On Site | November 2059 | July 2080 | 20.75 |
| **Dismantling & Decontamination (D&D)** | | | |
| Decommissioning Planning | July 2073 | January 2075 | 1.44 |
| Internals Segmentation and Site Preparations | January 2075 | May 2076 | 1.36 |
| Major Components and Systems Removal | May 2076 | March 2078 | 1.83 |
| Building Decontamination | March 2078 | November 2079 | 1.62 |
| License Termination | November 2079 | July 2080 | 0.71 |
| **Site Restoration** | | | |
| Site Restoration | November 2079 | March 2080 | 0.34 |

## Table 2.2

## Decommissioning Costs Summary

## (Thousands of 2018 dollars)

| Decommissioning Periods | License Termination | Spent Fuel Management | Site Restoration |
|---|---|---|---|
| **Pre-Shutdown** | | | |
| Pre-Shutdown Planning | 11,509 | 443 | |
| **Transition to Dormancy** | | | |
| Wet and Dry Fuel Storage | 91,762 | 129,601 | |
| Dry Fuel Storage | 19,315 | 2,941 | |
| **Dormancy** | | | |
| Dormancy Period | 102,171 | 121,582 | |
| **Decommissioning Preparations** | | | |
| Planning for D&D | 50,840 | 1,640 | |
| **Decommissioning Operations** | | | |
| Internals Segmentation and Site Preparations | 120,283 | | |
| Major Component and Systems Removal and ISFSI demolition | 221,117 | 4,898 | |
| Building Decontamination | 103,240 | | |
| License Termination | 4,451 | | |
| **Site Restoration** | | | |
| Site Restoration | | | 36,447 |
| **Totals**[a] | 724,688 | 261,106 | 36,447 |

[a] Columns may not add due to rounding.

## 2.2 DISCUSSION OF DECOMMISSIONING ACTIVITIES

The following narrative describes the basic activities associated with decommissioning the DAEC. The site specific DCE (Attachment 1) is divided into phases or periods based upon major milestones within the project or significant changes in the annual projected expenditures. The following sub-sections correspond to the five major decommissioning periods within the estimate.

### 2.2.1 Preparations for Dormancy

The NRC defines SAFSTOR as, "A method of decommissioning in which a nuclear facility is placed and maintained in a condition that allows the facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use." The facility is left largely intact (during the dormancy period), with most structures maintained in a stable condition. Some outbuildings not related to power production may be removed. While fuel remains in the Fuel Pool, systems that support required functions (such as, spent fuel cooling, HVAC, Emergency Plan, or site security) are maintained operational. Systems that are not required to support required functions are drained, de-energized, and secured. Some cleaning/removal of loose contamination and/or fixation and sealing of remaining contamination is performed and access to contaminated areas is maintained secure to provide controlled access for inspection and maintenance.

The process of placing the plant in safe-storage will include, but is not limited to, the following activities:

- Creation of an organizational structure to support the decommissioning plan and evolving emergency planning and site security requirements.
- Revision of technical specifications, plans and operating procedures appropriate to the operating conditions and requirements.
- Characterization of the facility and major components as may be necessary to plan and prepare for the dormancy phase.
- Management of the Spent Fuel Pool and reconfiguring Fuel Pool support systems so that draining and de-energizing may commence in other areas of the plant.
- Deactivation (de-energizing and or draining) of systems that are no longer required during the dormancy period.
- Processing and disposal of water and water filter and treatment media (resins) not required to support dormancy operation.
- Removal of select structures to improve safety and monitoring.
- Disposition of incidental waste that may be present and is ready to ship prior to the start of the dormancy period, such as excess tools and equipment and waste produced while deactivating systems and preparing the facility for dormancy.
- Reconfiguration of power, lighting, heating, ventilation, fire protection, and any other services needed to support long-term storage and periodic plant surveillance and maintenance.
- Stabilization by fixing or removing loose incidental surface contamination to facilitate future building access and plant maintenance

The following is a general discussion of the planned reconfiguration expected after plant shutdown.

#### 2.2.1.1 Electrical Systems

The electrical systems will undergo a series of reconfigurations between shutdown and the time all spent fuel has been transferred to dry storage. The reconfigurations will be performed to reduce operating and maintenance expenses, while maintaining adequate power for station loads, and backup power for Spent Fuel Pool-related systems and critical security equipment.

#### 2.2.1.2 Mechanical Systems

Following shutdown, as applicable, fluid filled systems will be drained and abandoned, and resins removed based on an evaluation of system category, functionality, and plant configuration. The plant configuration and functionality of each system within the plant configuration as it evolves will determine when a system can be drained and abandoned.

#### 2.2.1.3 Ventilation and Heating Systems

Ventilation will be reconfigured to support remaining systems and habitability. Fluid filled systems will either be drained or have freeze protection installed, with the building heating system secured. The ventilation system will be reconfigured to maintain building temperature to support habitability and to support the function of Fuel Pool Cooling systems, Fire Protection systems, and Security systems while they are required.

#### 2.2.1.4 Fire Protection Systems

Fire Protection systems will be reconfigured based on a fire risk analysis. The fire risk analysis provides a comprehensive evaluation of the facility's fire risk, the fire protection capability to mitigate hazards that pose a risk, and the ability to protect spent fuel and other radioactive materials from potential fire induced releases. The fire risk analysis will be reevaluated and revised as necessary to reflect the unique or different fire protection issues and strategies associated with decommissioning. It is expected that as the plant's systems are drained and the combustible loading footprint shrinks, the Fire Protection requirements will be reduced.

#### 2.2.1.5 Maintenance of Systems Critical to Decommissioning

There are no mechanical systems that will be critical to the final decommissioning process. As such, mechanical systems will be abandoned after all spent fuel has been transferred to Dry Fuel Storage, with the exception of systems required to maintain habitability during dormancy. The site power distribution system will be abandoned with some exceptions, such as motor control centers that are required to support ventilation and lighting.

In order to support final dismantlement of the plant, temporary services, including but not limited to electrical and cranes, will be required.

### 2.2.2 Dormancy

Activities required during transition to the dormancy period while spent fuel is stored in the Fuel Pool will be substantially different than those activities required during dormancy, when all fuel is in dry fuel storage.

Early activities include operating and maintaining the Spent Fuel Pool and its associated systems, and transferring spent fuel from the pool to the ISFSI. Spent fuel transfer is expected to be complete in 2023. After the fuel transfer is completed, the Spent Fuel Pool and systems will be drained and de-energized for long-term storage.

Dormancy activities will include a 24-hour security force, preventive and corrective maintenance on security systems, area lighting, general maintenance of buildings, freeze protection heating, ventilation of buildings for periodic habitability, routine radiological inspections of contaminated structures, maintenance of structural integrity, and a site environmental and radiation monitoring program.

Security during the dormancy period will be conducted primarily to safeguard the spent fuel on site and prevent unauthorized entry. Security barriers, sensors, alarms, and other surveillance equipment will be maintained as required to provide security. Additionally, an environmental surveillance program will be carried out during the dormancy period to monitor for radioactive material in the environment. Appropriate procedures will be established and initiated for potential releases that exceed prescribed limits. The on-going environmental surveillance program will consist of a version of the program in effect during normal plant operations that will be modified to reflect the plant's conditions and risks at the time.

During the dormancy period, additional activities will include transferring the spent fuel from the ISFSI to the DOE. NEDA will seek to remove fuel from the site when the DOE commences performance. Following the spent fuel removal, the ISFSI pad and associated facilities will be decommissioned along with the power block structures during the decontamination and dismantlement phases.

### 2.2.3 Decommissioning Preparations

Prior to the commencement of decommissioning operations, preparations may be undertaken to reactivate site services and prepare for decommissioning. Preparations include engineering and planning, a site characterization, and the assembly of a decommissioning management organization. This would likely include the development of work plans, specifications and procedures.

### 2.2.4 Decommissioning Operations (Decontamination and Dismantlement)

Following the preparations for decommissioning, physical decommissioning activities will take place. This includes the removal and disposal of contaminated and activated components and structures, leading to the termination of the 10 CFR 50 operating license. Although much of the radioactivity will decrease during the dormancy period due to decay of radionuclides, the internal components of the reactor vessel will still exhibit radiation dose rates that will likely

require remote sectioning under water due to the presence of long-lived radionuclides. Portions of the biological shield wall may also be radioactive due to the presence of activated trace elements. It is assumed that radioactive contamination on SSC surfaces will not have decayed to levels that will permit unrestricted release. These surfaces will be surveyed and items dispositioned in accordance with the license termination release criteria.

Significant decommissioning activities in this phase include, but not limited to:

- Reconfiguration and modification of site structures and facilities, as needed, to support decommissioning operations. Modifications may also be required to the reactor or other buildings to facilitate movement of equipment and materials, support the segmentation of the reactor vessel and reactor vessel internals, and for large component removal.
- Design and fabrication of temporary and longer-term shielding to support removal and transportation activities, construction of contamination control envelopes, and the procurement of specialty tooling.
- Procurement or leasing of shipping cask, cask liners, and industrial packages for the disposition of low-level radioactive waste.
- Decontamination of components and piping systems, as required, to control (minimize) worker exposure.
- Removal of piping and components no longer essential to support decommissioning operations.
- Removal of reactor head and segmentation as necessary.
- Removal and segmentation of the dryer, separator, and top guide. Segmentation will maximize the loading of the shielded transport casks, i.e., by weight and activity. The operations are conducted under water using remotely operated tooling and contamination controls.
- Disassembly and segmentation of the remaining reactor internals, including the core materials left above the core support guide, core shroud, fuel support castings, core support guide, and control rod drive guide tubes. Some material is expected to exceed Class C disposal requirements. As such, the segments will be packaged in modified fuel storage canisters for future geologic disposal.
- Segmentation of the reactor vessel as necessary. Cutting operations will likely be performed using remotely operated equipment within a contamination control envelope. The water level is maintained to minimize the working area dose rates.
- Removal of the steel liners from the drywell, torus, refueling pool and Spent Fuel Pool, disposing of the activated and/or contaminated sections as radioactive waste.
- Removal of the activated portions of the concrete biological shield and accessible contaminated concrete surfaces. Removal of the recirculation piping and pumps for material recovery and controlled disposal.
- Surface soil, sub-surface media and groundwater will meet the unrestricted use criteria in 10 CFR 20.1402.
- Underground piping (or similar items) and associated soil will be removed as necessary to meet license termination criteria.

At least two years prior to the anticipated date of license termination, a License Termination Plan (LTP) will be submitted to the NRC. That plan will include: a site characterization,

description of the remaining dismantling / removal activities, plans for remediation of remaining radioactive materials, developed site-specific Derived Concentration Guideline Levels, methodology and criteria for the final status (radiation) survey (FSS), designation of the end use of the site, an updated cost estimate to complete the decommissioning, and associated environmental concerns.

The FSS plan will identify the radiological surveys to be performed once the decontamination activities are completed and will be developed using the guidance provided in the "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)" (Reference 6). The MARSSIM "provides information on planning, conducting, evaluating, and documenting building and surface soil final status radiological surveys for demonstrating compliance with dose or risk-based regulations or standards." The MARSSIM uses the Data Quality Objective/Analysis processes tool for data collection activities and provides a basis for balancing decision uncertainty with available resources. This document incorporates statistical approaches to survey design and data evaluation. It also identifies commercially available instrumentation and procedures for conducting radiological surveys. Use of this guidance ensures that the surveys are conducted in a manner that provides a high degree of confidence that applicable NRC criteria are satisfied.

Once the FSS is complete, the results will be submitted to the NRC, along with a request for termination of the NRC license.

NEDA may release unaffected portions of the site on a partial site release basis, as they become available, before all site decommissioning work has been completed.

### 2.2.5 Site Restoration

After the NRC terminates the license, site restoration activities will be performed, at the licensee's discretion. NEDA currently assumes that remaining structures will be removed to restore the site to an appropriately graded and vegetated condition (green field). Suitable backfill material will be used where necessary and appropriate erosion controls established.

Non-contaminated concrete remaining after the demolition activities may be used for backfilling subsurface voids or may be transported to an offsite area for appropriate disposal as construction debris.

## 2.3 GENERAL DECOMMISSIONING CONSIDERATIONS

### 2.3.1 Major Decommissioning Activities

As defined in 10 CFR 50.2, "Definitions," a "major decommissioning activity" is "any activity that results in permanent removal of major radioactive components, permanently modifies the structure of the containment, or results in dismantling components for shipment containing greater than class C waste in accordance with § 61.55 of this chapter." The following discussion provides a summary of the major decommissioning activities currently planned for decommissioning of the DAEC. These activities are envisioned to occur in the Dismantling and Decontamination Period. The schedule may be modified as conditions dictate.

Prior to starting a major decommissioning activity, the affected components will be surveyed and decontaminated, as required in order to minimize worker exposure, and a plan will be developed for the activity. Shipping casks and other equipment necessary to conduct major decommissioning activities will be procured.

The initial major decommissioning activity inside the containment building will be the removal, packaging, and disposal of systems and components attached to the reactor in order to provide access and allow it to be removed.

The reactor vessel internals will be removed from the reactor vessel and segmented, if necessary, for packaging, transport, and disposal, or to separate greater than Class C (GTCC) waste. Internals classified as GTCC waste will be segmented and packaged into containers similar to spent fuel canisters for transfer to the DOE. Removal of the reactor vessel follows the removal of the reactor internals. Industry experience indicates that there may be several options available for the removal and disposal of the reactor vessel (i.e., segmentation or disposal as an intact package). The viability of these options will be analyzed as a part of future planning and preparation activities. If segmented, it is likely that the work would be performed remotely, using a contamination control envelope.

Other major decommissioning activities that would be conducted include the removal and disposal of the turbine, condenser, main steam piping, feed water piping, pumps and heaters, Spent Fuel Pool support equipment, and neutron activated/contaminated concrete or metals.

In addition to the reactor and large components discussed above, all other plant components will be removed from the Reactor, Turbine, and associated support buildings, radiologically surveyed, and dispositioned appropriately.

### 2.3.2 Decontamination and Dismantlement Activities

The overall objective of D&D is to ensure that radioactively contaminated or activated materials will be removed from the site to allow the site to be released for unrestricted use. This is achieved in part by radioactive decay during the SAFSTOR (dormancy) period which will significantly reduce the quantity of contamination and radioactivity that must be disposed of during decontamination and dismantlement. The disposition of remaining radioactive materials will be accomplished by the decontamination and/or dismantlement of contaminated structures. This may be accomplished by decontamination in place, off-site processing of the materials, or direct disposal of the materials as radioactive waste. A combination of these methods may be utilized. The methods chosen will be those deemed most appropriate for the particular circumstances. Low-level radioactive waste (LLRW) will be managed in accordance with approved procedures and commercial disposal facility requirements. This includes characterizing contaminated materials, packaging, transporting and disposal at a licensed LLRW disposal facility.

### 2.3.3 Radioactive Waste Management

A major component of the decommissioning work scope for the DAEC is the packaging, transportation and disposing of primarily contaminated/activated equipment, piping, concrete,

and in some cases soil. A waste management plan will be developed to incorporate the most prudent disposal strategy, consistent with regulatory requirements and disposal/processing options for each waste type at the time of the D&D activities. Decommissioning wastes from the DAEC may be disposed of at any available licensed LLRW facilities that engage in an agreement with NEDA. Radioactive wastes from the DAEC will be transported by licensed transporters.

The waste management plan will be based on the evaluation of available methods and strategies for processing, packaging, and transporting radioactive waste in conjunction with the available disposal facility options and associated waste acceptance criteria.

### 2.3.4 Removal of Mixed Wastes

If mixed wastes are generated, they will be managed in accordance with applicable Federal and State regulations.

If generated, mixed wastes will be transported by authorized and licensed transporters and shipped to authorized and licensed facilities. If technology, resources, and approved processes are available, the processes will be evaluated to render the mixed waste non-hazardous.

### 2.3.5 Site Characterization

During the decommissioning process, site characterization will be performed in which radiological, regulated, and hazardous wastes will be identified, categorized, and quantified. Surveys will be conducted to establish the contamination and radiation levels throughout the site. This information will be used in developing procedures, surveys and sampling plans to ensure that hazardous, regulated, and radiologically contaminated areas are remediated and to ensure that worker exposure is controlled. As decontamination and dismantlement work proceeds, surveys will be conducted to maintain a current site characterization and to ensure that decommissioning activities are adjusted accordingly.

As part of the site characterization process, a neutron activation analysis calculation study of the reactor internals and the reactor vessel will be performed. Using the results of this analysis (along with benchmarking surveys), neutron irradiated components will be classified (projected for the future D&D time-frame) in accordance with 10 CFR 61, "Licensing requirements for land disposal of radioactive waste." The results of the analysis form the basis of the plans for removal, segmentation, packaging and disposal.

### 2.3.6 Groundwater Protection and Radiological Decommissioning Records Program

A groundwater (GW) protection program currently exists at the DAEC in accordance with the Nuclear Energy Institute (NEI) Technical Report 07-07, "Industry Groundwater Protection Initiative - Final Guidance Document" (Reference 10). This program is directed by procedures and will continue during decommissioning.

A site hydrology study was completed as part of the ongoing monitoring program. Groundwater monitoring wells were installed at the plant to identify any radiological contaminants. In 2012,

measureable amounts of tritium began to be detected in some of the groundwater monitoring wells in an area immediately adjacent to the south side of the Turbine and Reactor buildings, continuing for a short distance to the southeast on the plant property. The sources of the tritium were identified from a spill of contaminated water in 2012 and leakage from Turbine Building drains in 2016. Corrective actions were taken to stop the leakage. Monitoring wells installed at the site have confirmed termination of the leakage. This area has been and continues to be mitigated through mitigation wells. The mitigation wells have confined the tritium to the on-site shallow aquifer through continuous pumping of contaminated water. Further, the plant shutdown has stopped production of any additional tritium. Since the system of monitoring and mitigation wells were installed at the site prior to shutdown, there is no significant impact to the site decommissioning budget for maintaining the system until mitigation is complete.

As a result of the ongoing mitigation and given a tritium half-life of 12.3 years, tritium mitigation is expected to be completed in 4 to 5 years. The cleanup will meet requirements for unrestricted use under 10 CFR 20.1402, "Radiological Criteria for Unrestricted Use". NEDA will also continue to maintain the existing radiological decommissioning records program required by 10 CFR 50.75(g). The program is directed by procedures. None of the events noted in records required by 10 CFR 50.75(g) indicate the presence of long-lived radionuclides in sufficient concentrations to preclude unrestricted release under 10 CFR 20.1402 at the end of the SAFSTOR period.

### 2.3.7 Changes to Management and Staffing

Throughout the decommissioning process, plant management and staffing levels will be adjusted to reflect the ongoing transition of the site organization. Staffing levels and qualifications of personnel used to monitor and maintain the plant during the various periods after plant shutdown will be subject to appropriate Technical Specification and Emergency Plan requirements. Some of the staffing requirements may be filled by contract personnel used to provide general services, staff augmentation or replace permanent staff. These staffing levels, however, do not include contractor staffing that may be used to carry out the future fuel movements, plant modifications in preparation for SAFSTOR, and the D&D/license termination/site restoration work. The monitoring and maintenance staff will be comprised of radiation protection, radiological environmental monitoring program, plant engineering and craft workers as appropriate for the anticipated work activities.

# 3.0 SCHEDULE OF PLANNED DECOMMISSIONING ACTIVITIES

## 3.1 DESCRIPTION OF PLANNED DECOMMISSIONING ACTIVITIES

NEDA intends to pursue the decommissioning of DAEC utilizing a SAFSTOR methodology and will make appropriate filings with the NRC to obtain authority prior to beginning radiological decommissioning. The SAFSTOR method involves removal of radioactively contaminated or activated material from the site following an extended period of dormancy. Work activities associated with the planning and preparation period have begun during the final operating cycle of the plant and will continue through 2023. The schedule of spent fuel management and major decommissioning activities is provided in Table 2.1. Additional detail is provided in the site-specific DCE (Attachment 1). Dates in the site-specific DCE are based on the October 30, 2020, shutdown date and have been adjusted as reflected in Table 2.1.

The schedule accounts for spent fuel being stored in the ISFSI until the assumed date of transfer to the DOE.

# 4.0 ESTIMATE OF EXPECTED DECOMMISSIONING AND SPENT FUEL MANAGEMENT COSTS

10 CFR 50.82(a)(8)(iii) requires that a site-specific decommissioning cost estimate be prepared and submitted within two years following permanent cessation of operations. 10 CFR 50.82(a)(4)(i) requires that the PSDAR contain a site-specific decommissioning cost estimate including the projected costs of managing irradiated fuel. A site-specific decommissioning cost analysis has been prepared for DAEC, which also provides projected costs of managing spent fuel, as well as non-radiological decommissioning and site restoration costs, accounted for separately.

The site-specific decommissioning cost analysis is provided in Attachment 1 and fulfills the requirements of 10 CFR 50.82(a)(4)(i) and 10 CFR 50.82(a)(8)(iii). A summary of the site-specific decommissioning cost analysis and projected cost of managing spent fuel is provided in Table 2-1. A summary of the annual costs, earnings, and trust balances associated with decommissioning, spent fuel management, and site restoration will be provided in an update to the Irradiated Fuel Management Plan being submitted as a separate document in accordance with 10 CFR 50.54(bb).

The methodology used to develop the site-specific decommissioning cost analysis follows the basic approach originally advanced by the Atomic Industrial Forum in their program to develop a standardized model for decommissioning cost estimates. The results of this program were published as AIF/NESP-036, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," (Reference 12). This document presents a unit cost factor method for estimating direct activity costs, simplifying the estimating process. The unit cost factors used in the study reflect the latest available data at the time of the study concerning worker productivity during decommissioning.

10 CFR 50.82(c) states that for a facility that has permanently ceased operation before the expiration of its license, the collection period for any shortfall of funds will be determined, upon application by the licensee, on a case-by-case basis taking into account the specific financial situation of each licensee. At the time that operations cease at DAEC, sufficient funds will be available in the plant decommissioning fund to complete the planned decommissioning activities.

10 CFR 50.82(a)(6)(ii) states that licensees shall not perform any decommissioning activities, as defined in 10 CFR 50.2, that would result in there no longer being reasonable assurance that adequate funds will be available for decommissioning. No such activities have been identified, since adequate funding exists based on the site-specific decommissioning cost analysis in Attachment 1.

## 4.1 COST ESTIMATE ADJUSTMENTS

The DAEC SAFSTOR schedule and the associated site-specific cost estimate summarized in Tables 2.1 and 2.2 and detailed in the DCE (Attachment 1) is reported in 2018 dollars using current pricing. NEDA will update the DAEC DCE as required by procedure and regulation. In calculating projected earnings, NEDA will apply a compounded 2% real rate of return on the trust fund per 10 CFR 50.75 (e). In accordance with 10 CFR 50.82(a)(8)(v)-(vii), NEDA will provide annual reports projecting the cost to complete decommissioning and spent fuel management costs.

## 4.2 MEANS OF ADJUSTING ASSOCIATED FUNDING LEVELS

During the SAFSTOR period, the site-specific DCE will be periodically updated in compliance with NEDA procedures and applicable regulatory requirements. In accordance with 10 CFR 50.82(a)(8)(v), decommissioning funding assurance will be reviewed and reported to the NRC annually during the SAFSTOR period. The latest site-specific DCE adjusted for inflation, in accordance with applicable regulatory requirements, will be used to demonstrate funding assurance. In addition, actual radiological and spent fuel management expenses will be included in the annual report in accordance with the applicable regulatory requirements. If the funding assurance demonstration shows the DTF is not sufficient, then an alternate funding mechanism allowed by 10 CFR 50.75(e) and the guidance provided in Regulatory Guide 1.159 (Reference 11) will be put in place.

# 5.0 ENVIRONMENTAL IMPACTS

To support the PSDAR environmental impacts review, the environmental effects of decommissioning activities planned for DAEC, as currently understood, were evaluated to determine if potential environmental impacts are bounded by previously issued environmental impact statements. 10 CFR 50.82(a)(4)(i) requires that the PSDAR include "...a discussion that provides the reasons for concluding that the environmental impacts associated with site-specific decommissioning activities will be bounded by appropriate previously issued environmental impact statements." To determine if the estimated potential environmental impacts associated with DAEC decommissioning activities are bounded, the potential environmental impacts were compared to those in:

- NUREG-0586, Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors (Reference 3) (Referred to as the GEIS).
- Atomic Energy Commission, Final Environmental Statement related to the Operation of Duane Arnold Energy Center (Reference 7).
- NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 42, Regarding Duane Arnold Energy Center (Reference 4) (Referred to as the SEIS).

As required, site-specific assessments were conducted for threatened and endangered species and environmental justice. Site-specific assessments were also performed for offsite land use and impacts to aquatic ecology, terrestrial ecology, and cultural and historic resources for decommissioning activities beyond the operational area. For the purpose of assessing decommissioning environmental impacts, the operational area at DAEC consists of roughly the southern half of the approximately 500 acres on the west bank of a north-south reach of the Cedar River, approximately 2.5 miles north-northeast of the town of Palo. DAEC uses only a small portion of the area for power production.

The levels of significance assigned to site-specific environmental impacts are classified as small, moderate, or large, as defined by NRC in the Decommissioning GEIS (Reference 3, pgs. 4-1 and 4-2). NEDA has concluded that the environmental impacts associated with planned DAEC decommissioning activities are bounded by the impacts addressed by previously issued environmental impact statements. NEDA's decommissioning plans are consistent with the methods assumed by NRC in the GEIS. No unique site-specific features or unique aspects of the planned decommissioning have been identified.

## 5.1 ENVIRONMENTAL IMPACT OF DAEC DECOMMISSIONING

The following is a summary of the reasons for reaching the conclusion that the environmental impacts of decommissioning DAEC are bounded by the GEIS. Each environmental impact standard in the GEIS is listed along with an explanation as to why NEDA concludes the GEIS analysis bounds the impacts of DAEC decommissioning on that standard. As a general matter, DAEC is smaller than the reference boiling water reactor used in the GEIS to evaluate the environmental impacts of decommissioning, and is therefore bounded by those assessments.

Further, no unique site-specific features or unique aspects of the planned decommissioning have been identified.

### 5.1.1 Onsite and Offsite Land Use

As part of decommissioning activities, NEDA will utilize onsite land for laydown, staging, or handling of equipment. The DAEC has sufficient area onsite that has been previously disturbed (due to construction or operations activities) upon which to conduct all of these decommissioning activities. Section 4.3.1 of the GEIS concluded that the impacts on land use are not detectable or small for facilities having only onsite land use changes as a result of large component removal, structure dismantlement, and low-level waste packaging and storage.

NEDA will not require addition or modification to existing transportation links that could impact offsite land use. Based on the GEIS, the experience of plants that are being decommissioned has not included any needs for additional land offsite. Consistent with this determination, NEDA does not anticipate any changes in land use beyond the site boundary during decommissioning.

Therefore, NEDA concludes that the impacts of DAEC decommissioning on onsite/offsite land use are bounded by the GEIS.

### 5.1.2 Water Use

After plant shutdown, the operational demand for cooling water and makeup water will dramatically decrease. Additionally, after the plant is shut down and defueled, the amount of water used by the service water system will be much less than during normal operation of the plant. The need for cooling water will continue to decrease as the heat load of spent fuel in the Spent Fuel Pool declines due to radioactive decay and as spent fuel is relocated from the Spent Fuel Pool to the ISFSI. During plant shutdown, the use of potable water will decrease commensurate with the expected decrease in plant staffing levels. For these reasons, Section 4.3.2.2 of the GEIS concluded that water use at decommissioning nuclear reactor facilities is significantly smaller than water use during operation.

The GEIS also concluded that water use during the decontamination and dismantlement phase will be greater than that during the storage phase. However, there are no unique aspects associated with the decommissioning of DAEC and water use for such activities as flushing piping, dust abatement, etc. Consequently, DAEC water use impacts were addressed by the evaluation of the reference facility in the GEIS.

Therefore, NEDA concludes that the impacts of DAEC decommissioning on water use are bounded by the GEIS.

### 5.1.3 Water Quality

This section considers water quality impacts of nonradioactive material for both surface and groundwater during the decommissioning process. Table E-3 of the GEIS identifies decommissioning activities that may affect water quality. These activities include system deactivation activities (draining, flushing, and liquid processing) as well as facility decontamination and dismantlement activities (water spraying for dust suppression). The GEIS also emphasizes the need to minimize water infiltration during the SAFSTOR period.

NEDA has chosen to decommission DAEC using the SAFSTOR method. During the SAFSTOR planning and actual storage periods, storm water runoff and drainage paths will be maintained in their current configuration. Regulatory mandated programs and processes designed to minimize, detect, and contain spills will be maintained throughout the decommissioning process. Federal, state and local regulations and permits pertaining to water quality will remain in effect and no significant changes to water supply reliability are expected. The National Pollutant Discharge Elimination System (NPDES) permit, which regulates surface water discharges from the site will remain in place as will the Groundwater Discharge Permit for the DAEC Wastewater Treatment Facility. The GEIS makes a generic conclusion that for all facilities, the impacts on nonradioactive aspects of water quality are small. NEDA concludes that the impacts of DAEC decommissioning on water quality are bounded by the GEIS.

### 5.1.4 Air Quality

There are many types of decommissioning activities listed in Section 4.3.4 of the GEIS that have the potential to affect air quality. NRC considered the potential for adverse impacts from these activities, the greatest of which would be fugitive dust, for the range of decommissioning plants and generically determined air quality impacts to be small. For those activities applicable to the SAFSTOR option, NEDA does not anticipate any activities beyond those listed in the GEIS that could potentially affect air quality. Also, reasonable and appropriate control measures such as wetting down unpaved areas, wetting of soil piles, covering loads and staging areas, and seeding of bare areas would be implemented to minimize fugitive dust. In addition, federal, state and local regulations pertaining to air quality will remain in effect to regulate emissions associated with criteria air pollutants, hazardous air pollutants, ozone-depleting gases and fugitive dust. Therefore, NEDA concludes that the impacts of DAEC decommissioning on air quality are bounded by the GEIS.

### 5.1.5 Aquatic Ecology

Aquatic ecology encompasses the plants and animals in the Cedar River and wetlands near DAEC. Aquatic ecology also includes the interaction of those organisms with each other and the environment. Section 4.3.5 of the GEIS evaluates both the direct and indirect impacts from decommissioning on aquatic ecology.

Direct impacts can result from activities such as the removal of shoreline structures or active river dredging. The DAEC shoreline structures are similar to those of sites listed in Table E-2 of the GEIS, and there are no apparent discriminators based on characteristics (size and location) listed in Table E-5 of the GEIS. Removal of the intake structure and discharge canal will be conducted in accordance with best management practices outlined in government permits. Intake structure dredging will be greatly reduced due to the diminished residual heat removal requirements.

As previously discussed in Section 5.1.2, the amount of cooling water withdrawn from the Cedar River will significantly decrease thus reducing the potential impacts from impingement and entrainment of aquatic species. Additionally, any significant potential for sediment runoff or erosion on disturbed areas will be controlled in accordance with best management practices outlined in the storm water permit. The GEIS concluded that impacts on aquatic ecology would be small if disturbance of lands beyond the operational areas of the plant. NEDA does not anticipate disturbance of lands beyond the current operational areas of the plant, so there

should not be any new impacts to aquatic ecology from runoff associated with land disturbance activities. Therefore, NEDA concludes that the impacts of DAEC decommissioning on aquatic ecology are consistent with the GEIS.

### 5.1.6 Terrestrial Ecology

Terrestrial ecology considers the plants and animals in the vicinity of DAEC as well as the interaction of those organisms with each other and the environment. Evaluations of impacts to terrestrial ecology are usually directed at important habitats and species, including plant and animals that are important to industry, recreational activities, the area ecosystems, and those protected by endangered species regulations and legislation. Section 4.3.6 of the GEIS evaluates the potential impacts from both direct and indirect disturbance of terrestrial ecology.

Direct impacts can result from activities such as clearing native vegetation or filling a wetland. NEDA does not anticipate any decommissioning activities will disturb habitat beyond the industrial area of the plant. All dismantlement, demolition, and waste staging activities are expected to be conducted within this industrial area of the site. Also the EPA controls significant impacts to the environment through regulation of construction activities.

Indirect impacts may result from effects such as erosional runoff, dust or noise. Any construction activities that would disturb one acre or greater of soil would require a permit from the EPA prior to proceeding with the activity. The storm water permit would contain best management practices to control sediment and the effects of erosion associated with the construction activity. Fugitive dust emissions would be controlled through the judicious use of water spraying.

The GEIS concluded that impacts to terrestrial ecology would be small if habitat was not disturbed beyond the operational area of the plant. NEDA, therefore, concludes that decommissioning of DAEC is consistent with the GEIS.

### 5.1.7 Threatened and Endangered Species

The GEIS lists stabilization, large component removal, decontamination and dismantlement (removal of contaminated soil), and structure dismantlement as activities with potential to impact threatened and endangered species.

Section 4.3.7 in the GEIS did not make a generic determination on the impact of decommissioning on threatened and endangered species, noting that impacts to these species are expected to be minor and non-detectable when activities are confined to the site operational area.

Impacts are to be determined on a site-specific basis, paying particular attention to activities outside of the developed operational area. Noise and dust generation from construction activity and increased truck traffic, rather than direct impacts such as habitat destruction, are the primary concerns.

Under the SAFSTOR methodology, the DAEC will enter a long period of dormancy with minimal activity that may last decades. The site activity during this period is expected to be much less than during plant operation. NEDA has evaluated the industrial activities during the dormancy period and determined the impacts to the environment and species outside the operational area to be minor. Operational noises and traffic in and out of the facility will be minimal. Habitat

destruction will not occur in the dormancy phase. With respect to all threatened and endangered species, the environmental impacts during dormancy are expected to be minimal.

Once the dormancy period of SAFSTOR ends and prior to significant decommissioning activities, NEDA will perform an assessment of endangered species in the area of the plant and consider the adverse impacts on the state and federally listed species at that time. This will ensure an assessment that is contemporary with the dismantling and demolition activities that could impact endangered species. NEDA will obtain the necessary permits under the Endangered Species Act (ESA) prior to the active decommissioning period.

With respect to the threatened and endangered aquatic species, the environmental impacts during decommissioning are expected to be minimal. Removal of the intake and discharge facilities as well as other shoreline structures will be conducted in accordance with best management practices outlined in permits issued by Linn County, the Iowa Department of Sovereign Lands, and the U.S. Army Corps of Engineers.

Attachment 2, Table 1 identifies state and federally listed species potentially occurring in the vicinity of DAEC based on site-specific assessments conducted in support of license renewal, information collected from the Iowa DNR Iowa Natural Areas Inventory (INAI) interactive website. The Iowa Natural Areas Inventory (INAI) interactive website combines current technologies to bring threatened, endangered, special concern, and selected rare species data and maps to professional natural resource managers as well as to the public.

Section 4.3.7 of the GEIS also suggests that care be exercised in conducting decommissioning activities after an extended SAFSTOR period because there is a greater potential for rare species to colonize the disturbed portion of the site. However, as previously discussed, administrative controls and federal and state regulations that will remain in effect would ensure that mitigation measures are implemented as appropriate to protect wildlife.

Based on the site-specific findings summarized above, NEDA concludes that DAEC decommissioning activities are unlikely to adversely affect any threatened or endangered species. Therefore, additional mitigation is not warranted. However, as decommissioning plans mature, if changes in threatened and endangered species listings or critical habitat designations occur that affect this conclusion, NEDA will update the PSDAR in accordance with applicable NRC regulations.

### 5.1.8 Radiological

The GEIS considered radiological doses to workers and members of the public when evaluating the potential consequences of decommissioning activities.

#### Occupational Dose

The occupational radiation exposure to DAEC plant personnel will be maintained As Low as Reasonably Achievable (ALARA) and below the occupational dose limits in 10 CFR Part 20 during decommissioning. The need for plant personnel to routinely enter radiological areas to conduct maintenance, calibration, inspection, and other activities associated with an operating plant will be reduced, thus it is expected that the occupational dose to plant personnel will significantly decrease after the plant is shut down and defueled.

NEDA has elected to decommission DAEC using the SAFSTOR alternative. It is expected that the occupational dose required to complete the decommissioning activities at DAEC will be within the range of SAFSTOR dose estimates (326 - 834 person-rem) provided in Table 4-1 of the GEIS. This is based on the fact that DAEC is bounded by the BWRs evaluated in the GEIS as discussed in Appendix G, and because the ALARA program will be maintained to ensure that occupational dose is maintained ALARA and well within 10 CFR Part 20 limits.

Public Dose

Section 4.3.8 of the GEIS considered doses from liquid and gaseous effluents when evaluating the potential impacts of decommissioning activities on the public. Table G-15 of the GEIS compared effluent releases between operating facilities and decommissioning facilities and concluded that decommissioning releases are lower. The GEIS also concluded that the collective dose and the dose to the maximally exposed individual from decommissioning activities are expected to be well within the regulatory standards in 10 CFR Part 20 and Part 50.

The expected radiation dose to the public from DAEC decommissioning activities will be maintained within regulatory limits and below comparable levels when the plant was operating through the continued application of radiation protection and contamination controls combined with the reduced source term available in the facility. Therefore, NEDA concludes that the impacts of DAEC decommissioning on public dose are small and are bounded by the GEIS.

5.1.9 Radiological Accidents

The likelihood of a large offsite radiological release that impacts public health and safety after DAEC is shut down and defueled is considerably lower than the likelihood of a release from the plant during power operation. This is because the majority of the potential releases associated with power operation are not relevant after the fuel has been removed from the reactor. Furthermore, handling of spent fuel assemblies will continue to be controlled under work procedures designed to minimize the likelihood and consequences of a fuel handling accident. In addition, emergency plans and procedures will remain in place to protect the health and safety of the public while the possibility of significant radiological releases exists.

Section 4.3.9 of the GEIS assessed the range of possible radiological accidents during decommissioning and separated them into two general categories; fuel related accidents and non-fuel related accidents. Fuel related accidents have the potential to be more severe and zirconium fire accidents, in particular, could produce offsite doses that exceed EPA's protective action guides (Reference 5). As part of its effort to develop generic, risk-informed requirements for decommissioning, the NRC staff performed analysis of the offsite radiological consequences of beyond-design-basis Spent Fuel Pool accidents using fission product inventories at 30 and 90 days and 2, 5, and 10 years. The results of the study indicate that the risk at Spent Fuel Pools is low and well within the Commission's Quantitative Health Objectives. The generic risk is low primarily due to the very low likelihood of a zirconium fire.

The potential for decommissioning activities to result in radiological releases not involving spent fuel (i.e., releases related to decontamination, dismantlement, and waste handling activities) will be minimized by use of procedures designed to minimize the likelihood and consequences of such releases.

Therefore, NEDA concludes that the impacts of DAEC decommissioning on radiological accidents are small and are bounded by the previously issued GEIS.

5.1.10 Occupational Issues

Occupational issues are related to human health and safety. Section 4.3.10 of the GEIS evaluated physical, chemical, ergonomic, and biological hazards and concluded that impacts due to occupational issues would be small for all plants based on strict adherence to NRC and Occupational Safety and Health Administration (OSHA) safety standards, practices and procedures. NEDA has reviewed these occupational hazards in the GEIS and concluded that the decommissioning approach chosen for DAEC poses no unique hazards from those evaluated in the GEIS. NEDA will continue to maintain appropriate administrative controls and requirements to ensure occupational hazards are minimized and that applicable federal, state and local occupational safety standards and requirements continue to be met. Therefore, NEDA concludes that the impacts of DAEC decommissioning on occupational issues are bounded by the GEIS.

5.1.11 Cost

Decommissioning costs for DAEC are discussed in Section 4.0 and in Attachment 1 to this report.

Section 4.3.11 of the GEIS recognizes that an evaluation of decommissioning cost is not a National Environmental Policy Act requirement. Therefore, a bounding analysis is not applicable.

5.1.12 Socioeconomics

Decommissioning of DAEC is expected to result in minor socioeconomic impacts. As DAEC transitions from an operating plant to a shutdown plant and into the different phases of decommissioning, an overall decrease in plant staff will occur. The lost wages of these plant staff will result in decreases in revenues available to support the local economy and local tax authorities. Some employee relocation will occur. In 2018, there were approximately 600 employees working at DAEC. The majority of DAEC employees live in Linn County (2017 population: 224,115). These relocations are not expected to impact the local cost of housing or availability of public services.

Section 4.3.12 of the GEIS evaluated changes in workforce and population, changes in local tax revenues, and changes in public services. The evaluation also examined plants that permanently shut down early and selected the SAFSTOR option. The GEIS determined that this situation is likely to have negative impacts. However, the GEIS concluded that socioeconomic impacts are neither detectable nor destabilizing and that mitigation measures are not warranted. Therefore, after review of the GEIS, NEDA concludes that the impacts of DAEC decommissioning on socioeconomic impacts are bounded by the GEIS analysis.

5.1.13 Environmental Justice

Executive Order 12898, dated February 16, 1994, directs Federal executive agencies to consider environmental justice under the National Environmental Policy Act. It is designed to

ensure that low-income and minority populations do not experience disproportionately high and adverse human health or environmental effects because of Federal actions.

Section 4.9.7 of the SEIS (Reference 4) analyzed 2000 census data within 50 miles of DAEC to identify minority and low-income populations. The SEIS analysis determined there were 25 block groups having minority population percentages that exceeded the State percentage by 20 percentage points or more, or that were more than 50 percent minority. The majority of these block groups are concentrated in urban areas with high population densities in Black Hawk County, Linn County, and Johnson County. There are also minority population groups in Muscatine County and Tama County. The closest high density minority population to DAEC is located in the city of Cedar Rapids, Iowa.

There were also 15 block groups within the 50-mile radius of DAEC that exceeded the State average for low-income households by 20 percentage points or more, or that were more than 50 percent low-income. The majority of census block groups with low-income populations were located in urban areas with high population densities in Black Hawk County, Johnson County, and Linn County. The nearest high-density low-income population to DAEC is located in Cedar Rapids, Iowa.

NEDA reviewed the 2010 census data for comparison to the analysis conducted as part of the SEIS using the 2000 census data. The 2010 census data for the 50-mile radius around DAEC did not show significant changes to the demographics reviewed in the SEIS. The 2010 census showed an increase in minority populations commensurate with overall population increases during the ten-year period, but those populations were generally located in the same geographic areas as the 2000 census, with the closest minority or high-density low-income population approximately 10 miles away in Cedar Rapids, Iowa. The SEIS analysis and conclusion is, therefore, still considered valid for assessing the impact of DAEC decommissioning. As stated previously, NEDA will utilize onsite land for laydown, staging, or handling of equipment. The DAEC has sufficient area onsite upon which to conduct decommissioning activities. Further, there will not be a need for addition or modification to existing transportation links that could have offsite impacts. Water usage (both process and potable usage) during decommissioning activities will be much less than that during plant operation. Controls for water runoff and drainage will continue to be controlled under regulatory mandated programs and processes throughout decommissioning. Given the fact that decommissioning activities will be confined to the area on site, the low impact of decommissioning activities to offsite environment, and the location of minority and high-density low-income populations, there will be no significant impact to these populations as a result of decommissioning activities.

Section 4.13.3 of the GEIS reviewed environmental justice decommissioning impacts related to land use, environmental and human health, and socioeconomics. NEDA does not anticipate any offsite land disturbances during decommissioning, thus the land use impacts are not applicable for DAEC. In addition, as previously discussed in Section 5.1.12, it was determined that socioeconomic impacts from decommissioning are bounded by the GEIS. Potential impacts to minority and low-income populations would mostly consist of radiological effects. Based on the radiological environmental monitoring program data from DAEC, the SEIS determined that the radiation and radioactivity in the environmental media monitored around the plant has no significant or measurable radiological impact on the environment. As a result, the SEIS found that no disproportionately high and adverse human health impacts would be

expected in special pathway receptor populations (i.e., minority and/or low income populations) in the region as a result of subsistence consumption of water, local food, fish, and wildlife. The 2019 Radiological Environmental Monitoring Program Report findings showed no levels of radioactivity above background in environmental samples. It concluded there was no effect on the environment in the areas surrounding the DAEC.

Therefore, NEDA concludes that the impacts of DAEC decommissioning on environmental justice are small and are bounded by the analysis and conclusion of the SEIS.

5.1.14 Cultural, Historical, and Archeological Resources

The GEIS states that "[i]n most cases, the amount of land required to support the decommissioning process is relatively small and is a small portion of the overall plant site. Usually, the areas disturbed or utilized to support decommissioning are within the operational areas of the site and typically are within the protected area." It goes on to state that "[a]ctivities conducted within the operational areas are not expected to have a detectable effect on important cultural resources because these areas have normally been highly degraded during facility construction and operation. Activities conducted outside of the operational areas may have detectable impacts, depending on the size and type of impact, and the cultural resources potentially affected."

NEDA anticipates the decommissioning activities at DAEC will be confined to the operational area. Therefore, there would be no impact to previously existing cultural, historical, or archeological resources because this area was degraded during site construction. Although decommissioning activities inside the operational area are not anticipated to impact historic or archaeological resources, NEDA will consult with the Iowa SHPO to determine any necessary mitigating measures.

As noted above, NEDA does not anticipate decommissioning activities outside the operational area. If NEDA's decommissioning plans change to involve significant activities with a potential for impacts outside the operational area, NEDA will notify the NRC in writing, in accordance with 10 CFR 50.82(a)(7). The following information would be relevant to an evaluation of impacts in that circumstance.

In the SEIS for the DAEC license renewal, the NRC concluded that "due to the dense concentration of cultural material in the area, there remains a high potential for undiscovered resources. Additionally, many of the resources found in the region are of high importance (e.g., mound groups)." As a result, the NRC concluded that "[i]f resources were encountered during plant activities, the effect would be expected to be MODERATE." This license renewal SEIS finding was based on a 2008 report by the Louis Berger Group, Inc. (ML092450278), which covered the entire 500-acre DAEC property and identified nine locations on the DAEC property that could contain historic and archaeological remains. None of the nine sites were located within the operational area of the site. (See 2008 Berger report, App. A, Figure 2).

Section 4.9.6 of the SEIS determined that potential impacts to historic and archaeological resources were possible during the period of extended operations due to the potential richness of archaeological resources on the DAEC property. It stated that most impacts to historic and archaeological resources occur during ground disturbing activities. The SEIS acknowledged

that, while known resources are considered in the excavation and trenching procedures, undiscovered historic and archaeological sites could be affected by plant activities. In coordination with the SHPO, NEDA developed and maintains excavation and trenching procedures for the DAEC which address potential impacts to both known and undiscovered resources. These procedures also include an inadvertent discovery (stop work) provision. The SEIS concluded that the any land disturbing activities would be considered through the DAEC revised excavation and trenching procedures and, although the potential impacts on historic and archaeological resources could be moderate, these impacts would be addressed through application of the mitigation measures.

As noted above, the decommissioning activities for DAEC are expected to be confined to the current DAEC operational area with no offsite impact and so are bounded by the GEIS. Based on the discussion in the SEIS, NEDA concludes that potential impacts on historic and archaeological resources from decommissioning activities outside the operational area at DAEC, which are not currently anticipated, could be MODERATE and that if necessary these potential impacts would be mitigated through application of controls for ground disturbance, as is fully described in the SEIS.

Therefore, NEDA has concluded that the environmental impacts associated with the DAEC decommissioning activities are bounded by the impacts addressed by previously issued environmental impact statements. Prior to commencing decommissioning activities affecting the power plant, NEDA will consult with the Iowa SHPO to determine any historical impacts of that activity to ensure its conclusions remain valid.

5.1.15 Aesthetic Issues

Section 4.3.15 in the GEIS singles out structure dismantlement and entombment as the only activities that may have impacts on aesthetic resources. NEDA does not plan to utilize entombment for decommissioning any structures at DAEC. The aesthetic impacts of decommissioning fall into two categories: (a) impacts, such as noise, associated with decommissioning activities that are temporary and cease when decommissioning is complete and (b) the changed appearance of the site when decommissioning is complete. The NRC drew the generic conclusion that for all plants, the potential impacts from decommissioning on aesthetics are small and that the removal of structures is generally considered beneficial to the aesthetics of the site.

The GEIS concluded that the retention of structures during a SAFSTOR period or the retention of structures onsite at the time the license is terminated is likewise not an increased visual impact, but instead a continuation of the visual impact analyzed in the facility construction or operations final environmental statement.

During DAEC decommissioning, the impact of noise and dust would be temporary and controlled to minimize impacts. The appearance of DAEC will be altered as the buildings and structures are dismantled. The visual intrusion during dismantlement would be temporary and would serve to reduce the aesthetic impact of the site. Therefore, NEDA concludes that the impacts of DAEC decommissioning on aesthetics are small and generally considered beneficial. Thus, such impacts are bounded by the analysis in the GEIS.

5.1.16 Noise

Section 4.3.16 in the GEIS generically examined noise during decommissioning, concluding that noise impacts would be small. The NRC considered noise impacts for operation of DAEC in the SEIS for license renewal (Reference 4) and concluded the noise impact of plant operation would be small. The noise levels associated with the decommissioning activities are not expected to be any more severe than those that occur as a result of plant operational activities and are not expected to present an audible intrusion on the surrounding community and environment. Decommissioning activities will be primarily limited to previously disturbed land surrounding the power block and isolated from both wildlife and members of the public. Therefore, because DAEC decommissioning activities are of the type previously considered by the NRC and DAEC has no site-specific conditions that would alter the NRC's prior findings, NEDA concludes that the noise impacts from decommissioning activities would be small and thus bounded by the analysis in the GEIS.

5.1.17 Transportation

The transportation impacts of decommissioning are dependent on the number of shipments to and from the plant, the types of shipments, the distance the material is shipped, and the radiological waste quantities and disposal plans. The shipments to and from the plant would primarily result from construction activities associated with relocation of the fuel to the ISFSI and shipments of radioactive wastes and non-radioactive wastes associated with dismantlement and disposal of structures, systems and components.

The estimated cubic feet of radioactive waste associated with DAEC decommissioning that will either be processed, destined for land disposal (Class A, B and C), or placed in a geologic repository (Greater than Class C) is summarized as follows:

- Class A: 503,709 cubic feet
- Class B: 1,203 cubic feet
- Class C: 226 cubic feet
- Greater than Class C (GTCC): 128 cubic feet

Table 4-7 of the GEIS estimated that the volume of land needed for LLRW (Class A, B and C) disposal from the referenced BWR was 636,000 cubic feet under the SAFSTOR alternative. NEDA presently estimates the LLRW volume of Class A, B, and C for DAEC that is destined for shallow land disposal is approximately 505,138 cubic feet using the SAFSTOR alternative which is below the GEIS bounding volume.

The quantity of recycle/potentially contaminated waste reflects the volume of bulk material such as ductwork before it is processed. This recycle/potentially contaminated waste is shipped off-site to a licensed waste processing vendor for volume reduction, survey and release, decontamination, segregation, or other appropriate methods of waste minimization.

The NRC has concluded in Section 4.3.17 of the GEIS that these regulations are adequate to protect the public against unreasonable risk from the transportation of radioactive materials. The number of GTCC waste shipments during decommissioning is expected to be below the

number referenced in Table 4-6 of the GEIS. These shipments will occur over an extended period of time and will not result in significant changes to local traffic density or patterns, the need for construction of new methods of transportation, or significant dose to workers or the public. In addition, shipments of non-radioactive wastes from the site are not expected to result in measurable deterioration of affected roads or a destabilizing increase in traffic density.

Therefore, NEDA concludes that the impacts of DAEC decommissioning on transportation are bounded by the GEIS.

5.1.18 Irreversible and Irretrievable Commitment of Resources

Irreversible commitments are commitments of resources that cannot be recovered, and irretrievable commitments of resources are those that are lost for only a period of time.

Uranium is a natural resource that is irretrievably consumed during power operation. After the plant is shutdown, uranium is no longer consumed. The use of the environment (air, water, land) is not considered to represent a significant irreversible or irretrievable resource commitment, but rather a relatively short-term investment. Since the DAEC site will be decommissioned under the provisions of 10 CFR 20 Subpart E, the land is not considered an irreversible resource. The only irretrievable resources that would occur during decommissioning would be materials used to decontaminate the facility (e.g., rags, solvents, gases, and tools), and the fuel used for decommissioning activities and transportation of materials to and from the site. However, the use of these resources is minor.

While the GEIS does not specify quantitative bounds for commitment of irreversible and irretrievable resources, NEDA concludes that the impacts of DAEC decommissioning on these resources are negligible and consistent with the conclusions of the GEIS.

## 5.2 ENVIRONMENT IMPACTS OF LICENSE TERMINATION – NUREG-1496

As stated in the schedule provided in Table 2.1 of this report, a license termination plan for DAEC will not be developed until approximately five years prior to the final site decontamination which is currently assumed to be approximately the year 2080. At that time, a supplemental environmental report will be submitted as required by 10 CFR 50.82(a)(9). While detailed planning for license termination activities will not be performed until after the SAFSTOR dormancy period, the absence of any unique site-specific factors, significant groundwater contamination, unusual demographics, or impediments to achieving unrestricted release support an expectation that impacts resulting from license termination will be similar to those evaluated in NUREG-1496 (Reference 8).

## 5.3 DISCUSSION OF DECOMMISSIONING IN THE SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT (SEIS)

As part of the DAEC license renewal process, decommissioning was discussed in Section 7.0 of the SEIS (Reference 4). Identified were six issues related to decommissioning as follows:

- Radiation Doses
- Waste Management
- Air Quality
- Water Quality
- Ecological Resources
- Socioeconomic Impacts

The NRC staff did not identify any new and significant information during their independent review of the DAEC license renewal environmental report (Reference 4), the site audit, or the scoping process for license renewal. The NRC concluded that there are no impacts related to these issues beyond those discussed in the SEIS for license renewal (Reference 4) or the GEIS for decommissioning (Reference 3). For the issues identified above, the license renewal and decommissioning GEISs both concluded the impacts are small. The NRC found no site-specific issues related to decommissioning. There are no contemplated decommissioning activities that would alter that conclusion.

## 5.4 ADDITIONAL CONSIDERATIONS

The following considerations are relevant to concluding that decommissioning activities will not result in significant environmental impacts not previously reviewed:

- The release of effluents will continue to be controlled by plant license requirements and plant procedures.
- NEDA will continue to comply with the Offsite Dose Assessment Manual, Radiological Environmental Monitoring Program, and the Groundwater Protection Initiative Program during decommissioning.
- Releases of non-radiological effluents will continue to be controlled per the requirements of the NPDES permit and applicable State of Iowa permits. Systems used to treat or

control effluents during power operation will either be maintained or replaced by temporary or mobile systems for the decommissioning activities.

- Radiation protection principles used during plant operations will remain in effect during decommissioning.
- Sufficient decontamination and source term reduction prior to dismantlement will be performed to ensure that occupational dose and public exposure will be maintained below applicable limits.
- Transport of radioactive waste will be in accordance with plant procedures, applicable Federal regulations, and the requirements of the receiving facility.
- Site access control during decommissioning will minimize or eliminate radiation release pathways to the public.

Additionally, NUREG-2157, Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel, found that the generic environmental impacts of ongoing spent fuel storage are small (Reference 9).

## 5.5 CONCLUSIONS

Based on the above discussions, NEDA concludes that the environmental impacts associated with planned DAEC site-specific decommissioning activities are less than and bounded by the impacts addressed by previously issued environmental impact statements. Specifically, the environmental impacts are bounded by the GEIS (Reference 3) and SEIS (Reference 4).

1. The postulated impacts associated with the decommissioning method chosen, SAFSTOR, have already been considered in the SEIS and GEIS.
2. There are no unique aspects of DAEC or of the decommissioning techniques to be utilized that would invalidate the conclusions reached in the SEIS and GEIS.
3. The methods assumed to be employed to dismantle and decontaminate DAEC are standard construction-based techniques fully considered in the SEIS and GEIS.

Therefore, it can be concluded that the environmental impacts associated with the site-specific decommissioning activities for DAEC will be bounded by appropriate previously issued environmental impact statements.

10 CFR 50.82(a)(6)(ii) states that licensees shall not perform any decommissioning activities, as defined in 10 CFR 50.2, that result in significant environmental impacts not previously reviewed. No such impacts have been identified.

## 6.0 REFERENCES

1. Regulatory Guide 1.185, Standard Format and Content for Post-Shutdown Decommissioning Activities Report, Revision 1. June 2013. (ML13143A259)

2. Letter, NextEra Energy Duane Arnold to USNRC, Certification of Permanent Cessation of Power Operations, January 18, 2019. (ML19023A196)

3. NUREG-0586, Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors, Final Report. November 2002. (ML18057B048)

4. NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 42, Regarding Duane Arnold Energy Center, October 2010. (ML102790308)

5. PAG Manual, Protective Action Guides and Planning Guidance for Radiological Incidents, EPA-400/R-17/001, January 2017. (ML17129A150)

6. NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual. August 2000. (ML003761445)

7. Atomic Energy Commission, Final Environmental Statement related to the Operation of Duane Arnold Energy Center, March 1973 (ML091200609)

8. NUREG-1496, Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities, July 1997. (ML042310492)

9. NUREG-2157, Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel, Final Report, September 2014. (ML14196A105)

10. NEI 07-07, Industry Ground Water Protection Initiative – Final Guidance Document, August 2007. (ML072600290)

11. Regulatory Guide 1.159, Assuring the Availability of Funds for Decommissioning Nuclear Reactors, Revision 2. October 2011. (ML112160012)

12. Atomic Industrial Forum, Inc., Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates, AIF/NESP-036, May 1986

Duane Arnold Energy Center

Post-Shutdown Decommissioning Activities Report

Attachment 1

# 2018 Decommissioning Cost Estimate for the Duane Arnold Energy Center

ENERGYSOLUTIONS

**Document No. 164053-DCE-021**

# 2018 Decommissioning Cost Estimate for the Duane Arnold Energy Center

**Project No. 164053** **Revision 2**

**Prepared for:**
NextEra Energy Duane Arnold, LLC
Central Iowa Power Cooperative
Corn Belt Power Cooperative


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Approved By: Michael A. Williams — January 27, 2020
Mike Williams, Project Manager — Date

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Barry Sims, Senior Technical Advisor — Date

- [ ] New Report
- [ ] Title Change
- [x] Report Revision
- [ ] Report Rewrite

Effective Date January 27, 2020

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## APPENDICES

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AIF | Atomic Industrial Forum |
| ALARA | As Low As Reasonably Achievable |
| BWR | Boiling Water Reactor |
| CFR | Code of Federal Regulations |
| CPM | Critical Path Method |
| DAEC | Duane Arnold Energy Center |
| D&D | Decontamination and Demolition |
| DGC | Decommissioning General Contractor |
| DOE | U.S. Department of Energy |
| DSC | Dry Shielded Canister |
| FEMA | Federal Emergency Management Agency |
| FSS | Final Status Survey |
| GSA | U.S. General Services Administration |
| GTCC | Greater Than Class C |
| HP | Health Physics |
| HSM | Horizontal Storage Modules |
| ISFSI | Independent Spent Fuel Storage Installation |
| LLRW | Low-Level Radioactive Waste |
| LLW | Low Level Waste |
| LLWPA | Low-Level Waste Policy Act |
| LOP | Life-of-Plant |
| MARSSIM | Multi-Agency Radiation Survey and Site Investigation Manual |
| MPC | Multi-Purpose Canister |
| MWt | Megawatt thermal |
| NRC | Nuclear Regulatory Commission |
| NSSS | Nuclear Steam Supply System |
| ORISE | Oak Ridge Institute for Science and Education |
| PCB | Polychlorinated Biphenyl |
| PSDAR | Post-Shutdown Decommissioning Activities Report |
| PWR | Pressurized Water Reactor |
| RCRA | Resource Conservation and Recovery Act |
| TCEQ | Texas Commission on Environmental Quality |
| WBS | Work Breakdown Structure |
| UCF | Unit Cost Factor |

# 1.0 EXECUTIVE SUMMARY

This report presents an update to "Decommissioning Cost Estimate Study for the Duane Arnold Energy Center", Revision 1 (Ref. No. 1). The Duane Arnold Energy Center (DAEC) is 70% owned by NextEra Energy Duane Arnold, LLC. The other owners of DAEC are Central Iowa Power Cooperative (20%) and Corn Belt Power Cooperative (10%). All numbers presented in this report are on a 100% basis.

This Decommissioning Cost Estimate (DCE) has been performed for financial planning purposes to determine costs for (1) decommissioning DAEC to the extent required to terminate the plant's operating license pursuant to 10 Code of Federal Regulations (CFR) 50.75(c), (2) post-shutdown management of spent fuel until acceptance by the U.S. Department of Energy (DOE) pursuant to 10 CFR 50.54(bb), (3) clean demolition of structures or Greenfield, and (4) Independent Spent Fuel Storage Installation (ISFSI) decommissioning pursuant to 10 CFR 72.30.

The DCE methodology follows the basic approach originally presented in the Atomic Industrial Forum/National Environmental Studies Project Report AIF/NESP-036, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," (Ref. No. 2). The report was prepared in accordance with Nuclear Regulatory Commission (NRC) Regulatory Guide 1.202, "Standard Format and Content of Decommissioning Cost Estimates for Nuclear Power Reactors," (Ref. No. 3). The estimate is based on compliance with current regulatory requirements and proven decommissioning technologies.

NRC requirements, set forth in Title 10 of the CFR, differentiate between the post-shutdown costs associated with storage of spent fuel on site and those associated with the decommissioning of the facility. 10 CFR 50.75(c) requires funding by the licensee of the facility for the decommissioning program, but specifically excludes the cost of removal and disposal of spent fuel and the removal of clean structures. 10 CFR 50.75(c) also excludes the cost of site restoration activities that do not involve the removal of residual radioactivity necessary to terminate the NRC license, which restores the site to either "Brownfield" or "Greenfield" conditions depending on the desired end-state. 10 CFR 50.54 (bb) requires funding by the licensee "for the management of all irradiated fuel at the reactor upon expiration of the reactor operating license until title to the irradiated fuel and possession of the fuel is transferred to the Secretary of Energy for its ultimate disposal in a repository."

Accordingly, the costs and schedules for all activities are segregated for regulatory purposes as follows: costs for "License Termination" (10 CFR 50.75(c)), costs for "Spent Fuel Management," (10 CFR 50.54(bb)), costs for "Greenfield" (clean removal and site restoration) final site conditions, and Independent Spent Fuel Storage (ISFSI) Decontamination and Demolition (D&D) (10 CFR 72.30). Energy*Solutions* has established a Work Breakdown Structure (WBS) and cost accounting system to differentiate between these four project accounts.

This DCE analyzes the following scenario, as defined by DAEC:

60 Year SAFSTOR, 2030 DOE Acceptance, Dry Fuel Storage

- Shutdown on October 30, 2020.
- DAEC's spent fuel shipping schedules based on a 2030 start date for DOE's acceptance of spent fuel.
- Termination of spent fuel pool operation approximately three years after permanent shutdown.
- Following shutdown Phase II and III of the ISFSI will be constructed and all spent fuel will be transferred to Multi-Purpose Canisters (MPCs) for interim storage.
- SAFSTOR methodology, with decommissioning completed within 60 years of shutdown.
- Decommissioning will be performed by the utility staff and a Decommissioning General Contractor (DGC).

The cost estimate results are provided in 2018 dollars in Table 1-1. Table 1-1 gives License Termination costs (which correspond to 10 CFR 50.75 (c) requirements), Spent Fuel Management costs (which correspond to 10 CFR 50.54 (bb) requirements), Greenfield costs (which correspond to activities such as clean building demolition and site grading and re-seeding), and ISFSI D&D (which correspond to 10 CFR 72.30).

**Table 1-1**
**Decommissioning Cost Summary**
**(2018 Dollars in Thousands)**

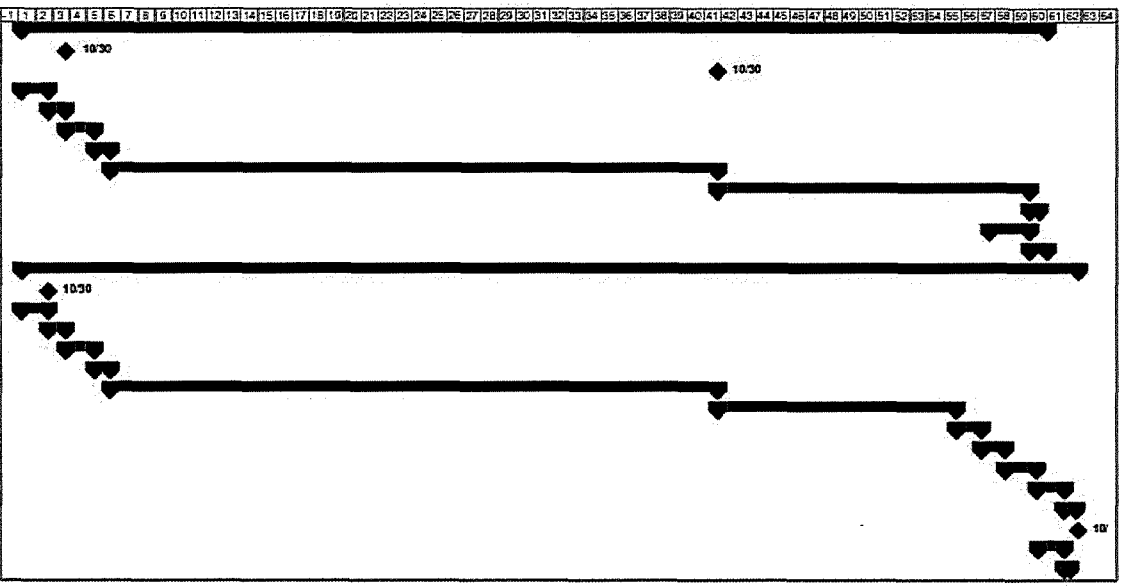
| Account | Total |
|---|---|
| License Termination – 50.75 (c) | $724,688 |
| Spent Fuel – 50.54 (bb) | $259,466 |
| Greenfield | $36,447 |
| ISFSI D&D 72.30 | $1,640 |
| **Total** | **$1,022,240** |

Note: Numbers may not add due to rounding.

The estimate is based on site-specific plant systems and buildings inventories. These inventories, and Energy*Solutions*' proprietary Unit Cost Factors (UCFs), were used to generate required manhours, activity schedule hours and costs, and waste volume, weight, and classification. Based on the activity schedule hours and a decommissioning activities analysis, a Critical Path Method (CPM) analysis was performed to determine the decommissioning schedules. These schedules reflect the effects of sequenced activity-dependent or distributed decommissioning elements such as planning and preparations, major component removal, building decontamination, and spent fuel shipping. The schedules are divided into project phases (periods) and presented, as noted previously, by cost account "License Termination," "Spent Fuel Management," "ISFSI D&D," or "Greenfield." The summary schedule is shown in Figure 1-1 and may also be found in Section 6.0 of this report.

## Figure 1-1
## Summary SAFSTOR Schedule

| Task Name | Start | Finish |
|---|---|---|
| Spent Fuel Management | 04/01/2019 | 01/12/2079 |
| Zirconium Fire Window Closes | 10/30/2021 | 10/30/2021 |
| Spent Fuel Shipping Complete | 10/30/2059 | 10/30/2059 |
| SNF Pd 1 - Spent Fuel Planning | 04/01/2019 | 10/30/2020 |
| SNF Pd 2 - Spent Fuel Cooling During Zirc Fire Window | 10/30/2020 | 10/30/2021 |
| SNF Pd 3 - Spent Fuel Transfer to Dry Storage | 10/30/2021 | 08/31/2023 |
| SNF Pd 3 - Dry Storage During Completion of SAFSTOR Preparations | 08/31/2023 | 08/1/2024 |
| SNF Pd 4 - Dry Storage During Dormancy | 08/1/2024 | 10/30/2059 |
| SNF Pd 5 - ISFSI Demolition Delay | 10/30/2059 | 12/31/2077 |
| SNF Pd 6 - ISFSI and Support Structure Clean Demolition | 12/31/2077 | 07/28/2078 |
| ISFSI D&D Pd 1 - ISFSI D&D Planning | 08/23/2075 | 12/30/2077 |
| ISFSI D&D Pd 2 - ISFSI Final Status Survey | 12/30/2077 | 01/12/2079 |
| License Termination | 04/01/2019 | 10/29/2080 |
| Unit 1 Shutdown | 10/30/2020 | 10/30/2020 |
| Decon Pd 1 - SAFSTOR Planning Prior to Shutdown | 04/01/2019 | 10/30/2020 |
| Decon Pd 2 - Transition Following Shutdown | 10/30/2020 | 10/30/2021 |
| Decon Pd 3 - SAFSTOR Preparations Delay During Fuel Transfer | 10/30/2021 | 08/31/2023 |
| Decon Pd 4 - Completion of SAFSTOR Preparations | 08/31/2023 | 08/1/2024 |
| Decon Pd 5 - Dormancy During Dry Storage | 08/1/2024 | 10/30/2059 |
| Decon Pd 6 - Dormancy Only | 10/30/2059 | 09/26/2073 |
| Decon Pd 7 - Decommissioning Planning During Dormancy | 09/26/2073 | 03/07/2075 |
| Decon Pd 8 - Internals Segmentation and Site Preparations | 03/07/2075 | 07/16/2076 |
| Decon Pd 9 - Major Component and Systems Removal | 07/16/2076 | 05/19/2078 |
| Decon Pd 10 - Building Decontamination | 05/19/2078 | 01/03/2080 |
| Decon Pd 11 - License Termination | 01/03/2080 | 09/19/2080 |
| End 60 year SAFSTOR | 10/29/2080 | 10/29/2080 |
| Grn Pd 1 - Clean Building Demolition During Decommissioning | 06/22/2078 | 01/03/2080 |
| Grn Pd 2 - Site Restoration | 01/03/2080 | 05/08/2080 |



# 2.0 INTRODUCTION

## 2.1 Study Objective

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The DCE methodology follows the basic approach originally presented in the Atomic Industrial Forum/National Environmental Studies Project Report AIF/NESP-036, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," (Ref. No. 2). The report was prepared in accordance with Nuclear Regulatory Commission (NRC) Regulatory Guide 1.202, "Standard Format and Content of Decommissioning Cost Estimates for Nuclear Power Reactors," (Ref. No. 3). The estimate is based on compliance with current regulatory requirements and proven decommissioning technologies.

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- Termination of spent fuel pool operation approximately three years after permanent shutdown.
- Following shutdown Phase II and III of the ISFSI will be constructed and all spent fuel will be transferred to Multi-Purpose Canisters (MPCs) for interim.
- SAFSTOR methodology, with decommissioning completed within 60 years of shutdown.
- Decommissioning will be performed by the utility staff and a Decommissioning General Contractor (DGC).

## 2.2 Regulatory Framework

Provisions of current laws and regulations affecting decommissioning, waste management, and spent fuel management are as follows:

1. NRC regulations require a license for on-site storage of spent fuel. Wet storage in a spent fuel pool is authorized by a facility's 10 CFR Part 50 license. On-site dry

storage of spent fuel at an Independent Spent Fuel Storage Installation (ISFSI) is licensed by either: (a) the general license set forth in 10 CFR 72.210, which requires that a Part 50 license be in place; or (b) a site-specific ISFSI license issued pursuant to 10 CFR Part 72.

2. 10 CFR 50.75 (c) requires funding by the licensee of the facility for the decommissioning program, but specifically excludes the cost of removal and disposal of spent fuel and the removal of clean structures.

3. 10 CFR 50.54 (bb) requires the licensee, within two years following permanent cessation of operation of the reactor or five years before expiration of the operating license, whichever occurs first, to submit written notification to the NRC for its review and preliminary approval of the program by which the licensee intends to manage and provide funding "for the management of all irradiated fuel at the reactor upon expiration of the reactor operating license until title to the irradiated fuel and possession of the fuel is transferred to the Secretary of Energy for its ultimate disposal in a repository." However, the NRC does not currently consider post-shutdown spent fuel management costs to be decommissioning costs.

4. 10 CFR 72.30 (b) requires that a licensee under Part 72 must submit a decommissioning funding plan that contains information that provides assurance that funds will be available to decommission the ISFSI.

Decommissioning Alternatives

The three methods for decommissioning are DECON, SAFSTOR, and ENTOMB, which are summarized as follows:

1. DECON: The equipment, structures, and portions of the facility and site that contain radioactive contaminants are promptly removed or decontaminated to a level that permits termination of the license after cessation of operations.

2. SAFSTOR: The facility is placed in a safe, stable condition and maintained in that state (safe storage). The facility is decontaminated and dismantled at the end of the storage period to levels that permit license termination. NRC regulations require decommissioning to be completed within 60 years of cessation of operation.

3. ENTOMB: Radioactive structures, systems, and components are encased in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained and monitored until radioactivity decays to a level that permits termination of the license. Since entombment will exceed the requirement for decommissioning to be completed within 60 years of cessation of operation, NRC handles entombment requests on a case-by-case basis.

The selection of a preferred decommissioning alternative is influenced by a number of factors pertinent at the time of final plant shutdown. These factors include the cost of each decommissioning alternative, minimization of occupational radiation exposure, availability of a

low-level waste disposal facility, availability of a high-level waste (spent fuel) repository, regulatory requirements, and public comments.

Post-Shutdown Spent Fuel Management Alternatives

Selection of a decommissioning strategy and the associated schedule for completion is in part contingent upon an assumed start date for DOE acceptance of spent fuel and an assumed end date for completion of the transfer of all spent fuel assemblies projected to be generated during a power reactor's operating life. The basic options for long-term post-shutdown spent fuel management currently available to power plant operators are (1) wet storage consisting of continued maintenance and operation of the spent fuel pool, and (2) dry storage consisting of transfer of spent fuel from the fuel pool to on-site dry storage modules after a cooling period. Maintaining the spent fuel pool for an extended duration following cessation of operations prevents termination of the Part 50 license and typically has a higher annual maintenance and operating cost than the dry storage alternative. Transfer of spent fuel to an ISFSI requires additional capital expenditures for purchase and construction of the ISFSI and dismantlement and disposal of the ISFSI following completion of spent fuel transfer to DOE. In both cases the decommissioning and spent fuel management costs are significantly affected by the assumed start and end dates for DOE acceptance of spent fuel.

In January 2013, DOE released its "Strategy for Management and Disposal of Used Nuclear Fuel and High Level Radioactive Waste" (Ref. No. 5). The DOE Strategy contemplates building the capability to begin executing DOE's commitment to address waste disposal within the next ten years. Under this Strategy, by 2021, operation would begin of a "pilot storage facility" with an "initial focus on accepting spent fuel from shutdown reactor sites." By 2025, a "larger interim storage facility" would be available, and by 2048, a geologic repository would commence operations.

For purposes of this DCE, DAEC has conservatively assumed that the larger interim storage facility is delayed five years and commences operations in 2030. DAEC has further assumed that the DOE acceptance rate is consistent with the 2004 "Acceptance Priority Ranking & Annual Capacity Report" (Ref. No. 6), which is the most current information regarding acceptance of fuel.

# 3.0 STUDY METHODOLOGY

## 3.1 General Description

Energy*Solutions* maintains a proprietary decommissioning cost model based upon the fundamental technical approach established in AIF/NESP-036, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," dated May 1986 (Ref. No. 2). The cost model has been updated in accordance with regulatory requirements and industry experience. The cost model includes elements for estimating distributed and undistributed costs. Distributed costs are activity specific and include planning and preparation costs as well as the decontamination, packaging, disposal, and removal of major components and systems. For example, the segmentation, packaging, and disposal of the reactor internals is a distributed cost. Undistributed costs, sometimes referred to as collateral costs, are typically time dependent costs such as utility and DGC staff, property taxes, insurance, regulatory fees and permits, energy costs, and security staff.

The methodology for preparing cost estimates for a selected decommissioning alternative requires development of a site-specific detailed work activity sequence based upon the plant inventory. The activity sequence is used to define the labor, material, equipment, energy resources, and duration required for each activity. In the case of major components, individual work sequence activity analyses are performed based on the physical and radiological characteristics of the component and the packaging, transportation, and disposal options available.

In the case of structures and small components and equipment such as piping, pumps, and tanks, the work durations and costs are calculated based on Unit Cost Factors (UCFs). UCFs are economic parameters developed to express costs per unit of work output, piece of equipment, or time. They are developed using decommissioning experience, information on the latest technology applicable to decommissioning, and engineering judgment. The total cost of a specific decommissioning activity can be determined by multiplying the total number of units associated with that activity by the UCF, expressed as $/unit, for that activity. For example, the estimated demolition cost of a non-contaminated concrete structure can be obtained by multiplying the volume of concrete in the structure by the UCF for non-contaminated reinforced concrete demolition, expressed in $/unit volume. Each UCF has associated with it a man-hours/unit and schedule-hours/unit. From these values, total man-hours and total schedule-hours can be determined for a particular activity.

## 3.2 Schedule Analysis

Once the work activity durations are calculated for all distributed activities, a critical path schedule analysis is performed using Microsoft Project. The schedule accounts for constraints such as spent fuel cooling periods and regulatory reviews. The schedule is typically delineated into phases or time periods (hereinafter referred to as period or periods) that differentiate manpower requirements and undistributed costs.

In order to differentiate between License Termination, Spent Fuel, Greenfield, and ISFSI D&D elements of the entire decommissioning scope of work, Energy*Solutions* has established a Work Breakdown Schedule (WBS) and cost accounting system to treat each element as a subproject.

Accordingly, the overall project schedule is divided into interrelated periods with major milestones defining the beginning and ending of each period. The major milestones also serve as the basis for integrating the periods of the four subprojects.

## 3.3 Decommissioning Staff

A site-specific staffing plan was developed by DAEC and Energy*Solutions* based on the existing DAEC operational staff and the assumption that the decommissioning will be performed by a DGC, with oversight and management of the DGC performed by DAEC staff. It was also assumed that DAEC staff would be supplemented by professional consulting engineering, particularly in the planning and preparation phase. The DAEC existing salary structure serves as the basis for calculating DAEC staff labor costs. The DGC salary costs are based on industry data.

Staffing levels for each project period are based on the AIF guidelines and industry experience. The sizes of the DAEC and DGC staffs are varied in each period in accordance with regulatory requirements and work activities.

## 3.4 Waste Disposal

Waste management costs comprise a significant portion of the decommissioning cost estimate. Additionally, limited future access to disposal sites licensed for receipt of Class B and C wastes introduces a significant level of uncertainty with respect to the appropriateness of using existing rate structures to estimate disposal costs of these wastes. The approach used in this DCE to estimate waste disposal costs is discussed in the following paragraphs.

Waste Classification

Regulations governing disposal of radioactive waste are stringent in order to ensure control of the waste and preclude adverse impact on public health and safety. At present, LLRW disposal is controlled by NRC regulation 10 CFR 61, which went into effect December, 1983. This regulation stipulates the criteria for the establishment and operation of shallow-land LLRW burial facilities. Embodied within this regulation are criteria and classifications for packaging LLRW such that it is acceptable for burial at licensed LLRW disposal sites.

For each waste classification, 10 CFR 61 stipulates specific criteria for physical and chemical properties that the LLRW must meet in order to be accepted at a licensed disposal site. The LLRW disposal criteria of 10 CFR 61 require that LLRW generators determine the proportional amount of a number of specific radioactive isotopes present in each container of disposable LLRW. This requirement for isotopic analysis of each container of disposable LLRW is met by employing a combination of analytical techniques such as computerized analyses based upon scaling factors, sample laboratory analyses, and direct assay methods. After performing an isotopic analysis of each container of disposable LLRW, the waste must then be classified according to one of the classifications (Class A, B, C, or Greater Than Class C (GTCC) as defined in 10 CFR 61.

The classification of LLRW resulting from decommissioning activities is based on AIF/NESP-036 (Ref. No. 2) and NUREG/CR-0672 for Boiling Water Reactors (BWRs) (Ref. No. 8), and

recent industry experience. The estimated curie content of the reactor vessel and internals at shutdown is derived from NUREG/CR-0672 and adjusted for the different mass of components as well as the period of decay.

Packaging

Selection of the type and quantity of containers required for Class B and C wastes is based on the most restrictive of the following constraints: curie content, dose-rate, container weight limit, or container volume limit. GTCC waste from segmentation of the reactor vessel internals is packaged in MPCs. The selection of container type for Class A waste is based on the transportation mode (rail, truck, barge, etc.) and waste form. The quantity of Class A waste containers is determined by the most restrictive of either container weight limit or container volume limit. Large components, such as steam generators, pressurizers, and reactor recirculation pumps, are shipped as their own container with shielding as required.

Container costs are obtained from manufacturers. Shielded transport cask and liner costs are obtained from the cask owners and operators.

Transportation

Transportation routes to processing and disposal facilities are determined based on available transportation modes (truck, rail, barge, or combinations). Transportation costs for the selected routes and modes are obtained from vendor quotes or published tariffs whenever possible.

Class A Disposal Options and Rates

In accordance with the existing LOP Disposal Agreement (Ref. No. 9), all Class A waste that meets the Clive facility waste acceptance criteria is to be disposed of at Clive. All reported waste disposal costs include packaging, transportation, and any applicable surcharges.

Class B and C Disposal Options and Rates

Currently, within the United States, there are only three operational commercial disposal facilities licensed to accept Class B and C LLRW: the Barnwell facility, operated by Energy*Solutions* in Barnwell, South Carolina; the U.S. Ecology facility in Richland, Washington; and the facility in Andrews County, Texas operated by Waste Control Specialists. Barnwell only accepts waste from states within the Atlantic Compact, and U.S. Ecology only accepts waste from states within the Northwest and Rocky Mountain Compacts. However, the WCS facility will accept waste from the Texas Compact (comprised of Texas and Vermont) and non-Compact generators. The Texas Compact Commission on March 23, 2012 approved amendments to rules allowing the import of non-compact generator LLRW for disposal at the Andrews County facility.

Greater Than Class C (GTCC)

Wastes identified as 10 CFR 61 Class A, B, and C may be disposed of at a near-surface disposal facility. Certain components are highly activated and may exceed the radionuclide concentration limitations for 10 CFR 61 Class C waste. In accordance with 10 CFR 61, these components

cannot be disposed of in a near-surface LLRW disposal facility and must be transferred to a geologic repository or a similar site approved by the NRC.

Highly activated sections of the reactor vessel internals will result in GTCC waste. Presently, a facility does not exist for the disposal of wastes exceeding 10 CFR 61 Class C limitations. The courts have held that DOE is obligated to accept and dispose of GTCC and, therefore, this estimate assumes that the DOE will accept this waste along with spent fuel. Although there may be no additional costs for DOE disposal of GTCC, this estimate conservatively assumes a GTCC waste disposal cost. This estimate further assumes that the GTCC waste will be packaged in DSCs and will be shipped to a storage or disposal facility by DOE along with the spent fuel at a shipping costs equivalent to the commercial cost of shipping a Type B licensed, shielded cask such as the CNS 8-120B cask.

LLRW Volume Reduction

Based on current Class A LLRW disposal rates on-site volume reduction techniques such as waste compaction or an aggressive decontamination, survey and release effort are not currently considered to be cost effective over disposal.

Non-Radioactive Non-Hazardous Waste Disposal

Energy*Solutions* assumes that recyclable, non-radioactive scrap metal resulting from the decommissioning program will be transported to a scrap metal dealer. However, no credit is assumed in the estimate for the value of the scrap metal. Concrete debris is assumed to be processed by size reduction, with removal of structural reinforcing steel, and used on site as engineered fill for voids. Asphalt from parking lots and roadways is assumed to be stockpiled on site and removed, at no cost to the project, by a recycler. All other demolition debris is removed from the site and disposed of at a local construction debris landfill.

Hazardous and Industrial Waste Disposal

Lead shielding remaining after shutdown is assumed to be removed from its installed locations and disposed of as a mixed waste. In accordance with information furnished by DAEC thirty percent of insulated systems in radiologically controlled areas are assumed to contain asbestos, therefore; this DCE includes a line item for asbestos abatement. The decommissioning estimate also includes an estimate for hazardous and industrial waste disposal based on information provided by DAEC. The cost of hazardous and industrial waste disposal includes DAEC's estimated cost for closure of Resource Conservation and Recovery Act (RCRA) storage areas. Additionally, surfaces coated with lead based paint will be remediated as required for demolition.

## 3.5 Final Status Survey

The cost of performing a final status survey (FSS) is based on NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)" (Ref. No. 10). Estimates of MARSSIM Class I, II, and III survey designations are based on radiological characterization data furnished by DAEC and assumptions regarding contamination resulting from small and large component removal activities. The FSS activity cost calculation includes the in-place remote

survey of underground metal and concrete pipe, soil, and groundwater sampling and analysis. Estimated costs for NRC and Oak Ridge Institute for Science and Education (ORISE) verification are also included, and the NRC review period is incorporated into the project schedule.

## 3.6 Contingency

Contingencies are applied to cost estimates primarily to allow for unknown or unplanned occurrences during the actual program, e.g. increased radioactive waste materials volumes over that expected, equipment breakdowns, weather delays, labor strikes, etc. This is consistent with the definition provided in the DOE Cost Estimating Guide, DOE G 430.1-1, 3-28-97 (DOE G) (Ref. No. 11): Contingency "Covers costs that may result from incomplete design, unforeseen and unpredictable conditions, or uncertainties within the defined project scope. The amount of contingency will depend on the status of design, procurement, and construction; and the complexity and uncertainties of the component parts of the project. Contingency is not to be used to avoid making an accurate assessment of expected costs." Energy*Solutions* determines site-specific contingency factors to be applied to each estimate based on industry practices.

The DOE has established a recommended range of contingencies as a function of completeness of program design, DOE G. The ranges are:

| Type of Estimate | Contingency Range as a % of Total Estimate |
|---|---|
| Planning Phase Estimate | 20-30 |
| Budget Estimate | 15-25 |
| Title I (Preliminary Design Estimate) | 10-20 |
| Title II (Definitive Design Estimate) | 5-15 |

Energy*Solutions'* approach to assigning appropriate contingency rates is based on adaptations of published values for the specific decommissioning activities. One source for such published information is AIF/NESP-036 "Guidelines for Producing Nuclear Plant Decommissioning Cost Estimates" (Ref. No. 2). The AIF guideline identifies contingencies for activities specific to a nuclear power plant decommissioning, such as reactor internals removal. The contingencies presented in the AIF guideline are based on the assumption that the estimated costs are not well known; therefore, the recommended contingencies are greater than they would be if the estimated costs were well known. With the exception of the system decontamination, reactor vessel and reactor internals removal, and disposal, the contingencies presented in the AIF guideline are consistent with the values presented in DOE G 430.1-1 for a Budget/Title I estimate. The system decontamination, reactor vessel and reactor internals removal, and disposal contingencies recommended in the AIF guideline are significantly higher than the ranges identified by the DOE, even for a planning phase document. This is due to the unique nature of these activities and the relatively small amount of historical data available at the time the AIF document was written.

This estimate applies site-specific contingency factors to each WBS element based on industry practices. The contingencies rates applied in this estimate are specific to decommissioning estimates consistent with information presented in AIF guideline and DOE G. The

decommissioning costs generated in the estimate are considered well known and, as such, the contingencies presented in AIF guideline were reduced for each category of costs. There have also been a number of large-scale decommissioning projects since AIF was published, providing some historical information that has been used in preparing this estimate. This allows for additional reduction in contingency costs. The following table provides a summary of contingency values applied in this estimate where the plant structures, systems, and major component material inventories are well defined, as with this study.

| Category | Labor | Material & Equipment | Package Ship & Bury | Other |
|---|---|---|---|---|
| Engineering | 13% | | | |
| Contaminated components/Concrete | 23% | 23% | 23% | |
| Clean components | 13% | 13% | 13% | |
| Reactor Vessel and Reactor Internals | 50% | 23% | 25% | |
| Other | | | | 15% |

The above contingency categories address the difference in uncertainty associated with performance of the work. In the case of a power plant decommissioning project, the segmentation of the reactor internals and pressure vessel and removal of radiologically contaminated plant systems and structures have the highest degree of uncertainty and are therefore assigned the higher contingency rates.

## 3.7 Cost Reporting

Total project costs are aggregated from the distributed activity and undistributed costs into the following categories – Labor, Materials and Equipment, Waste Disposal, and Other costs. Other costs include property taxes, insurance, license fees, permits, and energy. Waste Disposal costs are the summation of packaging, transportation, base disposal rate, and any applicable surcharges. Health physics (HP) supplies and small tool costs are calculated as a component of each distributed activity cost and included in the category of Material and Equipment, with the exception that HP supplies for third party HP staff are calculated and reported as an undistributed line item. A line item specific contingency is then calculated for each activity cost element.

# 4.0 SITE SPECIFIC TECHNICAL APPROACH

## 4.1 Facility Description

DAEC is a nuclear powered electrical generating facility consisting of one BWR located on a site near Palo in Linn County, Iowa. The plant site comprises approximately 500 acres adjacent to the Cedar River approximately 2.5 miles northeast of the Village of Palo, Iowa.

The nuclear system includes a single-cycle, forced-circulation, General Electric (GE) BWR producing steam for direct use in the steam turbine. The nuclear steam supply system (NSSS) and the turbine-generator were furnished by GE. The balance of plant was designed and constructed by Bechtel Power Corporation (Bechtel) as architect engineer and constructor.

The unit was originally designed, analyzed, and licensed for a steady-state core power of 1,658 MWt, although the plant Technical Specifications restricted operation to a rated power of 1,593 MWt. In 1985, the Technical Specifications were amended to allow the DAEC to operate at a steady-state power level of 1,658 MWt (License Amendment #115). Then, in 2001, the rated power level was increased again to 1,912 MWt (License Amendment #243). The current shutdown date is October 30, 2020.

Spent fuel assemblies are stored in the spent fuel storage racks in the spent fuel pool or may, after appropriate decay, be transferred to an ISFSI for interim onsite storage. The re-rack project of 1994 increased the spent fuel pool capacity to 2,411 assemblies. In addition, racks were licensed for the cask pit to retain full-core offload capability. The cask pit racks have a storage capacity of 323 assemblies, but are not licensed for long term storage.

There is an ISFSI on site that houses 10 CFR 72 licensed spent fuel storage systems that can provide interim on-site storage of spent fuel and reactor-related GTCC waste.

Appendix A provides a list of the DAEC systems and structures included in the material inventory for this study.

## 4.2 Decommissioning Periods for SAFSTOR

The project periods for SAFSTOR consist of eleven License Termination periods, seven Spent Fuel Management periods, two Greenfield periods, and two ISFSI D&D periods. The project periods defined for this site-specific study and the major activities performed during each period are as follows:

**License Termination Periods**

Decon Pd 1 – SAFSTOR Planning Prior to Shutdown
- SAFSTOR Planning and Design
- Preparation of SAFSTOR Plan and License Documents

Decon Pd 2 – Transition Following Shutdown
- Perform Historical Site Assessment and Site Characterization
- Flush, Drain, and De-Energize Non-Essential Systems
- Volume Reduce Control Rod Blades, Fuel Channels, and LPRMs
- General Area Cleanup

Decon Pd 3 – SAFSTOR Preparation Delay During Spent Fuel Pool Operations
- Periodic Maintenance, Surveillance and Inspection of Non-fuel Related Systems and Structures

Decon Pd 4 – Completion of SAFSTOR Preparations
- Flush and Drain Essential Systems Following Fuel Pool Closure
- Secure Site for Dormancy Period
- Drain and De-Energize Remaining Systems and Secure Site

Decon Pd 5 – Dormancy With Dry Storage
- Periodic Maintenance, Surveillance, and Inspection of Non-fuel Related Systems and Structures
- Bituminous Roof Replacement – 20 year
- Bituminous Roof Replacement – 40 year

Decon Pd 6 – Dormancy Only
- Periodic Maintenance, Surveillance and Inspection of Non-fuel Related Systems and Structures

Decon Pd 7 – Decommissioning Planning During Dormancy
- Decommissioning Planning and Design
- Planning and Design of Site Revitalization

Decon Pd 8 – Internals Segmentation and Site Preparations
- Revitalize Infrastructure and Re-Power Site
- Perform Post-SAFSTOR Baseline Radiation Survey
- Remove and Dispose of Spent Fuel Storage Racks
- Segment, Package, and Ship Reactor Internals
- Construct Site Modifications
- Preparation of License Termination Plan

Decon Pd 9 – Major Component and Systems Removal
- Remove, Package, and Dispose of Non-Essential Systems
- Segment, Package, and Dispose of Nuclear Steam Supply System
- Perform Asbestos Abatement on Plant Systems
- Remove and Dispose of Control Rod Drives

- Package and Ship Reactor Pressure Vessel
- Remove, Package, and Dispose of Remaining Active Plant Systems

Decon Pd 10 – Building Decontamination
- Decontaminate Structures
- Remove Underground Storm Drains and Manholes
- Final Status Survey for Structures
- Final Status Survey for Land Areas

Decon Pd 11 – License Termination
- NRC Review and Approval of the Final Status Survey

**Spent Fuel Management Periods**

SNF Pd 1 – Fuel Pool Island Design
- Design Spent Fuel Support System Modification
- Design Control Room Relocation
- Design Spent Fuel Security Modification

SNF Pd 2 – Spent Fuel Cooling During Zirc Fire Window
- Install Spent Fuel Pool, Control Room, and Security Modifications

SNF Pd 3 – Spent Fuel Transfer to Dry Storage
- Fuel Pool Operation and Maintenance
- Construction of ISFSI Phase II and III Expansion
- Construction of ISFSI Monitoring Building
- Transfer Fuel Assemblies into MPCs

SNF Pd 4 – Dry Storage During Completion SAFSTOR Preparations

SNF Pd 5 – Dry Storage During Dormancy
- Periodic Fuel Shipments to DOE

SNF Pd 6 – ISFSI Demolition Delay

SNF Pd 7 – ISFSI and Support Structure Clean Demolition
- Demolition of HSMs and ISFSI Foundation
- Demolition of ISFSI Security Building and Support Structures
- Site Restoration of ISFSI site

**ISFSI D&D Periods (10 CFR 72.30)**

ISFSI D&D Pd 1 – ISFSI D&D Planning
- Preparation and NRC Review of License Termination Plan

ISFSI D&D Pd 2 – ISFSI Final Status Survey
- Final Status Survey of ISFSI
- Preparation of FSS Report and NRC Review

**Greenfield Periods**

Grn Pd 1 – Clean Building Demolition During Decommissioning
- Demolition of Structures

Grn Pd 2 – Site Restoration
- Finish Grading and Re-Vegetate Site

## 4.3 Decommissioning Staff

A site-specific staffing plan was developed by DAEC and Energy*Solutions* based on the existing DAEC operational staff and the assumption that the decommissioning will be performed by a DGC, with oversight and management of the decommissioning operations performed by DAEC staff. It is also assumed that the DAEC staff will be supplemented by professional consulting engineering, particularly in the planning and preparation phase. The sizes of the staffs are varied in each period in accordance with regulatory requirements and the work activities. Details on the staff levels during each period are provided in Section 6.0.

## 4.4 Spent Fuel Management Staff

The largest spent fuel staff is in place while the fuel pool is operational during the cooling period and when fuel assemblies are being transferred to dry storage. Once all spent fuel has been removed from the spent fuel pool, the staff is reduced. Details on the staff levels during each period are provided in Section 6.0.

## 4.5 Spent Fuel Shipments

The spent fuel shipping schedule was provided by DAEC. The spent fuel shipping schedule is based on the DOE 2004 "Acceptance Priority Ranking & Annual Capacity Report" (Ref. No. 6). The spent fuel shipping schedule is provided in Appendix B.

## 5.0 BASES OF ESTIMATE AND KEY ASSUMPTIONS

The bases of, and key assumptions for, this site-specific decommissioning estimate are presented below.

1. All cost data used in this study is current as of 2018 or has been escalated to 2018 dollars. Totals and subtotals have been rounded to significant figures.

2. The estimate is based on a shutdown date of October 30, 2020.

3. The decommissioning will be performed under the current regulations. These regulations require a Post-Shutdown Decommissioning Activities Report (PSDAR) to be submitted prior to, or within, two years after permanent shutdown. In addition, a certificate of permanent cessation of operations must be submitted to the NRC within 30 days of permanent cessation of operations. Certification of the final core off-load must also be submitted to the NRC upon completion of this activity. 90 days after the NRC receives the PSDAR and after submittal of both certifications, major decommissioning activities that meet the criteria of 10 CFR Part 50.59 may be performed, provided the NRC does not notify DAEC of any deficiencies.

4. The decommissioning will be performed using currently available technologies.

5. The spent fuel shipping schedule assumes DOE begins accepting spent fuel in 2030.

6. The material inventory for this estimate is based on prior Energy*Solutions*' take-offs and has been updated, based on information furnished by DAEC, to reflect major structural modifications.

7. All transformers on site following shutdown are assumed to be polychlorinated biphenyl (PCB)-free; therefore, this estimate does not include costs for disposition of PCB contaminated transformers.

8. Cost for transportation of clean scrap metal to a recycler is included in the estimate; however, no credit is taken for the value of the scrap metal. A portion of the concrete debris is assumed to be processed by size reduction, with removal of structural reinforcing steel, and used on site as engineered fill for voids. All other concrete and demolition debris is removed from the site and disposed of at a local off-site construction landfill.

9. This estimate is based on final site restoration to Greenfield conditions, in which all existing and proposed structures, with the exception of the switchyard, will be removed. Clean demolition costs are based on structures removal to three feet below grade. Clean topsoil will be imported and placed on the top three feet. The entire disturbed area of the site is to be graded, to restore the natural grade to the extent possible, and seeded.

10. Lead shielding remaining after shutdown is assumed to be disposed of as a mixed waste.

11. A budget for hazardous material is included in the estimate, which is based on information provided by DAEC. All other chemicals and hazardous materials present at shutdown are assumed to be removed and disposed of by the plant staff prior to decommissioning, as a normal part of plant operations.

12. No known areas of radiologically contaminated soil have been identified. Additionally, documented tritium levels in groundwater are below drinking water standards. Therefore, no soil or groundwater remediation costs will be assumed.

13. DAEC provided information on the current amount of asbestos insulation on systems piping. It is assumed that asbestos not replaced during an outage and still remaining at shutdown will be limited to areas with higher dose rates. Therefore, this study considers that 30% of the insulation on contaminated and insulated piping will be asbestos and disposed of as Class A waste.

14. Costs for disposition of greater than Class A LLRW either currently stored on site or anticipated to be on site at the time of decommissioning are included in this estimate. The types and quantities of greater than Class A LLRW were provided by DAEC, and include, but are not limited to the following expected to be stored in the spent fuel pool at the time of shutdown:

    27 control blades
    24 Local Power Range Monitors
    25 blade guides
    6 half blade guides

15. All Class A waste is assumed to be disposed of at Energy*Solutions*' facility in Clive, Utah, in accordance with the existing LOP Disposal Agreement between Energy*Solutions* and DAEC (Ref. No. 9).

16. DAEC furnished Class B and C waste disposal rates.

17. DAEC provided costs used to estimate the assumed GTCC disposal cost.

18. GTCC waste generated from the segmentation of the reactor internals will be packaged in MPCs. In this estimate, the MPCs are assumed to be accepted by DOE at the time of the deferred decommissioning.

19. Vessel and internals curie estimates were derived from the values for the Reference BWR vessel and internals in NUREG/CR-0672 (Ref. No. 8) and adjusted for mass and the SAFSTOR decay period.

20. The site-specific classification of radioactive wastes for DAEC identified one components within the reactor vessel (the Core Shroud) will exceed Class C limitations. Two NUHOMs MPCs are assumed to be required and DAEC provided the estimated costs.

21. Spent fuel will remain in the spent fuel pool for approximately three years before being transferred to the ISFSI.

22. Spent fuel management costs include the purchase of dry storage MPCs and HSMs required following shutdown. An estimated cost for labor, material, and equipment for the pool to pad transfer of spent fuel to the ISFSI was provided by DAEC.

23. The existing ISFSI will have to be expanded post-shutdown in order to accommodate all spent fuel. The cost for constructing the ISFSI expansion was furnished by DAEC.

24. The ISFSI pad and HSMs are assumed to have no activated concrete or surface contamination.

25. The 10 CFR Part 50 license will be maintained until DOE has taken possession of the spent fuel.

26. State emergency preparedness, Federal Emergency Management Agency (FEMA) fees, and Environmental Permits costs are based on data furnished by DAEC and were adjusted to meet the requirements of each period based on the status of on-site spent fuel.

27. An estimate of the annual property taxes was furnished by DAEC and included in the estimate.

28. Annual NRC 10 CFR 171.15 fees, for reactors in decommissioning, of $198,000 are included in the estimate.

29. The estimate includes annual NRC inspection fees during each decommissioning period based on the type and level of activities being performed along with NRC review fees for license amendment requests, exemption requests and the License Termination Plan based on NRC's hourly rate of $275 per hour.

30. Annual operating insurance premiums were supplied by DAEC. The premium amounts were adjusted to meet the requirements of each period based on information provided by DAEC.

31. DAEC provided an annual allowance for miscellaneous materials and services to account for costs such as communications, miscellaneous utilities and services, office supplies, and consumables not captured elsewhere in the estimate.

32. DAEC staff positions and average burdened salary data were supplied by DAEC and account for fringe benefits, overhead and payroll taxes.

33. DGC staff salaries, including overhead and profit, were determined by Energy*Solutions* and represent Energy*Solutions*' standard assumptions for these rates

34. DAEC staff severance and retention costs were supplied by DAEC.

35. The current utility staff size is considered to be sufficiently stable to remain virtually unchanged to end of life. For this reason, the utility staff is assumed to be the same size at the time of shutdown.

36. The professional personnel used for the planning and preparation activities are assumed to be paid per diem at the rate of $93/day, based on per diem rates from U.S. General Services Administration (GSA) for Cedar Rapids, Iowa.

37. Craft labor rates were furnished by DAEC. Craft labor rates for disciplines not furnished by DAEC have been taken from the 2018 RS Means Labor Rates for the Construction Industry (Ref. No. 12), for Cedar Rapids, Iowa. Since the skilled laborers are assumed to be supplied by the local union hall, they will not be paid per diem.

38. The security guard force included in this DCE is in accordance with NRC security regulations as implemented by an NRC approved security plan and anticipated amendments to that plan applicable during each decommissioning period following shutdown.

39. This study follows the occupational exposure principles of As Low As Reasonably Achievable (ALARA) through the use of productivity loss factors that incorporate such items as the use of respiratory protection and personnel protective clothing. These factors increase the work duration and cost.

40. The costs of all required safety analyses and safety measures for the protection of the general public, the environment, and decommissioning workers are included in the cost estimates. This reflects the requirements of:

| | |
|---|---|
| 10 CFR 20 | Standards for Protection Against Radiation |
| 10 CFR 50 | Domestic Licensing of Production and Utilization Facilities |
| 10 CFR 61 | Licensing Requirements for Land Disposal of Radioactive Waste |
| 10 CFR 71 | Packaging of Radioactive Material for Transport |
| 10 CFR 72 | Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste |
| 29 CFR 1910 | Occupational Safety and Health Standards |
| 49 CFR 170-189 | Department of Transportation Regulations Governing the Transport of Hazardous Materials |

Regulatory guidance is also provided by Reg. Guide 1.159, Assuring the Availability of Funds for Decommissioning Nuclear Reactors.

41. Activity labor costs do not include any allowance for delays between activities, nor is there any cost allowance for craft labor retained on site while waiting for work to become available.

# 6.0 STUDY RESULTS

## 6.1 60-Year SAFSTOR, 2030 DOE Acceptance, Dry Fuel Storage

Based on the following:

- Shutdown on October 30, 2020.
- DOE begins accepting spent fuel in 2030.
- Termination of spent fuel pool operation approximately three years after permanent shutdown.
- Following shutdown Phase II and III of the ISFSI will be constructed and all spent fuel will be transferred to MPCs.
- SAFSTOR methodology, with decommissioning completed within 60 years of shutdown.
- Decommissioning will be performed by an independent Third Party.

Spent Fuel Shipping Schedule

The spent fuel shipping schedule is provided in Appendix B. All spent fuel will be removed from the spent fuel pool by the end of 2023. All spent fuel will be removed from the ISFSI by the end of 2059.

Cost and Schedule

A summary project schedule is shown in Figure 6-1. A detailed schedule is provided in Appendix C. Table 6-1 summarizes the period durations and total costs, including contingency, for License Termination, Spent Fuel, Greenfield and ISFSI D&D activities. A detailed cost table is provided in Appendix D, and a table of annual expenditures is provided in Appendix E.

Project Staffing

Staffing is based on the assumption that decommissioning will be performed by the utility staff and a DGC. Utility staffing levels, by organizational department and function, for each period are provided in Table 6-2. DGC staffing levels, by organizational department and function, for each period are provided in Table 6-3.

Waste Disposal Volumes

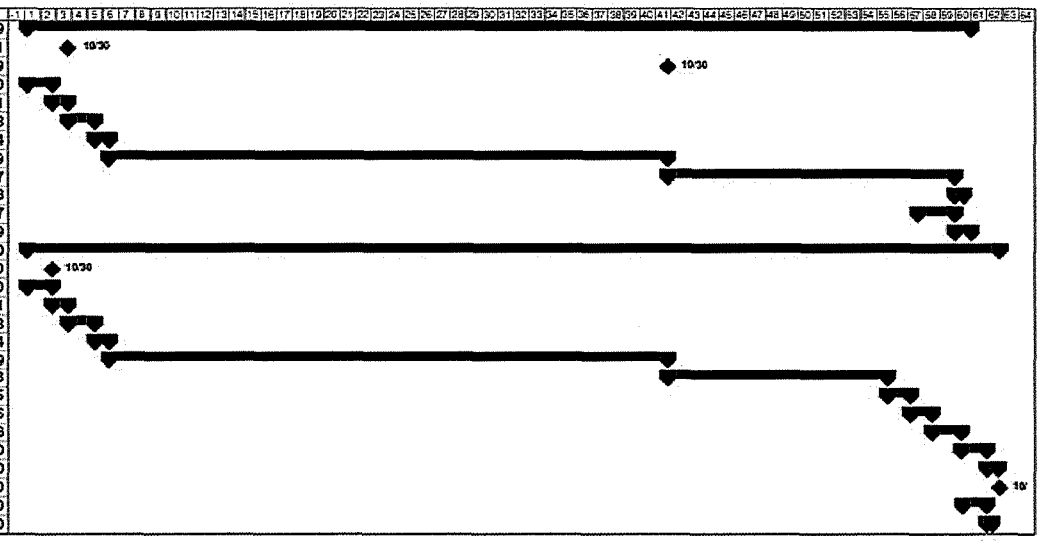
The estimated cubic feet of waste are summarized as follows:

| | |
|---|---|
| Class A | 503,709 |
| Class B | 1,203 |
| Class C | 226 |
| GTCC | 128 |

Waste disposal volumes and costs, itemized by packaging, transportation, surcharges, and disposal costs by waste class and facility, are provided in Table 6-4. The waste disposal costs provided in Table 6-4 do not include contingency.

## Figure 6-1
## Summary SAFSTOR Schedule

| Task Name | Start | Finish |
|---|---|---|
| Spent Fuel Management | 04/01/2019 | 01/12/2079 |
| Zirconium Fire Window Closes | 10/30/2021 | 10/30/2021 |
| Spent Fuel Shipping Complete | 10/30/2059 | 10/30/2059 |
| SNF Pd 1 - Spent Fuel Planning | 04/01/2019 | 10/30/2020 |
| SNF Pd 2 - Spent Fuel Cooling During Zirc Fire Window | 10/30/2020 | 10/30/2021 |
| SNF Pd 3 - Spent Fuel Transfer to Dry Storage | 10/30/2021 | 08/31/2023 |
| SNF Pd 3 - Dry Storage During Completion of SAFSTOR Preparations | 08/31/2023 | 08/1/2024 |
| SNF Pd 4 - Dry Storage During Dormancy | 08/1/2024 | 10/30/2059 |
| SNF Pd 5 - ISFSI Demolition Delay | 10/30/2059 | 12/31/2077 |
| SNF Pd 6 - ISFSI and Support Structure Clean Demolition | 12/31/2077 | 07/28/2078 |
| ISFSI D&D Pd 1 - ISFSI D&D Planning | 08/23/2075 | 12/30/2077 |
| ISFSI D&D Pd 2 - ISFSI Final Status Survey | 12/30/2077 | 01/12/2079 |
| License Termination | 04/01/2019 | 10/29/2080 |
| Unit 1 Shutdown | 10/30/2020 | 10/30/2020 |
| Decon Pd 1 - SAFSTOR Planning Prior to Shutdown | 04/01/2019 | 10/30/2020 |
| Decon Pd 2 - Transition Following Shutdown | 10/30/2020 | 10/30/2021 |
| Decon Pd 3 - SAFSTOR Preparations Delay During Fuel Transfer | 10/30/2021 | 08/31/2023 |
| Decon Pd 4 - Completion of SAFSTOR Preparations | 08/31/2023 | 08/1/2024 |
| Decon Pd 5 - Dormancy During Dry Storage | 08/1/2024 | 10/30/2059 |
| Decon Pd 6 - Dormancy Only | 10/30/2059 | 09/26/2073 |
| Decon Pd 7 - Decommissioning Planning During Dormancy | 09/26/2073 | 03/07/2075 |
| Decon Pd 8 - Internals Segmentation and Site Preparations | 03/07/2075 | 07/16/2076 |
| Decon Pd 9 - Major Component and Systems Removal | 07/16/2076 | 05/19/2078 |
| Decon Pd 10 - Building Decontamination | 05/19/2078 | 01/03/2080 |
| Decon Pd 11 - License Termination | 01/03/2080 | 09/19/2080 |
| End 60 year SAFSTOR | 10/29/2080 | 10/29/2080 |
| Grn Pd 1 - Clean Building Demolition During Decommissioning | 06/22/2078 | 01/03/2080 |
| Grn Pd 2 - Site Restoration | 01/03/2080 | 05/08/2080 |



## Table 6-1
## Cost and Schedule Summary
## (2018 Dollars in Thousands)

| Period No. | Period Description | Start | End | Years | Total Cost |
|---|---|---|---|---|---|
| **License Termination (50.75(c))** | | | | | |
| Decon Pd 1 | SAFSTOR Planning Prior to Shutdown | 4/1/2019 | 10/30/2020 | 1.58 | $11,509 |
| Decon Pd 2 | Transition Following Shutdown | 10/30/2020 | 10/30/2021 | 0.99 | $71,649 |
| Decon Pd 3 | SAFSTOR Preparation Delay During Spent Fuel Pool Operations | 10/30/2021 | 8/31/2023 | 1.83 | $20,113 |
| Decon Pd 4 | Completion of SAFSTOR Preparations | 8/31/2023 | 8/1/2024 | 0.91 | $19,315 |
| Decon Pd 5 | Dormancy With Dry Storage | 8/1/2024 | 10/30/2059 | 35.24 | $64,860 |
| Decon Pd 6 | Dormancy Only | 10/30/2059 | 9/26/2073 | 13.90 | $37,311 |
| Decon Pd 7 | Decommissioning Planning During Dormancy | 9/26/2073 | 3/7/2075 | 1.44 | $50,840 |
| Decon Pd 8 | Internals Segmentation and Site Preparations | 3/7/2075 | 7/16/2076 | 1.36 | $120,283 |
| Decon Pd 9 | Major Component and Systems Removal | 7/16/2076 | 5/19/2078 | 1.83 | $221,117 |
| Decon Pd 10 | Building Decontamination | 5/19/2078 | 1/3/2080 | 1.62 | $103,240 |
| Decon Pd 11 | License Termination | 1/3/2080 | 9/19/2080 | 0.71 | $4,451 |
| **Account Total** | | | | 61.41 | **$724,688** |
| **Spent Fuel** | **(50.54(bb))** | | | | |
| SNF Pd 1 | Spent Fuel Planning | 4/1/2019 | 10/30/2020 | 1.58 | $443 |
| SNF Pd 2 | Spent Fuel Cooling During Zirc Fire Window | 10/30/2020 | 10/30/2021 | 0.99 | $18,432 |
| SNF Pd 3 | Spent Fuel Transfer to Dry Storage | 10/30/2021 | 8/31/2023 | 1.83 | $111,169 |
| SNF Pd 4 | Dry Storage During Completion of SAFSTOR Preparations | 8/31/2023 | 8/1/2024 | 0.91 | $2,941 |
| SNF Pd 5 | Dry Storage During Dormancy | 8/1/2024 | 10/30/2059 | 35.24 | $121,582 |
| SNF Pd 6 | ISFSI Demolition Delay | 10/30/2059 | 12/31/2077 | 18.17 | $0 |
| SNF Pd 7 | ISFSI and Support Structure Clean Demolition | 12/31/2077 | 7/28/2078 | 0.57 | $4,898 |
| **Account Total** | | | | 59.29 | **$259,466** |
| **Greenfield** | | | | | |
| Grn Pd 1 | Clean Building Demolition During Decommissioning | 6/22/2078 | 1/3/2080 | 1.53 | $34,233 |
| Grn Pd 2 | Site Restoration | 1/3/2080 | 5/8/2080 | 0.34 | $2,214 |
| **Account Total** | | | | 1.87 | **$36,447** |
| **ISFSI D&D** | **(72.30)** | | | | |
| ISFSI D&D Pd 1 | ISFSI D&D Planning | 8/23/2075 | 12/30/2077 | 2.35 | $887 |
| ISFSI D&D Pd 2 | ISFSI Final Status Survey | 12/30/2077 | 1/12/2079 | 1.03 | $754 |
| **Account Total** | | | | 3.38 | **$1,640** |
| **Scenario Total** | | | | | **$1,022,240** |

Note: Numbers may not add due to rounding.

## Table 6-2
## Utility Staff Levels[1]

**License Termination – 50.75(c) Utility Staff**

| Department | Decon Pd 1 | Decon Pd 2 | Decon Pd 3 | Decon Pd 4 | Decon Pd 5 | Decon Pd 6 | Decon Pd 7 | Decon Pd 8 | Decon Pd 9 | Decon Pd 10 | Decon Pd 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Administration and Support | 1 | 22 | 3 | 3 | 0 | 0 | 3.50 | 10 | 10 | 8.5 | 3 |
| Emergency Preparedness | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Engineering, Oversight and Licensing | 9.75 | 43 | 3 | 3 | 0 | 0 | 12 | 16.75 | 15.25 | 11 | 2 |
| Executive Management | 0.25 | 10 | 1 | 1 | 2 | 2 | 2.50 | 3 | 3 | 3 | 1 |
| Plant Maintenance | 1.5 | 47 | 4 | 4 | 1 | 1 | 1 | 19 | 10 | 5 | 0 |
| Plant Operations[2] | 1.25 | 44.83 | 3 | 3 | 0 | 0 | 0 | 4 | 4 | 1 | 0 |
| Quality Assurance | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 3 | 2 |
| Radiation Protection & Chemistry | 2.75 | 26 | 5 | 5 | 2 | 2 | 4.5 | 19 | 37 | 37 | 1 |
| **Period Totals** | **17** | **194.83** | **19** | **19** | **5** | **5** | **23.75** | **73.75** | **82.25** | **68.5** | **9** |

**Spent Fuel - 50.54(bb) Utility Staff**

| Department | SNF Pd 1 | SNF Pd 2 | SNF Pd 3 | SNF Pd 4 | SNF Pd 5 | SNF Pd 6 | SNF Pd 7 |
|---|---|---|---|---|---|---|---|
| Administration and Support | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 |
| Emergency Preparedness | 0 | 4 | 4 | 0 | 0 | 0 | 0 |
| Engineering, Oversight and Licensing | 0.75 | 0 | 0 | 0 | 0 | 0 | 1.25 |
| Plant Maintenance | 0.25 | 0 | 0 | 0 | 0 | 0 | 0 |
| Radiation Protection & Chemistry | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 |
| Spent Fuel Pool Operations | 0 | 45 | 45 | 0 | 0 | 0 | 0 |
| **Period Total** | **1** | **49** | **49** | **0** | **0** | **0** | **2.25** |

[1] Security staff levels are safeguards information and therefore not included.
[2] Plant Operations staff during Decon Pd 2 includes personnel required to defuel the reactor.

## Table 6-2 (Continued)
## Utility Staff Levels

**Greenfield – Utility Staff**

| Department | Grn Pd 1 | Grn Pd 2 |
|---|---|---|
| Administration and Support | 0.5 | 0.5 |
| Engineering, Oversight and Licensing | 2.5 | 2 |
| Executive Management | 0 | 0.25 |
| Quality Assurance | 0.75 | 0 |
| Radiation Protection & Chemistry | 0 | 0.25 |
| **Period Totals** | **3.75** | **3** |

**ISFSI D&D – Utility Staff**

| Department | ISFSI D&D Pd 1 | ISFSI D&D Pd 2 |
|---|---|---|
| Engineering, Oversight and Licensing | 1 | 1 |
| Quality Assurance | 0 | 0.75 |
| Radiation Protection & Chemistry | 0.5 | 0.5 |
| **Period Totals** | **1.5** | **2.25** |

## Table 6-3
## Decommissioning General Contractor (DGC) Staff Levels

**License Termination – 50.75(c) DGC Staff**

| Department | Decon Pd 1 | Decon Pd 2 | Decon Pd 3 | Decon Pd 4 | Decon Pd 5 | Decon Pd 6 | Decon Pd 7 | Decon Pd 8 | Decon Pd 9 | Decon Pd 10 | Decon Pd 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Administration | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 9 | 9 | 9 | 1 |
| Decon Operations | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 18 | 14 | 0 |
| Engineering | 0 | 0 | 0 | 0 | 0 | 0 | 2.5 | 6 | 6 | 4.50 | 1 |
| Environmental Health & Safety | 0 | 0 | 0 | 0 | 0 | 0 | 1.5 | 5 | 6 | 6 | 0 |
| Executive | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 4 | 4 | 2 |
| Project Controls Work Planning | 0 | 0 | 0 | 0 | 0 | 0 | 4.5 | 7 | 7 | 5 | 1 |
| Quality Assurance | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 1 | 2 | 2 | 1 |
| Radiation Protection | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 13 | 33 | 24 | 1 |
| Site Closure | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 2 | 4 | 5 | 3 |
| Waste Operations | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 11 | 10 | 0 |
| **Period Totals** | **0** | **0** | **0** | **0** | **0** | **0** | **19** | **57** | **99.5** | **84** | **8** |

**Spent Fuel - 50.54(bb) DGC Staff**

| Department | SNF Pd 1 | SNF Pd 2 | SNF Pd 3 | SNF Pd 4 | SNF Pd 5 | SNF Pd 6 | SNF Pd 7 |
|---|---|---|---|---|---|---|---|
| Administration | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Decon Operations | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Engineering | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Environmental Health & Safety | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Executive | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Project Controls Work Planning | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Quality Assurance | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Radiation Protection | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Site Closure | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Waste Operations | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Period Total** | **0** | **0** | **0** | **0** | **0** | **0** | **4** |

## Table 6-3 (Continued)
## Decommissioning General Contractor (DGC) Staff Levels

**Greenfield – DGC Staff**

| Department | Grn Pd 1 | Grn Pd 2 |
|---|---|---|
| Administration | 0.5 | 0.5 |
| Decon Operations | 2.5 | 2 |
| Engineering | 0 | 0.25 |
| Environmental Health & Safety | 0.75 | 0 |
| Executive | 0 | 0.25 |
| Project Controls Work Planning | 0 | 6 |
| Quality Assurance | 0 | 0 |
| Radiation Protection | 0 | 0 |
| Site Closure | 0 | 0 |
| Waste Operations | 0 | 0 |
| **Period Totals** | **3.75** | **9** |

**ISFSI D&D – DGC Staff**

| Department | ISFSI D&D Pd 1 | ISFSI D&D Pd 2 |
|---|---|---|
| Engineering, Oversight and Licensing | 0 | 0 |
| Quality Assurance | 0 | 0 |
| Radiation Protection & Chemistry | 0 | 0 |
| **Period Totals** | **0** | **0** |

## Table 6-4
## Waste Disposal Volumes

| Facility and Waste Class | Waste Weight (LBs) | Waste Volume (CF) | Burial Volume (CF) |
|---|---|---|---|
| **Commercial Disposal Facility for B & C Wastes** | | | |
| Class B - Activated Hardware | 47,110 | 308 | 384 |
| Class C - Activated Hardware | 91,009 | 226 | 1,670 |
| Class B - Resin and Filters | 54,926 | 895 | 1,311 |
| | **193,045** | **1,429** | **3,365** |
| GTCC | 62,590 | 128 | 1,018 |
| **Energy*Solutions*** | | | |
| Class A – Debris | 18,599,692 | 329,908 | 456,435 |
| Class A – Oversized Debris | 7,824,790 | 112,378 | 166,355 |
| Class A – Cask Shipment | 75,416 | 154 | 1,502 |
| Class A – Containerized Waste | 207,054 | 2,307 | 4,974 |
| Class A – Large Component | 4,236,090 | 58,878 | 78,614 |
| Mixed Waste (Lead) | 30,000 | 85 | 288 |
| | **30,973,042** | **503,709** | **708,169** |
| **Other** | | | |
| Local Construction Debris Landfill | 90,303,566 | 1,031,207 | 1,306,313 |
| Process for On-Site Fill | 193,657,230 | 2,969,411 | 2,969,411 |
| Scrap Metal Recycler | 26,106,954 | 310,382 | 310,382 |
| | **310,067,750** | **4,311,000** | **4,586,106** |
| **Grand Total** | | | |

Note: Numbers may not add due to rounding.

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4. Federal Register, Vol. 4, "Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste," NRC 10 CFR Part 961 (DOE), January 1, 1999.

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11. U.S. Department of Energy, "Cost Estimating Guide," DOE G 430.1-1, March 1997.

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# Appendix A

## List of Systems and Structures

# Duane Arnold Energy Center System and Structure List

Unit 1

| Type | System Name or Description |
|---|---|
| ESS | Area Rad Monitoring |
| ESS | Breathing Air |
| ESS | CO2 Fire Protection |
| ESS | Control Bldg HVAC |
| ESS | Diesel Generator HVAC |
| ESS | Diesel Oil System |
| ESS | Domestic Water |
| ESS | Drywell Sumps |
| ESS | Fire Protection |
| ESS | Fuel Pool Cooling & Cleanup |
| ESS | Instrument Air |
| ESS | Liquid Radwaste |
| ESS | LLRPSF Area HVAC |
| ESS | LLRPSF Area Sumps |
| ESS | Offgas Exhaust |
| ESS | Primary Containment |
| ESS | Primary Containment HVAC |
| ESS | Radwaste Bldg HVAC |
| ESS | Radwaste Bldg Sumps |
| ESS | Reactor Bldg HVAC |
| ESS | Reactor Bldg Sumps |
| ESS | Reliable Hard Pipe Vent Modification |
| ESS | RW Evaporator & Solid |
| ESS | SEDS Self Engaging Dewatering System |
| ESS | Service Air |
| ESS | Solid Radwaste |
| ESS | Spent fuel pool instrumentation |
| ESS | Stack Gas & Bldg Kaman Rad Monitoring |
| ESS | Standby Diesel Generator |
| ESS | Training Center & Equipment |
| ESS | Turbine Bldg HVAC |
| ESS | Turbine RB Radwaste Bldg Sampling |
| ESS | Well Water |
| NON | Admin Bldg Sumps |
| NON | Administration Bldg HVAC |
| NON | Aux Heating Sys Boiler |
| NON | Chlorination & Acid Feed |
| NON | Circulating Water |
| NON | Condensate & Demin Water |
| NON | Condensate Demineralizer |
| NON | Condenser Air Removal |
| NON | Containment Atm Dilution |
| NON | Containment Atmosphere Control |
| NON | Cooling Tower |
| NON | Data Acquisition Center HVAC |
| NON | Drywell Radiation Monitors |

# Duane Arnold Energy Center System and Structure List

Unit 1

| Type | System Name or Description |
|---|---|
| NON | Electrical |
| NON | Extract Steam Htr-Vents-Drns |
| NON | Feedwater |
| NON | General Service Water |
| NON | H2 Water Chemistry |
| NON | Hydrogen Seal Oil |
| NON | Intake Structure HVAC |
| NON | Lube Oil Transfer & Storage |
| NON | Mach Shop & OG Bldg HVAC |
| NON | Makeup Demineralizer |
| NON | Misc HVAC |
| NON | Nitrogen |
| NON | Offgas Bldg Sumps |
| NON | Offgas Recombiner |
| NON | Post Accident Sampling |
| NON | Pumphouse HVAC |
| NON | Reactor Bldg Closed Cooling Water |
| NON | Reactor Water Cleanup |
| NON | Residual Heat Removal |
| NON | RHR Service Water |
| NON | River Water Supply |
| NON | Sanitary Drains |
| NON | Standby Gas Treatment |
| NON | Stator Cooling |
| NON | Technical Suppor Center HVAC |
| NON | Torus Vacuum Breakers |
| NON | Turbine Bldg Sumps |
| NSSS | Condensate |
| NSSS | Condenser |
| NSSS | CRD Hydraulic |
| NSSS | Emergency Service Water |
| NSSS | High Pressure Coolant Injection |
| NSSS | Low Pressure Core Spray |
| NSSS | Main Steam |
| NSSS | Nuclear Boiler |
| NSSS | Reactor Core Isolation Cooling |
| NSSS | Reactor Vessel Recirculation |
| NSSS | Standby Liquid Control |
| NSSS | Traversing Incore Probe Cal |
| NSSS | Turbine |
| NSSS | Turbine Steam Seals & Drains |
| STRUC | Administration Building |
| STRUC | Badging Center |
| STRUC | Breathing Air Enclosure |
| STRUC | Circulating Water Pipe |
| STRUC | Circulating Water Tower No 1 |

# Duane Arnold Energy Center System and Structure List

Unit 1

| Type | System Name or Description |
|---|---|
| STRUC | Circulating Water Tower No 2 |
| STRUC | Civil Shop |
| STRUC | Compressor Building |
| STRUC | Condensate Storage Tank Foundation |
| STRUC | Construction Support Center |
| STRUC | Control Building |
| STRUC | Cooling Tower Control & Valve House 1 |
| STRUC | Cooling Tower Control & Valve House 2 |
| STRUC | Cooling Tower Training |
| STRUC | Data Acquisition Center |
| STRUC | Discharge Structure |
| STRUC | East Warehouse |
| STRUC | Electrical Equipment Building - ISFSI |
| STRUC | Electrical Maintenance |
| STRUC | Existing Concrete Slabs |
| STRUC | Existing Waste Water Treatment Plant |
| STRUC | FLEX Storage Building |
| STRUC | Guard Facility and Security Structures |
| STRUC | HPCI and RCIC Building |
| STRUC | Intake Structure |
| STRUC | ISFSI - Phase 3 |
| STRUC | ISFSI Electrical Equipment Bldg |
| STRUC | ISFSI Monitoring Building |
| STRUC | Kelly Building |
| STRUC | LLRPSF Transformer Foundation |
| STRUC | Low Level Radwaste Storage and Processing |
| STRUC | Machine Shop |
| STRUC | Mechanical Maintenance |
| STRUC | New Site Support Building |
| STRUC | Off Gas Retention Building |
| STRUC | Off Gas Stack |
| STRUC | Oil Drum Storage Building |
| STRUC | Plant Support Center |
| STRUC | Pump House |
| STRUC | Radwaste Building |
| STRUC | Railroad Air-Lock |
| STRUC | Reactor Building |
| STRUC | Security Mods and Upgrades |
| STRUC | Site Transformer Foundations |
| STRUC | Sluice Gate Structure |
| STRUC | Sulfuric Acid Tank Foundation |
| STRUC | Support Shop |
| STRUC | Technical Support Center |
| STRUC | Trailer Pad |
| STRUC | Training Center |
| STRUC | Turbine Building |

# Duane Arnold Energy Center System and Structure List

Unit 1

| Type | System Name or Description |
|---|---|
| STRUC | Turbine Pedestal |
| STRUC | Underground Diesel Oil Tank |
| STRUC | Underground Fuel Oil Tank |
| STRUC | Waste Staging Area |
| STRUC | Waste Water Treatment Plant |
| STRUC | Well Water Pump House 1,2,3,4 |
| STRUC | West Warehouse |

# Appendix B

# Spent Fuel Shipping Schedule

# Duane Arnold Energy Center
## Spent Fuel Shipping Schedule for October 30, 2020 Shutdown
## Based on 2030 DOE Acceptance

| Year | Fuel Discharged | No Dry Modules | Assemblies Transfered from Pool to Dry Storage | Assemblies in Fuel Pool Storage | Assemblies in Dry Storage | Total Assemblies in On Site Storage | Assemblies Shipped to DOE From Pool | Assemblies Shipped to DOE from Dry Storage | Cumulative Assemblies Shipped to DOE |
|---|---|---|---|---|---|---|---|---|---|
| 2008 | 0 | 10 | 0 | 1758 | 610 | 2368 | 0 | 0 | 0 |
| 2009 | 152 | 0 | 0 | 1910 | 610 | 2520 | 0 | 0 | 0 |
| 2010 | 152 | 0 | 0 | 2062 | 610 | 2672 | 0 | 0 | 0 |
| 2011 | 0 | 10 | 610 | 1452 | 1220 | 2672 | 0 | 0 | 0 |
| 2012 | 152 | 0 | 0 | 1604 | 1220 | 2824 | 0 | 0 | 0 |
| 2013 | 0 | 0 | 0 | 1604 | 1220 | 2824 | 0 | 0 | 0 |
| 2014 | 152 | 0 | 0 | 1756 | 1220 | 2976 | 0 | 0 | 0 |
| 2015 | 0 | 0 | 0 | 1756 | 1220 | 2976 | 0 | 0 | 0 |
| 2016 | 152 | 0 | 0 | 1908 | 1220 | 3128 | 0 | 0 | 0 |
| 2017 | 0 | 0 | 0 | 1908 | 1220 | 3128 | 0 | 0 | 0 |
| 2018 | 152 | 0 | 0 | 2060 | 1220 | 3280 | 0 | 0 | 0 |
| 2019 | 0 | 0 | 0 | 2060 | 1220 | 3280 | 0 | 0 | 0 |
| 2020 | 368 | 10 | 610 | 1818 | 1830 | 3648 | 0 | 0 | 0 |
| 2021 | 0 | 0 | 0 | 1818 | 1830 | 3648 | 0 | 0 | 0 |
| 2022 | 0 | 0 | 0 | 1818 | 1830 | 3648 | 0 | 0 | 0 |
| 2023 | 0 | 30 | 1818 | 0 | 3648 | 3648 | 0 | 0 | 0 |
| 2024 | 0 | 0 | 0 | 0 | 3648 | 3648 | 0 | 0 | 0 |
| 2025 | 0 | 0 | 0 | 0 | 3648 | 3648 | 0 | 0 | 0 |
| 2026 | 0 | 0 | 0 | 0 | 3648 | 3648 | 0 | 0 | 0 |
| 2027 | 0 | 0 | 0 | 0 | 3648 | 3648 | 0 | 0 | 0 |
| 2028 | 0 | 0 | 0 | 0 | 3648 | 3648 | 0 | 0 | 0 |
| 2029 | 0 | 0 | 0 | 0 | 3648 | 3648 | 0 | 0 | 0 |
| 2030 | 0 | 0 | 0 | 0 | 3648 | 3648 | 0 | 0 | 0 |
| 2031 | 0 | 0 | 0 | 0 | 3648 | 3648 | 0 | 0 | 0 |
| 2032 | 0 | 0 | 0 | 0 | 3526 | 3526 | 0 | 122 | 122 |
| 2033 | 0 | 0 | 0 | 0 | 3282 | 3282 | 0 | 244 | 366 |
| 2034 | 0 | 0 | 0 | 0 | 3099 | 3099 | 0 | 183 | 549 |
| 2035 | 0 | 0 | 0 | 0 | 2916 | 2916 | 0 | 183 | 732 |
| 2036 | 0 | 0 | 0 | 0 | 2794 | 2794 | 0 | 122 | 854 |
| 2037 | 0 | 0 | 0 | 0 | 2611 | 2611 | 0 | 183 | 1037 |
| 2038 | 0 | 0 | 0 | 0 | 2489 | 2489 | 0 | 122 | 1159 |
| 2039 | 0 | 0 | 0 | 0 | 2367 | 2367 | 0 | 122 | 1281 |
| 2040 | 0 | 0 | 0 | 0 | 2245 | 2245 | 0 | 122 | 1403 |
| 2041 | 0 | 0 | 0 | 0 | 2062 | 2062 | 0 | 183 | 1586 |
| 2042 | 0 | 0 | 0 | 0 | 1879 | 1879 | 0 | 183 | 1769 |
| 2043 | 0 | 0 | 0 | 0 | 1757 | 1757 | 0 | 122 | 1891 |
| 2044 | 0 | 0 | 0 | 0 | 1635 | 1635 | 0 | 122 | 2013 |
| 2045 | 0 | 0 | 0 | 0 | 1635 | 1635 | 0 | 0 | 2013 |
| 2046 | 0 | 0 | 0 | 0 | 1513 | 1513 | 0 | 122 | 2135 |
| 2047 | 0 | 0 | 0 | 0 | 1330 | 1330 | 0 | 183 | 2318 |
| 2048 | 0 | 0 | 0 | 0 | 1269 | 1269 | 0 | 61 | 2379 |
| 2049 | 0 | 0 | 0 | 0 | 1147 | 1147 | 0 | 122 | 2501 |
| 2050 | 0 | 0 | 0 | 0 | 1025 | 1025 | 0 | 122 | 2623 |
| 2051 | 0 | 0 | 0 | 0 | 903 | 903 | 0 | 122 | 2745 |
| 2052 | 0 | 0 | 0 | 0 | 781 | 781 | 0 | 122 | 2867 |
| 2053 | 0 | 0 | 0 | 0 | 659 | 659 | 0 | 122 | 2989 |
| 2054 | 0 | 0 | 0 | 0 | 598 | 598 | 0 | 61 | 3050 |
| 2055 | 0 | 0 | 0 | 0 | 476 | 476 | 0 | 122 | 3172 |
| 2056 | 0 | 0 | 0 | 0 | 354 | 354 | 0 | 122 | 3294 |
| 2057 | 0 | 0 | 0 | 0 | 232 | 232 | 0 | 122 | 3416 |
| 2058 | 0 | 0 | 0 | 0 | 110 | 110 | 0 | 122 | 3538 |
| 2059 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 110 | 3648 |

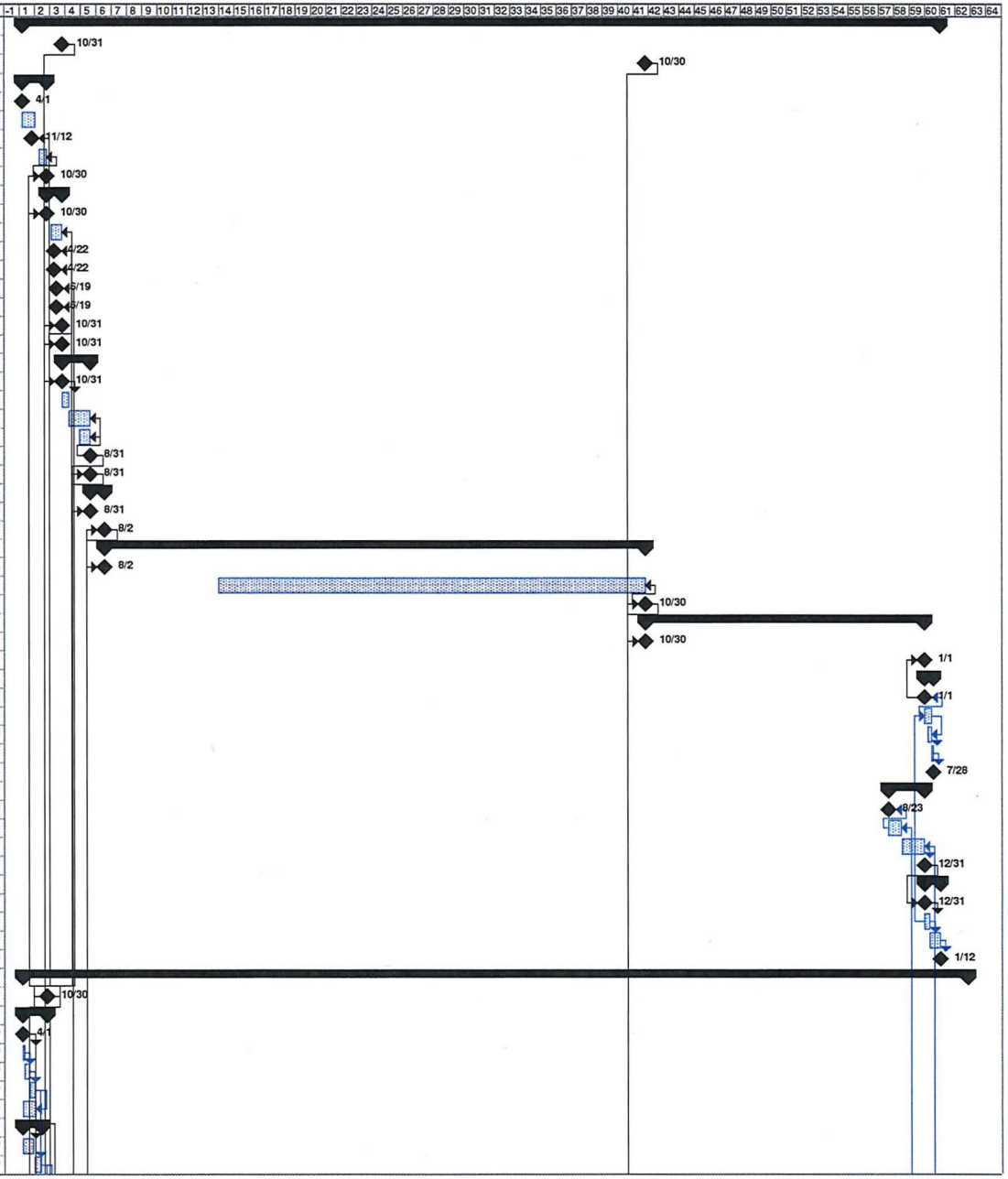
# Appendix C

# Detailed Project Schedule

# Duane Arnold Energy Center

Project Schedule for SAFSTOR, 2030 DOE Acceptance, Dry Storage

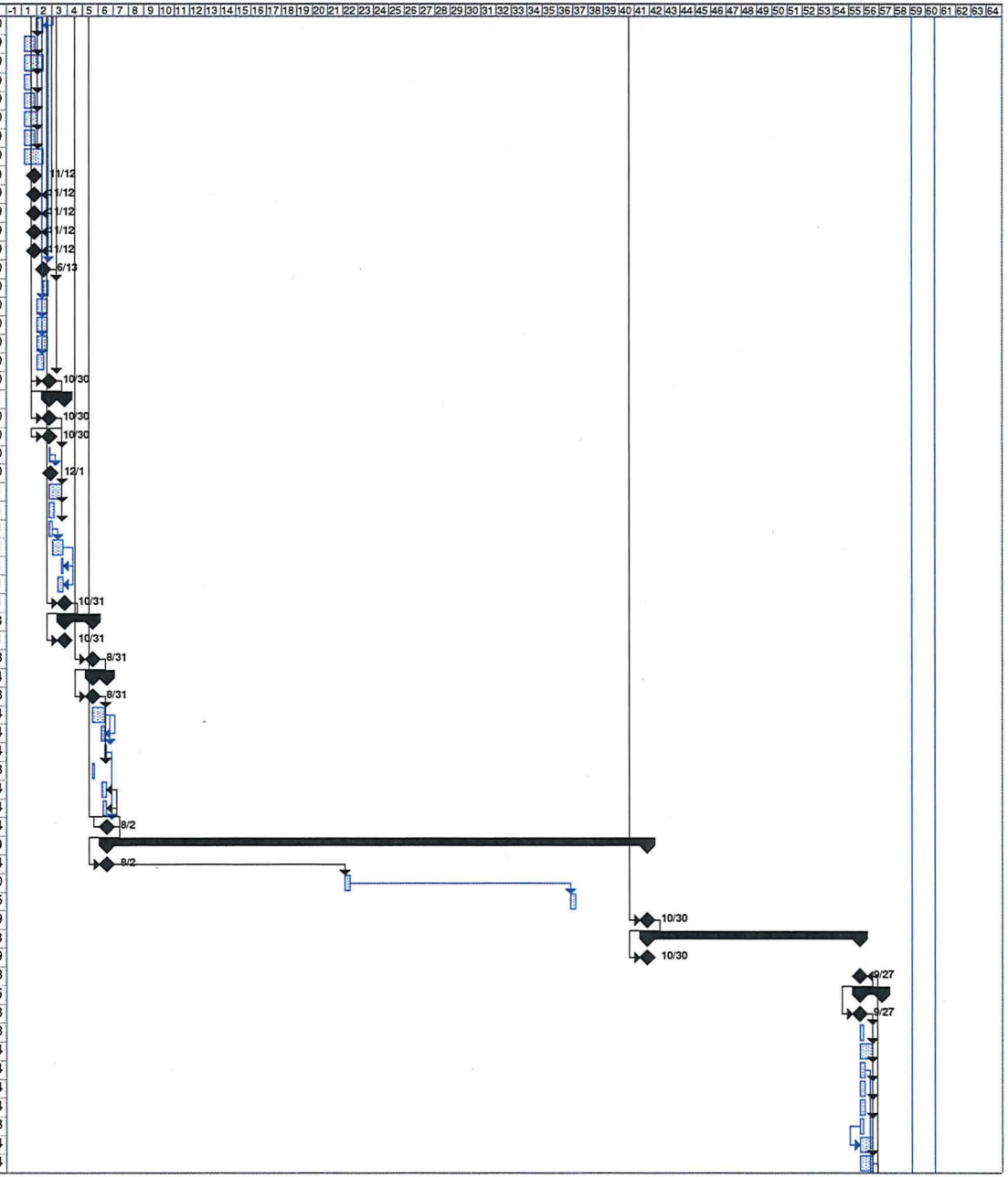
| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 1 | **Spent Fuel Management** | **15600 days** | **04/01/2019** | **01/12/2079** |
| 2 | Zirconium Fire Window Closes | 0 days | 10/30/2021 | 10/30/2021 |
| 3 | Spent Fuel Shipping Complete | 0 days | 10/30/2059 | 10/30/2059 |
| 4 | **SNF Pd 1 - Spent Fuel Planning** | **413 days** | **04/01/2019** | **10/30/2020** |
| 5 | SNF Pd 1 Begins | 0 days | 04/01/2019 | 04/01/2019 |
| 6 | Prepare Irradiated Fuel Management Plan | 220 days | 04/01/2019 | 01/31/2020 |
| 7 | Submit ER to Allow Spent Fuel Costs to Taken From DTF | 0 days | 11/12/2019 | 11/12/2019 |
| 8 | Design Spent Fuel Pool Security Modifications | 125 days | 05/07/2020 | 10/29/2020 |
| 9 | SNF Pd 1 Ends | 0 days | 10/29/2020 | 10/29/2020 |
| 10 | **SNF Pd 2 - Spent Fuel Cooling During Zirc Fire Window** | **263 days** | **10/30/2020** | **10/30/2021** |
| 11 | SNF Pd 2 Begins | 0 days | 10/29/2020 | 10/29/2020 |
| 12 | Implement Spent Fuel Pool Security Modifications | 180 days | 02/22/2021 | 10/30/2021 |
| 13 | Submit Irradiated Fuel Management Plan | 0 days | 04/21/2021 | 04/21/2021 |
| 14 | Submit Cask Vendor Revised Certificate of Compliance (CoC) | 0 days | 04/21/2021 | 04/21/2021 |
| 15 | Submit LAR for ISFSI only Emergency Plan | 0 days | 06/18/2021 | 06/18/2021 |
| 16 | Submit LAR for ISFSI Only Tech Specs and Revised QA Plan | 0 days | 06/18/2021 | 06/18/2021 |
| 17 | Submit LAR for Permanently Defueled Security Plan | 0 days | 10/30/2021 | 10/30/2021 |
| 18 | SNF Pd 2 Ends | 0 days | 10/30/2021 | 10/30/2021 |
| 19 | **SNF Pd 3 - Spent Fuel Transfer to Dry Storage** | **479 days** | **10/30/2021** | **08/31/2023** |
| 20 | SNF Pd 3 Begins | 0 days | 10/30/2021 | 10/30/2021 |
| 21 | Construct ISFSI Phase 2 and 3 Pad Expansion | 120 days | 11/01/2021 | 04/15/2022 |
| 22 | Spent Fuel Pool to Pad Transfer | 360 days | 04/15/2022 | 08/31/2023 |
| 23 | Construct ISFSI Monitoring Building | 180 days | 12/23/2022 | 08/31/2023 |
| 24 | Spent Fuel Pool Empty | 0 days | 08/31/2023 | 08/31/2023 |
| 25 | SNF Pd 3 Ends | 0 days | 08/31/2023 | 08/31/2023 |
| 26 | **SNF Pd 3 - Dry Storage During Completion of SAFSTOR Preparations** | **240 days** | **08/31/2023** | **08/01/2024** |
| 27 | SNF Pd 3 Begins | 0 days | 08/31/2023 | 08/31/2023 |
| 28 | SNF Pd 3 Ends | 0 days | 08/01/2024 | 08/01/2024 |
| 29 | **SNF Pd 4 - Dry Storage During Dormancy** | **9195 days** | **08/01/2024** | **10/30/2059** |
| 30 | SNF Pd 4 Begins | 0 days | 08/01/2024 | 08/01/2024 |
| 31 | Spent Fuel Transfer to DOE | 7258 days | 01/06/2032 | 10/30/2059 |
| 32 | SNF Pd 4 Ends | 0 days | 10/30/2059 | 10/30/2059 |
| 33 | **SNF Pd 5 - ISFSI Demolition Delay** | **4740 days** | **10/30/2059** | **12/31/2077** |
| 34 | SNF Pd 5 Begins | 0 days | 10/30/2059 | 10/30/2059 |
| 35 | SNF Pd 5 Begins | 0 days | 12/31/2077 | 12/31/2077 |
| 36 | **SNF Pd 6 - ISFSI and Support Structure Clean Demolition** | **150 days** | **12/31/2077** | **07/28/2078** |
| 37 | SNF Pd 6 Begins | 0 days | 12/31/2077 | 12/31/2077 |
| 38 | Clean Demolition of ISFSI | 120 days | 12/31/2077 | 06/16/2078 |
| 39 | Demolish ISFSI Support Structures | 60 days | 03/25/2078 | 06/16/2078 |
| 40 | Backfill and Grade ISFSI Site | 30 days | 06/17/2078 | 07/28/2078 |
| 41 | SNF Pd 5 Ends | 0 days | 07/28/2078 | 07/28/2078 |
| 42 | **ISFSI D&D Pd 1 - ISFSI D&D Planning** | **615 days** | **08/23/2075** | **12/30/2077** |
| 43 | ISFSI D&D Pd 1 Begins | 0 days | 08/23/2075 | 08/23/2075 |
| 44 | Preparation of ISFSI Portion of LTP | 220 days | 08/23/2075 | 06/25/2076 |
| 45 | NRC Review of ISFSI Portion LTP | 380 days | 07/17/2076 | 12/30/2077 |
| 46 | ISFSI D&D Pd 1 Ends | 0 days | 12/30/2077 | 12/30/2077 |
| 47 | **ISFSI D&D Pd 2 - ISFSI Final Status Survey** | **270 days** | **12/30/2077** | **01/12/2079** |
| 48 | ISFSI D&D Pd 2 Begins | 0 days | 12/30/2077 | 12/30/2077 |
| 49 | Final Status Survey of ISFSI | 90 days | 12/31/2077 | 05/05/2078 |
| 50 | Preparation of FSS Report and NRC Review | 180 days | 05/06/2078 | 01/12/2079 |
| 51 | ISFSI D&D Pd 2 Begins | 0 days | 01/12/2079 | 01/12/2079 |
| 52 | **License Termination** | **16067 days** | **04/01/2019** | **10/29/2080** |
| 53 | Unit 1 Shutdown | 0 days | 10/30/2020 | 10/30/2020 |
| 54 | **Decon Pd 1 - SAFSTOR Planning Prior to Shutdown** | **413 days** | **04/01/2019** | **10/30/2020** |
| 55 | Decon Pd 1 Begins | 0 days | 04/01/2019 | 04/01/2019 |
| 56 | Planning of Historical Site Assessment (HSA) and Scoping Survey | 30 days | 04/01/2019 | 05/10/2019 |
| 57 | Perform HSA | 90 days | 05/13/2019 | 09/13/2019 |
| 58 | Perform Scoping Survey | 90 days | 09/16/2019 | 01/17/2020 |
| 59 | Perform SAFSTOR Planning and Design | 220 days | 04/08/2019 | 02/07/2020 |
| 60 | **Preparation of SAFSTOR License Documents** | **320 days** | **04/01/2019** | **06/19/2020** |
| 61 | Perform Site Environmental Review and Environmental Assessm | 180 days | 04/01/2019 | 12/06/2019 |
| 62 | Prepare Decommissioning Cost Estimate | 120 days | 12/30/2019 | 06/12/2020 |



# Duane Arnold Energy Center

Project Schedule for SAFSTOR, 2030 DOE Acceptance, Dry Storage

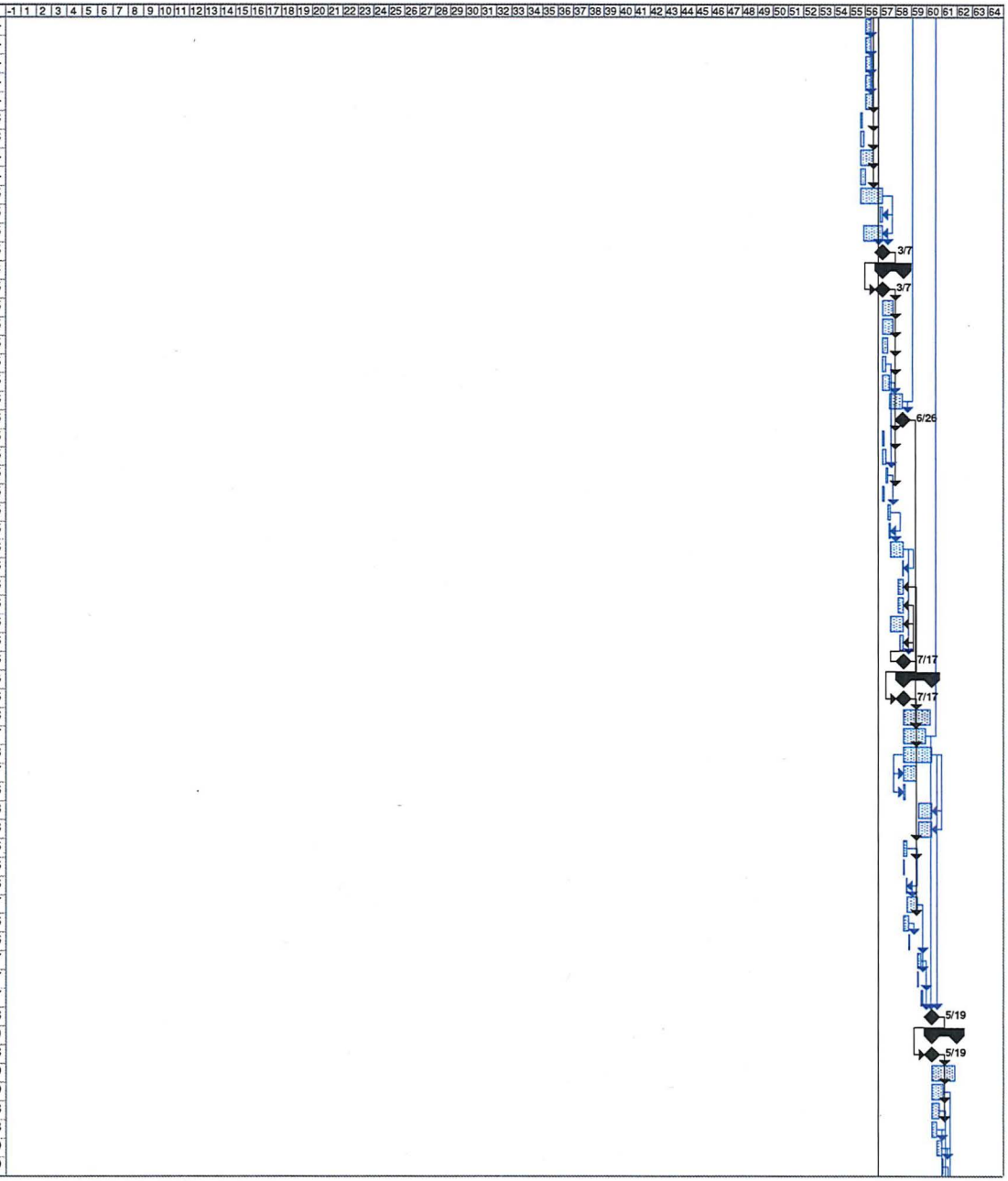
| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 63 | Prepare Post-Shutdown Decommissioning Activiites Report | 120 days | 12/30/2019 | 06/12/2020 |
| 64 | Prepare Post-Shutdown Technical Specification (TS) Modification | 180 days | 04/01/2019 | 12/06/2019 |
| 65 | Prepare Defuel Safety Analysis Report (DSAR) | 320 days | 04/01/2019 | 06/19/2020 |
| 66 | Perform Emergency Plan Supporting Calculations | 120 days | 04/01/2019 | 09/13/2019 |
| 67 | Prepare Post-Shutdown Emergency Plan | 180 days | 04/01/2019 | 12/06/2019 |
| 68 | Prepare Post-Shutdown Security and Cyber Security Plans | 220 days | 04/01/2019 | 01/31/2020 |
| 69 | Develop Certified Fuel Handlers (CFH) Training Program | 180 days | 04/01/2019 | 12/06/2019 |
| 70 | Revise Plant Programs and Procedures for Shutdown | 320 days | 04/01/2019 | 06/19/2020 |
| 71 | **Submit License Amendment and Exemption Requests** | **0 days** | **11/12/2019** | **11/12/2019** |
| 72 | Submit LAR for Permanently Defueled Technical Specifications | 0 days | 11/12/2019 | 11/12/2019 |
| 73 | Submit CFH LAR to Replace Licensed Operators with CFHs | 0 days | 11/12/2019 | 11/12/2019 |
| 74 | Submit Defueled Security Plan and Exemptions to 10 CFR 73.55 | 0 days | 11/12/2019 | 11/12/2019 |
| 75 | Submit ER to Revise Records Retention Requirements | 0 days | 11/12/2019 | 11/12/2019 |
| 76 | Submit PSDAR and DCE to NRC | 0 days | 06/12/2020 | 06/12/2020 |
| 77 | NRC Review of PSDAR and DCE | 90 days | 06/15/2020 | 10/16/2020 |
| 78 | Prepare SAFSTOR Integrated Work Schedule | 180 days | 01/20/2020 | 09/25/2020 |
| 79 | Prepare SAFSTOR Activity Specifications | 180 days | 01/20/2020 | 09/25/2020 |
| 80 | Prepare Detailed SAFSTOR Work Procedures | 180 days | 01/20/2020 | 09/25/2020 |
| 81 | Perform Part 37 and SNM Assessment | 120 days | 01/20/2020 | 07/03/2020 |
| 82 | Decon Pd 1 Ends | 0 days | 10/29/2020 | 10/29/2020 |
| 83 | **Decon Pd 2 - Transition Following Shutdown** | **263 days** | **10/30/2020** | **10/30/2021** |
| 84 | Decon Pd 2 Begins | 0 days | 10/29/2020 | 10/29/2020 |
| 85 | Submit Notification of Cessation of Operations | 0 days | 10/29/2020 | 10/29/2020 |
| 86 | Defuel Reactor | 21 days | 11/02/2020 | 11/30/2020 |
| 87 | Submit Notification of Fuel Removal from Vessel | 0 days | 11/30/2020 | 11/30/2020 |
| 88 | NRC Review of Post-Shutdown LARs and ERs | 220 days | 10/29/2020 | 08/31/2021 |
| 89 | Perform Activation Analyses of Reactor and Internals | 90 days | 10/29/2020 | 03/02/2021 |
| 90 | Volume Reduce Control Rod Blades, Fuel Channels, & LPRMs | 60 days | 10/29/2020 | 01/20/2021 |
| 91 | Flush and Drain Non-Essential Systems | 180 days | 01/21/2021 | 09/28/2021 |
| 92 | Remove and Dispose of Hazardous Waste | 30 days | 08/18/2021 | 09/28/2021 |
| 93 | Drain and Process Suppression Pool Water and Hydrolase Torus Wa | 90 days | 05/26/2021 | 09/28/2021 |
| 94 | Decon Pd 2 Ends | 0 days | 10/30/2021 | 10/30/2021 |
| 95 | **Decon Pd 3 - SAFSTOR Preparations Delay During Fuel Transfer** | **479 days** | **10/30/2021** | **08/31/2023** |
| 96 | Decon Pd 3 Begins | 0 days | 10/30/2021 | 10/30/2021 |
| 97 | Decon Pd 3 Ends | 0 days | 08/31/2023 | 08/31/2023 |
| 98 | **Decon Pd 4 - Completion of SAFSTOR Preparations** | **240 days** | **08/31/2023** | **08/01/2024** |
| 99 | Decon Pd 4 Begins | 0 days | 08/31/2023 | 08/31/2023 |
| 100 | Drain Spent Fuel Pool and Process Liquid Waste | 210 days | 09/01/2023 | 06/20/2024 |
| 101 | Flush and Drain Essential Systems Following Fuel Pool Closure | 60 days | 03/29/2024 | 06/20/2024 |
| 102 | Removal and Disposal of Spent Resins, Filter Media and Tank Sludge | 30 days | 06/21/2024 | 08/01/2024 |
| 103 | Segment, Package and Dispose of Spent Fuel Pool Island Equipment | 30 days | 09/01/2023 | 10/12/2023 |
| 104 | General Area Cleanup | 80 days | 04/12/2024 | 08/01/2024 |
| 105 | Secure Site for Dormancy | 60 days | 05/10/2024 | 08/01/2024 |
| 106 | Decon Pd 4 Ends | 0 days | 08/01/2024 | 08/01/2024 |
| 107 | **Decon Pd 5 - Dormancy During Dry Storage** | **9195 days** | **08/01/2024** | **10/30/2059** |
| 108 | Decon Pd 5 Begins | 0 days | 08/01/2024 | 08/01/2024 |
| 109 | Bituminous Roof Replacement - 20 year | 90 days | 02/17/2040 | 06/21/2040 |
| 110 | Bituminous Roof Replacement - 40 year | 90 days | 11/06/2054 | 03/11/2055 |
| 111 | Decon Pd 5 Ends | 0 days | 10/30/2059 | 10/30/2059 |
| 112 | **Decon Pd 6 - Dormancy Only** | **3627 days** | **10/30/2059** | **09/26/2073** |
| 113 | Decon Pd 6 Begins | 0 days | 10/30/2059 | 10/30/2059 |
| 114 | Decon Pd 6 Ends | 0 days | 09/26/2073 | 09/26/2073 |
| 115 | **Decon Pd 7 - Decommissioning Planning During Dormancy** | **378 days** | **09/26/2073** | **03/07/2075** |
| 116 | Decon Pd 7 Begins | 0 days | 09/26/2073 | 09/26/2073 |
| 117 | Install Office Trailer Complex | 60 days | 09/26/2073 | 12/18/2073 |
| 118 | Select Decommissioning General Contractor | 220 days | 09/26/2073 | 07/30/2074 |
| 119 | Post SAFSTOR Decommissioning Planning | 90 days | 09/26/2073 | 01/29/2074 |
| 120 | Planning of Post SAFSTOR Site Characterization | 90 days | 09/26/2073 | 01/29/2074 |
| 121 | Planning for Asbestos Abatement | 90 days | 09/26/2073 | 01/29/2074 |
| 122 | Prepare Integrated Work Sequence and Schedule for Decommissioni | 60 days | 09/26/2073 | 12/18/2073 |
| 123 | Prepare Decommissioning Activity Specifications | 220 days | 09/26/2073 | 07/30/2074 |
| 124 | Prepare Detailed Work Procedures for Decommissioning | 220 days | 09/26/2073 | 07/30/2074 |



# Duane Arnold Energy Center

Project Schedule for SAFSTOR, 2030 DOE Acceptance, Dry Storage

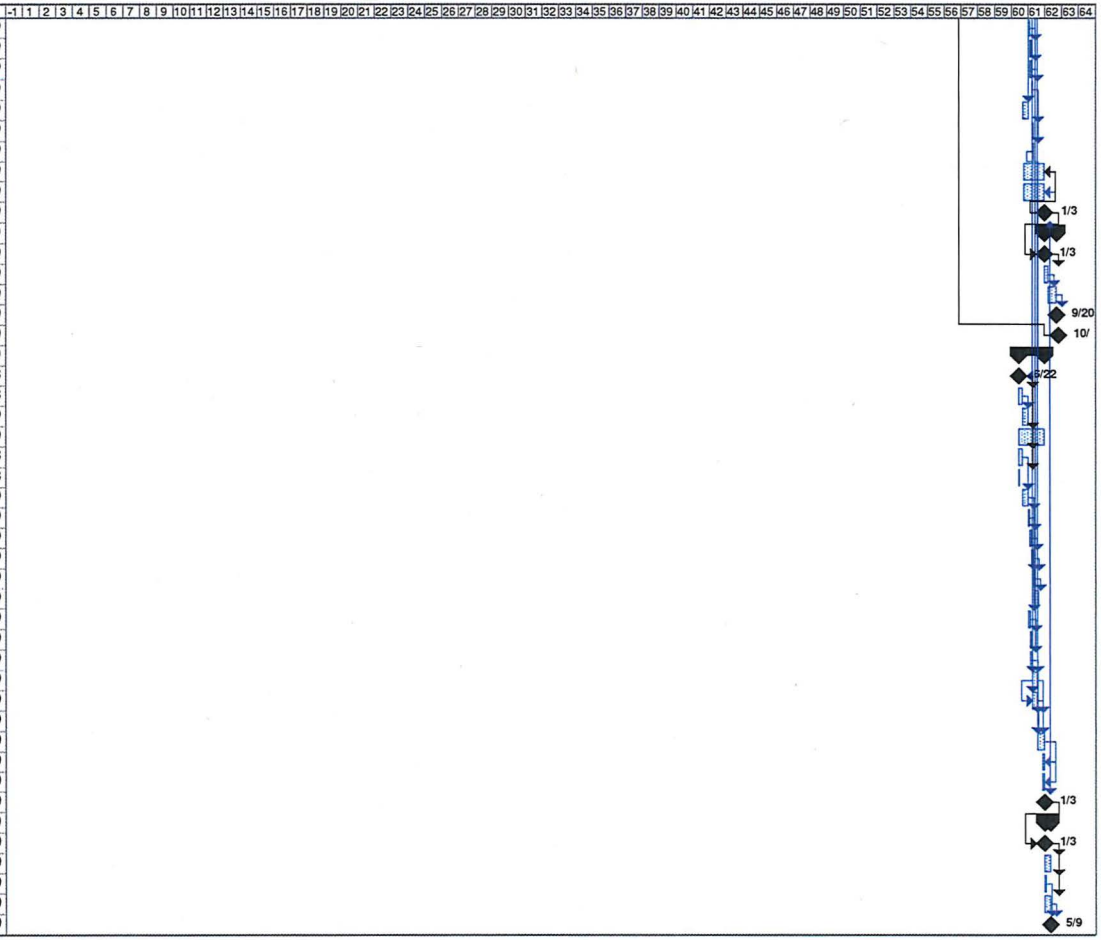
| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 125 | Update Decommissioning Cost Estimate (DCE) | 90 days | 01/30/2074 | 06/04/2074 |
| 126 | Update Post-Shutdown Decommissioning Activities Report (PSDAR) | 90 days | 01/30/2074 | 06/04/2074 |
| 127 | Planning and Design of Site Revitalization | 120 days | 01/30/2074 | 07/16/2074 |
| 128 | Planning and Design Rail Spur Upgrade | 120 days | 01/30/2074 | 07/16/2074 |
| 129 | Planning and Design Cold & Dark Site Repowering | 120 days | 01/30/2074 | 07/16/2074 |
| 130 | Develop Effluent Management Plan | 30 days | 09/26/2073 | 11/06/2073 |
| 131 | Design Liquid Radwaste Treatment and Demin Makeup Water Systen | 60 days | 09/26/2073 | 12/18/2073 |
| 132 | Prepare and Submit Environmental Permits | 220 days | 09/26/2073 | 07/30/2074 |
| 133 | Design Containment Access Modifications | 90 days | 09/26/2073 | 01/29/2074 |
| 134 | Design and Procure RPV/RVI Segmentation Tooling and Equipment | 18 mons | 09/26/2073 | 03/07/2075 |
| 135 | Select Shipping Casks and Obtain Shipping Permits | 40 days | 01/11/2075 | 03/07/2075 |
| 136 | Purchase Dry Storage Modules for GTCC Waste | 320 days | 12/15/2073 | 03/07/2075 |
| 137 | Decon Pd 7 Ends | 0 days | 03/07/2075 | 03/07/2075 |
| 138 | **Decon Pd 8 - Internals Segmentation and Site Preparations** | **355 days** | **03/07/2075** | **07/16/2076** |
| 139 | Decon Pd 8 Begins | 0 days | 03/07/2075 | 03/07/2075 |
| 140 | Revitalize Site Infrastructure | 180 days | 03/08/2075 | 11/14/2075 |
| 141 | Implement Cold & Dark | 180 days | 03/08/2075 | 11/14/2075 |
| 142 | Install Liquid Radwaste Treatment System | 90 days | 03/08/2075 | 07/11/2075 |
| 143 | Install Demin Makeup Water System for RVI Segementation | 60 days | 03/08/2075 | 05/30/2075 |
| 144 | Perform Post-SAFSTOR Site Characterization | 120 days | 03/08/2075 | 08/22/2075 |
| 145 | Prepare License Termination Plan (LTP) | 220 days | 08/23/2075 | 06/25/2076 |
| 146 | Submit LTP to NRC for review | 0 days | 06/25/2076 | 06/25/2076 |
| 147 | Remove and Dispose of Spent Fuel Storage Racks | 30 days | 03/08/2075 | 04/18/2075 |
| 148 | Segment and Dispose of Drywell Head | 60 days | 03/08/2075 | 05/30/2075 |
| 149 | Reflood RPV and Steam Separator Pool for RVI Segmentation | 30 days | 05/31/2075 | 07/11/2075 |
| 150 | Remove and Dispose of Rx Head | 30 days | 03/08/2075 | 04/18/2075 |
| 151 | Test Special Cutting and Handling Equipment and Train Operators | 45 days | 07/12/2075 | 09/12/2075 |
| 152 | Finalize Internals and Vessel Segmenting Details | 25 days | 08/09/2075 | 09/12/2075 |
| 153 | Segment, Package and Ship Reactor Internals | 220 days | 09/13/2075 | 07/16/2076 |
| 154 | RVI GTCC Waste Transportation and Disposal | 15 days | 06/26/2076 | 07/16/2076 |
| 155 | Construct New Change Rooms, Hot Laundry, Waste Staging Area | 90 days | 03/13/2076 | 07/16/2076 |
| 156 | Modify Containment Access | 90 days | 03/13/2076 | 07/16/2076 |
| 157 | Upgrade Rail Spur | 220 days | 09/13/2075 | 07/16/2076 |
| 158 | Install Truck Radiological Monitoring System | 60 days | 04/24/2076 | 07/16/2076 |
| 159 | Decon Pd 8 Ends | 0 days | 07/16/2076 | 07/16/2076 |
| 160 | **Decon Pd 9 - Major Component and Systems Removal** | **480 days** | **07/16/2076** | **05/19/2078** |
| 161 | Decon Pd 9 Begins | 0 days | 07/16/2076 | 07/16/2076 |
| 162 | Procure Non-Engineered Standard Equipment | 460 days | 07/17/2076 | 04/21/2078 |
| 163 | NRC Review and Approval of License Termination Plan | 380 days | 07/17/2076 | 12/30/2077 |
| 164 | Remove, Package and Dispose of Non-Essential Systems | 480 days | 07/17/2076 | 05/19/2078 |
| 165 | Perform Asbestos Abatement on Plant Systems | 220 days | 07/17/2076 | 05/20/2077 |
| 166 | Removal and Disposal of Off Gas System Adsorber | 30 days | 07/17/2076 | 08/27/2076 |
| 167 | Segment, Package and Dispose of Nuclear Steam Supply System | 220 days | 07/16/2077 | 05/19/2078 |
| 168 | Remove, Package and Dispose of Remaining Active Plant Systems | 220 days | 07/16/2077 | 05/19/2078 |
| 169 | Remove and Dispose of Control Rod Drives | 60 days | 07/17/2076 | 10/08/2076 |
| 170 | Remove and Dispose of Shield Plugs, Pool Plugs and Stud Tensioner | 15 days | 07/17/2076 | 08/06/2076 |
| 171 | Reactor Vessel Insulation Removal and Disposal | 10 days | 09/25/2076 | 10/08/2076 |
| 172 | Segment, Package and Ship Reactor Pressure Vessel | 180 days | 10/09/2076 | 06/17/2077 |
| 173 | Drain Steam Separator Pool and Process Liquid Waste | 90 days | 07/17/2076 | 11/19/2076 |
| 174 | Transportation and Disposal of Liquid Radwaste Filters and Resins | 15 days | 11/20/2076 | 12/10/2076 |
| 175 | Removal and Disposal of Sacrificial Shield Wall and Reactor Pedesta | 60 days | 06/18/2077 | 09/09/2077 |
| 176 | Segment, Package and Dispose of Refueling Bridge | 15 days | 06/18/2077 | 07/08/2077 |
| 177 | Removal and Disposal of Lead Shielding | 30 days | 09/10/2077 | 10/21/2077 |
| 178 | Decon Pd 9 Ends | 0 days | 05/19/2078 | 05/19/2078 |
| 179 | **Decon Pd 10 - Building Decontamination** | **423.7 days** | **05/19/2078** | **01/03/2080** |
| 180 | Decon Pd 10 Begins | 0 days | 05/19/2078 | 05/19/2078 |
| 181 | Procure Non-Engineered Standard Equipment | 400 days | 05/20/2078 | 11/30/2079 |
| 182 | Decon Reactor Building | 200 days | 05/20/2078 | 02/23/2079 |
| 183 | Decon Turbine Building | 130 days | 05/20/2078 | 11/17/2078 |
| 184 | Decon Radwaste Building | 90 days | 05/20/2078 | 09/22/2078 |
| 185 | Decon HPCI and RCIC Building | 90 days | 09/23/2078 | 01/26/2079 |
| 186 | Decon Administration Building | 10 days | 01/27/2079 | 02/09/2079 |



# Duane Arnold Energy Center

Project Schedule for SAFSTOR, 2030 DOE Acceptance, Dry Storage

| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 187 | Decon Off-Gas Retention Building | 10 days | 02/10/2079 | 02/23/2079 |
| 188 | Decon LLRW Storage and Processing Building | 20 days | 02/24/2079 | 03/23/2079 |
| 189 | Decon Off-Gas Stack | 30 days | 02/24/2079 | 04/06/2079 |
| 190 | Segment, Package and Dispose of Contaminated Decon Equipment a | 10 days | 04/07/2079 | 04/20/2079 |
| 191 | Remove Underground Storm Drains and Manholes | 90 days | 09/23/2078 | 01/26/2079 |
| 192 | Transportation and Disposal of Liquid Radwaste Filters and Resins | 15 days | 04/21/2079 | 05/11/2079 |
| 193 | Demolish Waste Staging Area | 20 days | 04/21/2079 | 05/18/2079 |
| 194 | Final Status Survey for Structures | 320 days | 10/12/2078 | 01/03/2080 |
| 195 | Final Status Survey for Land Areas | 320 days | 10/12/2078 | 01/03/2080 |
| 196 | Decon Pd 10 Ends | 0 days | 01/03/2080 | 01/03/2080 |
| 197 | **Decon Pd 11 - License Termination** | **186 days** | **01/03/2080** | **09/19/2080** |
| 198 | Decon Pd 11 Begins | 0 days | 01/03/2080 | 01/03/2080 |
| 199 | Prepare FSS Report | 60 days | 01/03/2080 | 03/27/2080 |
| 200 | NRC Review and Approval of FSS Report | 6 mons | 03/27/2080 | 09/19/2080 |
| 201 | Decon Pd 11 Ends | 0 days | 09/19/2080 | 09/19/2080 |
| 202 | End 60 year SAFSTOR | 0 days | 10/29/2080 | 10/29/2080 |
| 203 | **Grn Pd 1 - Clean Building Demolition During Decommissioning** | **400 days** | **06/22/2078** | **01/03/2080** |
| 204 | Grn Pd 1 Begins | 0 days | 06/22/2078 | 06/22/2078 |
| 205 | Prepare Site Restoration Demolition Plan and Schedule | 60 days | 06/22/2078 | 09/14/2078 |
| 206 | Obtain Required Demolition Permits | 90 days | 09/14/2078 | 01/18/2079 |
| 207 | Clean Building Demolition Equipment | 400 days | 06/22/2078 | 01/03/2080 |
| 208 | Perform Pre-Demolition Asbestos Abatement | 60 days | 06/22/2078 | 09/14/2078 |
| 209 | Remove and Dispose of Underground Storage Tanks | 15 days | 06/22/2078 | 07/13/2078 |
| 210 | Demolish Non-Essential Structures | 90 days | 09/14/2078 | 01/18/2079 |
| 211 | Demolish Training Center | 20 days | 01/18/2079 | 02/15/2079 |
| 212 | Demolish Plant Support Center and New Site Support Building | 30 days | 02/15/2079 | 03/29/2079 |
| 213 | Demolish Cooling Towers and Related Structures | 30 days | 03/29/2079 | 05/10/2079 |
| 214 | Demolish Existing Waste Water Treatment | 20 days | 05/10/2079 | 06/07/2079 |
| 215 | Demolish Intake and Discharge Structures | 60 days | 06/07/2079 | 08/30/2079 |
| 216 | Demolish Data Acquisition and Technical Support Building | 30 days | 01/18/2079 | 03/01/2079 |
| 217 | Demolish Guard Facility | 15 days | 03/01/2079 | 03/22/2079 |
| 218 | Demolish Control and Administrative Buildings | 30 days | 03/01/2079 | 04/12/2079 |
| 219 | Demolish Turbine Building | 80 days | 04/12/2079 | 08/02/2079 |
| 220 | Demolish Low-Level Radwaste Building | 80 days | 04/12/2079 | 08/02/2079 |
| 221 | Demolish HPCI and RCIC Building | 20 days | 08/02/2079 | 08/30/2079 |
| 222 | Demolish Reactor Building | 110 days | 08/02/2079 | 01/03/2080 |
| 223 | Demolish Off-Gas Stack | 30 days | 11/22/2079 | 01/03/2080 |
| 224 | Demolish Misc Foundations | 30 days | 11/22/2079 | 01/03/2080 |
| 225 | Grn Pd 1 Ends | 0 days | 01/03/2080 | 01/03/2080 |
| 226 | **Grn Pd 2 - Site Restoration** | **90 days** | **01/03/2080** | **05/08/2080** |
| 227 | Grn Pd 2 Begins | 0 days | 01/03/2080 | 01/03/2080 |
| 228 | Site Restoration Equipment | 90 days | 01/03/2080 | 05/08/2080 |
| 229 | Remove Temporary Structures | 25 days | 01/03/2080 | 02/07/2080 |
| 230 | Finish Grading and Re-Vegetate Site | 90 days | 01/03/2080 | 05/08/2080 |
| 231 | Grn Pd 2 Ends | 0 days | 05/08/2080 | 05/08/2080 |



# Appendix D

# Detailed Cost Table

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **A. License Termination** | | | | | | | |
| **Decon Pd 1** | **SAFSTOR Planning Prior to Shutdown** | | | | | | |
| **Distributed** | | | | | | | |
| 1.01 | Planning of Historical Site Assessment (HSA) and Scoping Survey | $233 | $4 | $0 | $0 | $31 | $269 |
| 1.02 | Perform HSA | $207 | $2 | $0 | $0 | $27 | $236 |
| 1.03 | Perform Scoping Survey | $249 | $122 | $0 | $565 | $122 | $1,058 |
| 1.04 | Perform SAFSTOR Planning and Design | $481 | $29 | $0 | $0 | $66 | $576 |
| 1.05 | NRC Review of PSDAR and DCE | $0 | $0 | $0 | $264 | $34 | $298 |
| 1.06 | Preparation of SAFSTOR License Documents | $2,741 | $15 | $0 | $165 | $380 | $3,301 |
| 1.07 | Prepare SAFSTOR Integrated Work Schedule | $78 | $9 | $0 | $0 | $11 | $97 |
| 1.08 | Prepare SAFSTOR Activity Specifications | $490 | $4 | $0 | $0 | $64 | $558 |
| 1.09 | Prepare Detailed SAFSTOR Work Procedures | $764 | $0 | $0 | $0 | $99 | $864 |
| 1.10 | Perform Part 37 and SNM Assessment | $0 | $0 | $0 | $50 | $7 | $57 |
| **Distributed** | **Subtotal** | **$5,243** | **$185** | **$0** | **$1,044** | **$841** | **$7,314** |
| **Undistributed** | | | | | | | |
| 1.01 | Utility Staff | $3,557 | $0 | $0 | $0 | $462 | $4,020 |
| 1.03 | Security | $147 | $0 | $0 | $0 | $22 | $169 |
| 1.16 | Workers Comprehensive Insurance | $0 | $5 | $0 | $0 | $1 | $6 |
| **Undistributed** | **Subtotal** | **$3,705** | **$5** | **$0** | **$0** | **$485** | **$4,195** |
| **Decon Pd 1** | **Subtotal** | **$8,948** | **$190** | **$0** | **$1,044** | **$1,327** | **$11,509** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **Decon Pd 2** | **Transition Following Shutdown** | | | | | | |
| **Distributed** | | | | | | | |
| 2.01 | Submit Notification of Cessation of Operations | $0 | $0 | $0 | $0 | $0 | $0 |
| 2.02 | Defuel Reactor | $1,160 | $0 | $0 | $0 | $151 | $1,311 |
| 2.03 | Submit Notification of Fuel Removal from Vessel | $0 | $0 | $0 | $0 | $0 | $0 |
| 2.04 | NRC Review of Post-Shutdown LARs and ERs | $0 | $0 | $0 | $564 | $73 | $637 |
| 2.05 | Perform Activation Analyses of Reactor and Internals | $49 | $4 | $0 | $308 | $47 | $408 |
| 2.06 | Volume Reduce Control Rods, Fuel Channels and LPRMS | $1,744 | $672 | $16,716 | $0 | $4,400 | $23,533 |
| 2.07 | Flush and Drain Non-Essential Systems | $44 | $8 | $1,016 | $0 | $246 | $1,313 |
| 2.08 | Remove and Dispose of Hazardous Waste | $0 | $0 | $0 | $185 | $28 | $213 |
| 2.09 | Drain and Process Suppression Pool Water and Hydrolase Torus Walls | $0 | $0 | $0 | $0 | $0 | $0 |
| **Distributed** | **Subtotal** | **$2,996** | **$685** | **$17,732** | **$1,057** | **$4,945** | **$27,414** |
| **Undistributed** | | | | | | | |
| 1.01 | Utility Staff | $23,471 | $0 | $0 | $0 | $3,051 | $26,522 |
| 1.02 | Utility Staff HP Supplies | $0 | $581 | $0 | $0 | $87 | $668 |
| 1.04 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $271 | $41 | $311 |
| 1.05 | Non-Nuclear Insurance | $0 | $0 | $0 | $45 | $7 | $52 |
| 1.06 | Property Taxes | $0 | $0 | $0 | $100 | $15 | $115 |
| 1.07 | NRC Annual Fees - LT | $0 | $0 | $0 | $462 | $69 | $531 |
| 1.08 | Materials and Services | $0 | $3,238 | $0 | $0 | $486 | $3,724 |
| 1.09 | Energy | $0 | $0 | $0 | $2,408 | $361 | $2,769 |
| 1.10 | Environmental Permits and Fees | $0 | $0 | $0 | $8 | $1 | $9 |
| 1.13 | DAW Disposal | $0 | $0 | $27 | $0 | $4 | $31 |
| 1.14 | Severance | $7,786 | $0 | $0 | $0 | $1,168 | $8,954 |
| 1.15 | Retention | $443 | $0 | $0 | $0 | $66 | $509 |
| 1.16 | Workers Comprehensive Insurance | $0 | $35 | $0 | $0 | $5 | $40 |
| **Undistributed** | **Subtotal** | **$31,699** | **$3,853** | **$27** | **$3,294** | **$5,362** | **$44,234** |
| **Decon Pd 2** | **Subtotal** | **$34,695** | **$4,538** | **$17,759** | **$4,350** | **$10,306** | **$71,649** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **Decon Pd 3** | **SAFSTOR Preparation Delay During Spent Fuel Pool Operations** | | | | | | |
| **Undistributed** | | | | | | | |
| 1.01 | Utility Staff | $4,362 | $0 | $0 | $0 | $567 | $4,929 |
| 1.02 | Utility Staff HP Supplies | $0 | $199 | $0 | $0 | $30 | $229 |
| 1.04 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $170 | $25 | $195 |
| 1.05 | Non-Nuclear Insurance | $0 | $0 | $0 | $83 | $13 | $96 |
| 1.06 | Property Taxes | $0 | $0 | $0 | $183 | $28 | $211 |
| 1.07 | NRC Annual Fees - LT | $0 | $0 | $0 | $508 | $76 | $585 |
| 1.08 | Materials and Services | $0 | $604 | $0 | $0 | $91 | $694 |
| 1.09 | Energy | $0 | $0 | $0 | $1,879 | $282 | $2,161 |
| 1.10 | Environmental Permits and Fees | $0 | $0 | $0 | $14 | $2 | $17 |
| 1.13 | DAW Disposal | $0 | $0 | $5 | $0 | $1 | $6 |
| 1.14 | Severance | $9,550 | $0 | $0 | $0 | $1,433 | $10,983 |
| 1.16 | Workers Comprehensive Insurance | $0 | $6 | $0 | $0 | $1 | $7 |
| **Undistributed** | **Subtotal** | **$13,912** | **$810** | **$5** | **$2,839** | **$2,548** | **$20,113** |
| **Decon Pd 3** | **Subtotal** | **$13,912** | **$810** | **$5** | **$2,839** | **$2,548** | **$20,113** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **Decon Pd 4** | **Completion of SAFSTOR Preparations** | | | | | | |
| **Distributed** | | | | | | | |
| 4.01 | Drain Spent Fuel Pool and Process Liquid Waste | $0 | $0 | $0 | $0 | $0 | $0 |
| 4.02 | Flush and Drain Essential Systems Following Fuel Pool Closure | $27 | $14 | $1,016 | $0 | $243 | $1,300 |
| 4.03 | Removal and Disposal of Spent Resins, Filter Media and Tank Sludge | $28 | $28 | $2,540 | $0 | $597 | $3,194 |
| 4.04 | Segment, Package and Dispose of Spent Fuel Pool Island Equipment | $7 | $2 | $190 | $0 | $46 | $245 |
| 4.05 | General Area Cleanup | $1,511 | $694 | $195 | $0 | $552 | $2,952 |
| 4.06 | Secure Site for Dormancy Period | $0 | $0 | $0 | $1,845 | $277 | $2,122 |
| **Distributed** | **Subtotal** | **$1,574** | **$738** | **$3,941** | **$1,845** | **$1,715** | **$9,812** |
| **Undistributed** | | | | | | | |
| 1.01 | Utility Staff | $2,187 | $0 | $0 | $0 | $284 | $2,472 |
| 1.02 | Utility Staff HP Supplies | $0 | $100 | $0 | $0 | $15 | $115 |
| 1.04 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $73 | $11 | $84 |
| 1.05 | Non-Nuclear Insurance | $0 | $0 | $0 | $42 | $6 | $48 |
| 1.06 | Property Taxes | $0 | $0 | $0 | $92 | $14 | $106 |
| 1.07 | NRC Annual Fees - LT | $0 | $0 | $0 | $425 | $64 | $489 |
| 1.08 | Materials and Services | $0 | $303 | $0 | $0 | $45 | $348 |
| 1.09 | Energy | $0 | $0 | $0 | $497 | $75 | $572 |
| 1.10 | Environmental Permits and Fees | $0 | $0 | $0 | $7 | $1 | $8 |
| 1.13 | DAW Disposal | $0 | $0 | $22 | $0 | $3 | $25 |
| 1.14 | Severance | $4,550 | $0 | $0 | $0 | $683 | $5,233 |
| 1.16 | Workers Comprehensive Insurance | $0 | $3 | $0 | $0 | $0 | $4 |
| **Undistributed** | **Subtotal** | **$6,737** | **$406** | **$22** | **$1,137** | **$1,202** | **$9,504** |
| **Decon Pd 4** | **Subtotal** | **$8,311** | **$1,144** | **$3,963** | **$2,981** | **$2,916** | **$19,315** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **Decon Pd 5** | **Dormancy With Dry Storage** | | | | | | |
| **Distributed** | | | | | | | |
| 5.01 | Bituminous Roof Replacement - 20 year | $421 | $106 | $31 | $0 | $84 | $642 |
| 5.02 | Bituminous Roof Replacement - 40 year | $421 | $106 | $31 | $0 | $84 | $642 |
| **Distributed** | **Subtotal** | **$842** | **$212** | **$61** | **$0** | **$167** | **$1,283** |
| **Undistributed** | | | | | | | |
| 1.01 | Utility Staff | $25,720 | $0 | $0 | $0 | $3,344 | $29,063 |
| 1.02 | Utility Staff HP Supplies | $0 | $1,607 | $0 | $0 | $241 | $1,848 |
| 1.04 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $2,798 | $420 | $3,217 |
| 1.05 | Non-Nuclear Insurance | $0 | $0 | $0 | $801 | $120 | $921 |
| 1.06 | Property Taxes | $0 | $0 | $0 | $641 | $96 | $737 |
| 1.06 | Property Taxes | $0 | $0 | $0 | $1,491 | $224 | $1,715 |
| 1.07 | NRC Annual Fees - LT | $0 | $0 | $0 | $9,770 | $1,466 | $11,236 |
| 1.08 | Materials and Services | $0 | $3,053 | $0 | $0 | $458 | $3,511 |
| 1.09 | Energy | $0 | $0 | $0 | $8,841 | $1,326 | $10,167 |
| 1.10 | Environmental Permits and Fees | $0 | $0 | $0 | $279 | $42 | $320 |
| 1.13 | DAW Disposal | $0 | $0 | $31 | $0 | $5 | $36 |
| 1.14 | Severance | $668 | $0 | $0 | $0 | $100 | $768 |
| 1.16 | Workers Comprehensive Insurance | $0 | $33 | $0 | $0 | $5 | $38 |
| **Undistributed** | **Subtotal** | **$26,388** | **$4,693** | **$31** | **$24,620** | **$7,845** | **$63,577** |
| **Decon Pd 5** | **Subtotal** | **$27,229** | **$4,905** | **$93** | **$24,620** | **$8,013** | **$64,860** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **Decon Pd 6** | **Dormancy Only** | | | | | | |
| **Undistributed** | | | | | | | |
| 1.01 | Utility Staff | $10,150 | $0 | $0 | $0 | $1,319 | $11,469 |
| 1.02 | Utility Staff HP Supplies | $0 | $634 | $0 | $0 | $95 | $729 |
| 1.03 | Security | $5,209 | $0 | $0 | $0 | $781 | $5,991 |
| 1.04 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $4,416 | $662 | $5,078 |
| 1.05 | Non-Nuclear Insurance | $0 | $0 | $0 | $316 | $47 | $364 |
| 1.06 | Property Taxes | $0 | $0 | $0 | $348 | $52 | $400 |
| 1.07 | NRC Annual Fees - LT | $0 | $0 | $0 | $3,855 | $578 | $4,434 |
| 1.08 | Materials and Services | $0 | $2,651 | $0 | $0 | $398 | $3,048 |
| 1.09 | Energy | $0 | $0 | $0 | $4,299 | $645 | $4,944 |
| 1.10 | Environmental Permits and Fees | $0 | $0 | $0 | $110 | $16 | $126 |
| 1.13 | DAW Disposal | $0 | $0 | $12 | $0 | $2 | $14 |
| 1.14 | Severance | $592 | $0 | $0 | $0 | $89 | $681 |
| 1.16 | Workers Comprehensive Insurance | $0 | $28 | $0 | $0 | $4 | $33 |
| **Undistributed** | **Subtotal** | **$15,951** | **$3,313** | **$12** | **$13,345** | **$4,690** | **$37,311** |
| **Decon Pd 6** | **Subtotal** | **$15,951** | **$3,313** | **$12** | **$13,345** | **$4,690** | **$37,311** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **Decon Pd 7** | **Decommissioning Planning During Dormancy** | | | | | | |
| **Distributed** | | | | | | | |
| 7.01 | Install Office Trailer Complex | $0 | $0 | $0 | $3,543 | $532 | $4,075 |
| 7.02 | Select Decommissioning General Contractor | $351 | $5 | $0 | $0 | $46 | $403 |
| 7.03 | Post SAFSTOR Decommissioning Planning | $225 | $0 | $0 | $0 | $29 | $254 |
| 7.04 | Planning Post SAFSTOR Site Characterization | $131 | $2 | $0 | $0 | $17 | $151 |
| 7.05 | Planning for Asbestos Abatement | $137 | $2 | $0 | $0 | $18 | $157 |
| 7.06 | Prepare Integrated Work Sequence and Schedule for Decommissioning | $179 | $0 | $0 | $0 | $23 | $202 |
| 7.07 | Prepare Decommissioning Activity Specifications | $2,201 | $19 | $0 | $0 | $289 | $2,508 |
| 7.08 | Prepare Detailed Work Procedures for Decommissioning | $2,154 | $0 | $0 | $0 | $280 | $2,434 |
| 7.09 | Update Decommissioning Cost Estimate (DCE) | $281 | $1 | $0 | $0 | $37 | $318 |
| 7.10 | Update Post-Shutdown Decommissioning Activities Report (PSDAR) | $229 | $1 | $0 | $0 | $30 | $259 |
| 7.11 | Planning and Design of Site Revitilization | $1,038 | $18 | $0 | $0 | $137 | $1,193 |
| 7.12 | Planning and Design Rail Spur Upgrade | $252 | $10 | $0 | $0 | $34 | $296 |
| 7.13 | Planning and Design Cold & Dark Site Repowering | $593 | $7 | $0 | $0 | $78 | $677 |
| 7.14 | Develop Effluent Management Plan | $93 | $0 | $0 | $0 | $12 | $105 |
| 7.15 | Design Liquid Radwaste Treatment and Demin Makeup Water Systems | $175 | $0 | $0 | $0 | $23 | $198 |
| 7.16 | Prepare and Submit Environmental Permits | $112 | $0 | $0 | $0 | $15 | $126 |
| 7.17 | Design Containment Access Modifications | $227 | $3 | $0 | $0 | $30 | $260 |
| 7.18 | Design and Procure RPV/RVI Segmentation Tooling and Equipment | $2,068 | $19,000 | $0 | $0 | $2,739 | $23,807 |
| 7.19 | Select Shipping Casks and Obtain Shipping Permits | $38 | $0 | $0 | $0 | $5 | $43 |
| 7.20 | Purchase Canisters for GTCC Waste | $0 | $1,588 | $0 | $0 | $238 | $1,826 |
| **Distributed** | **Subtotal** | **$10,482** | **$20,656** | **$0** | **$3,543** | **$4,611** | **$39,293** |
| **Undistributed** | | | | | | | |
| 1.01 | Utility Staff | $4,470 | $0 | $0 | $0 | $581 | $5,051 |
| 1.02 | Utility Staff HP Supplies | $0 | $157 | $0 | $0 | $23 | $180 |
| 1.03 | Security | $540 | $0 | $0 | $0 | $81 | $621 |
| 1.04 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $458 | $69 | $527 |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| 1.05 | Non-Nuclear Insurance | $0 | $0 | $0 | $33 | $5 | $38 |
| 1.06 | Property Taxes | $0 | $0 | $0 | $36 | $5 | $41 |
| 1.07 | NRC Annual Fees - LT | $0 | $0 | $0 | $400 | $60 | $460 |
| 1.08 | Materials and Services | $0 | $744 | $0 | $0 | $112 | $855 |
| 1.09 | Energy | $0 | $0 | $0 | $661 | $99 | $760 |
| 1.10 | Environmental Permits and Fees | $0 | $0 | $0 | $11 | $2 | $13 |
| 1.11 | Decommissioning General Contractor Staff | $2,599 | $0 | $0 | $0 | $338 | $2,936 |
| 1.12 | DGC HP Supplies | $0 | $43 | $0 | $0 | $6 | $50 |
| 1.13 | DAW Disposal | $0 | $0 | $4 | $0 | $1 | $4 |
| 1.16 | Workers Comprehensive Insurance | $0 | $8 | $0 | $0 | $1 | $9 |
| **Undistributed** | **Subtotal** | **$7,609** | **$951** | **$4** | **$1,600** | **$1,383** | **$11,547** |
| **Decon Pd 7** | **Subtotal** | **$18,091** | **$21,607** | **$4** | **$5,143** | **$5,994** | **$50,840** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **Decon Pd 8** | **Internals Segmentation and Site Preparations** | | | | | | |
| **Distributed** | | | | | | | |
| 8.01 | Revitalize Infrastructure | $0 | $0 | $0 | $17,683 | $2,652 | $20,336 |
| 8.02 | Implement Cold & Dark | $3,095 | $5,023 | $0 | $0 | $1,218 | $9,336 |
| 8.03 | Install Liquid Radwaste Treatment System | $0 | $0 | $0 | $1,750 | $263 | $2,013 |
| 8.04 | Install Demin Makeup Water System for RVI Segementation | $0 | $0 | $0 | $313 | $47 | $360 |
| 8.05 | Perform Post-SAFSTOR Site Characterization | $367 | $250 | $0 | $0 | $80 | $698 |
| 8.06 | Prepare License Termination Plan (LTP) | $331 | $10 | $0 | $0 | $44 | $385 |
| 8.07 | Remove and Dispose of Spent Fuel Storage Racks | $124 | $281 | $1,683 | $0 | $480 | $2,569 |
| 8.08 | Segment and Dispose of Drywell Head | $142 | $31 | $49 | $0 | $51 | $274 |
| 8.09 | Reflood RPV and Steam Separator Pool for RVI Segmentation | $129 | $80 | $0 | $0 | $48 | $257 |
| 8.10 | Remove and Dispose of Rx Head | $151 | $26 | $757 | $0 | $271 | $1,205 |
| 8.11 | Test Special Cutting and Handling Equipment and Train Operators | $1,335 | $217 | $0 | $0 | $202 | $1,753 |
| 8.12 | Finalize Internals and Vessel Segmenting Details | $23 | $0 | $0 | $0 | $3 | $26 |
| 8.13 | Segment, Package and Ship Reactor Internals | $4,247 | $1,449 | $12,486 | $0 | $5,578 | $23,760 |
| 8.14 | RVI GTCC Waste Transportation and Disposal | $0 | $0 | $5,674 | $2,288 | $1,648 | $9,610 |
| 8.15 | Construct New Change Rooms, Hot Laundry, Waste Staging Area | $0 | $1,192 | $0 | $0 | $179 | $1,371 |
| 8.16 | Modify Containment Access | $454 | $837 | $0 | $0 | $194 | $1,484 |
| 8.17 | Upgrade Rail Spur | $0 | $0 | $0 | $2,410 | $362 | $2,772 |
| 8.18 | Install Truck Radiological Monitoring System | $0 | $0 | $0 | $500 | $75 | $575 |
| **Distributed** | **Subtotal** | **$10,397** | **$9,397** | **$20,649** | **$24,944** | **$13,395** | **$78,782** |
| **Undistributed** | | | | | | | |
| 1.01 | Utility Staff | $12,716 | $0 | $0 | $0 | $1,653 | $14,369 |
| 1.02 | Utility Staff HP Supplies | $0 | $533 | $0 | $0 | $80 | $613 |
| 1.03 | Security | $510 | $0 | $0 | $0 | $76 | $586 |
| 1.04 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $432 | $65 | $497 |
| 1.05 | Non-Nuclear Insurance | $0 | $0 | $0 | $62 | $9 | $71 |
| 1.06 | Property Taxes | $0 | $0 | $0 | $34 | $5 | $39 |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| 1.07 | NRC Annual Fees - LT | $0 | $0 | $0 | $629 | $94 | $723 |
| 1.08 | Materials and Services | $0 | $1,880 | $0 | $0 | $282 | $2,162 |
| 1.09 | Energy | $0 | $0 | $0 | $727 | $109 | $836 |
| 1.10 | Environmental Permits and Fees | $0 | $0 | $0 | $11 | $2 | $12 |
| 1.11 | Decommissioning General Contractor Staff | $18,350 | $0 | $0 | $0 | $2,386 | $20,736 |
| 1.12 | DGC HP Supplies | $0 | $598 | $0 | $0 | $90 | $687 |
| 1.13 | DAW Disposal | $0 | $0 | $127 | $0 | $19 | $146 |
| 1.16 | Workers Comprehensive Insurance | $0 | $20 | $0 | $0 | $3 | $23 |
| **Undistributed** | **Subtotal** | **$31,576** | **$3,031** | **$127** | **$1,894** | **$4,873** | **$41,501** |
| **Decon Pd 8** | **Subtotal** | **$41,973** | **$12,428** | **$20,776** | **$26,838** | **$18,267** | **$120,283** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **Decon Pd 9** | **Major Component and Systems Removal** | | | | | | |
| **Distributed** | | | | | | | |
| 9.01 | Procure Non-Engineered Standard Equipment | $0 | $8,303 | $0 | $0 | $1,079 | $9,382 |
| 9.02 | NRC Review and Approval of License Termination Plan | $0 | $0 | $0 | $1,078 | $140 | $1,218 |
| 9.03 | Remove, Package and Dispose of Non-Essential Systems | $12,884 | $3,111 | $12,412 | $0 | $6,534 | $34,941 |
| 9.04 | Perform Asbestos Abatement on Plant Systems | $750 | $319 | $1,096 | $0 | $498 | $2,663 |
| 9.05 | Removal and Disposal of Off Gas System Adsorber | $28 | $28 | $3,175 | $0 | $743 | $3,974 |
| 9.06 | Segment, Package and Dispose of Nuclear Steam Supply System | $4,432 | $1,445 | $39,047 | $0 | $10,333 | $55,257 |
| 9.07 | Remove, Package and Dispose of Remaining Active Plant Systems | $4,379 | $1,359 | $4,451 | $0 | $2,344 | $12,533 |
| 9.08 | Remove and Dispose of Control Rod Drives | $330 | $79 | $1,585 | $0 | $458 | $2,452 |
| 9.09 | Remove and Dispose of Shield Plugs, Pool Plugs and Stud Tensioners | $82 | $58 | $1,774 | $0 | $440 | $2,354 |
| 9.10 | Reactor Vessel Insulation Removal and Disposal | $123 | $21 | $384 | $0 | $122 | $650 |
| 9.11 | Segment, Package and Ship Reactor Pressure Vessel | $3,328 | $1,394 | $5,761 | $0 | $3,425 | $13,908 |
| 9.12 | Drain Dryer Separator Pool and Process Liquid Waste | $0 | $0 | $0 | $0 | $0 | $0 |
| 9.13 | Transportation and Disposal of Liquid Radwaste Filters and Resins | $13 | $103 | $272 | $0 | $89 | $477 |
| 9.14 | Removal and Disposal of Sacrificial Shield Wall and Reactor Pedestal | $399 | $606 | $974 | $0 | $455 | $2,433 |
| 9.15 | Segment, Package and Dispose of Refueling Bridge | $60 | $13 | $313 | $0 | $89 | $475 |
| 9.16 | Removal and Disposal of Lead Shielding | $29 | $8 | $181 | $0 | $50 | $267 |
| **Distributed** | **Subtotal** | **$26,836** | **$16,847** | **$71,426** | **$1,078** | **$26,799** | **$142,987** |
| **Undistributed** | | | | | | | |
| 1.01 | Utility Staff | $18,319 | $0 | $0 | $0 | $2,381 | $20,701 |
| 1.02 | Utility Staff HP Supplies | $0 | $1,648 | $0 | $0 | $247 | $1,895 |
| 1.03 | Security | $689 | $0 | $0 | $0 | $103 | $792 |
| 1.04 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $584 | $88 | $672 |
| 1.05 | Non-Nuclear Insurance | $0 | $0 | $0 | $84 | $13 | $96 |
| 1.06 | Property Taxes | $0 | $0 | $0 | $46 | $7 | $53 |
| 1.07 | NRC Annual Fees - LT | $0 | $0 | $0 | $850 | $128 | $978 |
| 1.08 | Materials and Services | $0 | $2,813 | $0 | $0 | $422 | $3,235 |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| 1.09 | Energy | $0 | $0 | $0 | $834 | $125 | $960 |
| 1.10 | Environmental Permits and Fees | $0 | $0 | $0 | $15 | $2 | $17 |
| 1.11 | Decommissioning General Contractor Staff | $39,987 | $0 | $0 | $0 | $5,198 | $45,186 |
| 1.12 | DGC HP Supplies | $0 | $2,807 | $0 | $0 | $421 | $3,228 |
| 1.13 | DAW Disposal | $0 | $0 | $247 | $0 | $37 | $284 |
| 1.16 | Workers Comprehensive Insurance | $0 | $30 | $0 | $0 | $5 | $35 |
| **Undistributed** | **Subtotal** | **$58,995** | **$7,298** | **$247** | **$2,413** | **$9,177** | **$78,131** |
| **Decon Pd 9** | **Subtotal** | **$85,831** | **$24,146** | **$71,674** | **$3,491** | **$35,976** | **$221,117** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **Decon Pd 10** | **Building Decontamination** | | | | | | |
| **Distributed** | | | | | | | |
| 10.01 | Procure Non-Engineered Standard Equipment | $0 | $1,453 | $0 | $0 | $189 | $1,642 |
| 10.02 | Decon Reactor Building | $4,057 | $3,031 | $9,241 | $0 | $3,756 | $20,085 |
| 10.03 | Decon Turbine Building | $745 | $1,046 | $771 | $0 | $589 | $3,151 |
| 10.04 | Decon Radwaste Building | $162 | $201 | $253 | $0 | $142 | $758 |
| 10.05 | Decon HPCI and RCIC Building | $35 | $53 | $35 | $0 | $29 | $152 |
| 10.06 | Decon Administration Building | $13 | $7 | $14 | $0 | $8 | $42 |
| 10.07 | Decon Off-Gas Retention Building | $60 | $25 | $29 | $0 | $26 | $141 |
| 10.08 | Decon Low Level Radwaste Storage and Processing | $287 | $426 | $361 | $0 | $247 | $1,321 |
| 10.09 | Decon Off-Gas Stack | $69 | $53 | $188 | $0 | $71 | $382 |
| 10.10 | Segment, Package and Dispose of Contaminated Decon Equipment and Tooling | $24 | $6 | $172 | $0 | $46 | $249 |
| 10.11 | Remove Underground Storm Drains and Manholes | $33 | $30 | $45 | $0 | $25 | $133 |
| 10.12 | Transportation and Disposal of Liquid Radwaste Filters and Resins | $13 | $3 | $272 | $0 | $66 | $354 |
| 10.13 | Demolish Waste Staging Area | $543 | $322 | $2,441 | $0 | $761 | $4,067 |
| 10.14 | Final Status Survey for Structures | $4,564 | $4,377 | $0 | $1,087 | $1,304 | $11,332 |
| 10.15 | Final Status Survey for Land Areas | $712 | $392 | $0 | $0 | $144 | $1,248 |
| **Distributed** | **Subtotal** | **$11,318** | **$11,426** | **$13,823** | **$1,087** | **$7,402** | **$45,056** |
| **Undistributed** | | | | | | | |
| 1.01 | Utility Staff | $13,175 | $0 | $0 | $0 | $1,713 | $14,888 |
| 1.02 | Utility Staff HP Supplies | $0 | $1,457 | $0 | $0 | $219 | $1,675 |
| 1.03 | Security | $609 | $0 | $0 | $0 | $91 | $700 |
| 1.04 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $516 | $77 | $594 |
| 1.05 | Non-Nuclear Insurance | $0 | $0 | $0 | $74 | $11 | $85 |
| 1.06 | Property Taxes | $0 | $0 | $0 | $41 | $6 | $47 |
| 1.07 | NRC Annual Fees - LT | $0 | $0 | $0 | $751 | $113 | $864 |
| 1.08 | Materials and Services | $0 | $2,099 | $0 | $0 | $315 | $2,414 |
| 1.09 | Energy | $0 | $0 | $0 | $690 | $104 | $794 |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| 1.10 | Environmental Permits and Fees | $0 | $0 | $0 | $13 | $2 | $15 |
| 1.11 | Decommissioning General Contractor Staff | $29,651 | $0 | $0 | $0 | $3,855 | $33,506 |
| 1.12 | DGC HP Supplies | $0 | $2,071 | $0 | $0 | $311 | $2,382 |
| 1.13 | DAW Disposal | $0 | $0 | $168 | $0 | $25 | $194 |
| 1.16 | Workers Comprehensive Insurance | $0 | $23 | $0 | $0 | $3 | $26 |
| **Undistributed** | **Subtotal** | **$43,435** | **$5,650** | **$168** | **$2,086** | **$6,844** | **$58,184** |
| **Decon Pd 10** | **Subtotal** | **$54,754** | **$17,076** | **$13,991** | **$3,173** | **$14,246** | **$103,240** |
| **Decon Pd 11** | **License Termination** | | | | | | |
| **Distributed** | | | | | | | |
| 11.01 | Prepare Final Status Survey Report | $64 | $2 | $0 | $0 | $9 | $74 |
| 11.02 | NRC Review and Approval of FSS Report | $0 | $0 | $0 | $539 | $70 | $609 |
| **Distributed** | **Subtotal** | **$64** | **$2** | **$0** | **$539** | **$79** | **$683** |
| **Undistributed** | | | | | | | |
| 1.01 | Utility Staff | $828 | $0 | $0 | $0 | $108 | $936 |
| 1.03 | Security | $267 | $0 | $0 | $0 | $40 | $307 |
| 1.04 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $226 | $34 | $260 |
| 1.05 | Non-Nuclear Insurance | $0 | $0 | $0 | $16 | $2 | $19 |
| 1.06 | Property Taxes | $0 | $0 | $0 | $18 | $3 | $20 |
| 1.07 | NRC Annual Fees - LT | $0 | $0 | $0 | $141 | $21 | $162 |
| 1.08 | Materials and Services | $0 | $185 | $0 | $0 | $28 | $213 |
| 1.09 | Energy | $0 | $0 | $0 | $4 | $1 | $5 |
| 1.11 | Decommissioning General Contractor Staff | $1,632 | $0 | $0 | $0 | $212 | $1,844 |
| 1.16 | Workers Comprehensive Insurance | $0 | $2 | $0 | $0 | $0 | $2 |
| **Undistributed** | **Subtotal** | **$2,727** | **$187** | **$0** | **$405** | **$449** | **$3,768** |
| **Decon Pd 11** | **Subtotal** | **$2,791** | **$189** | **$0** | **$944** | **$527** | **$4,451** |
| **A. License Termination** | **Subtotal** | **$312,486** | **$90,346** | **$128,277** | **$88,768** | **$104,811** | **$724,688** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **B. Spent Fuel** | | | | | | | |
| **SNF Pd 1** | **Spent Fuel Planning** | | | | | | |
| **Distributed** | | | | | | | |
| 12.01 | Prepare Irradiated Fuel Management Plan | $101 | $1 | $0 | $0 | $13 | $115 |
| 12.02 | Submit ER to Allow Spent Fuel Costs to Taken From DTF | $0 | $0 | $0 | $0 | $0 | $0 |
| 12.03 | Design Spent Fuel Storage Security Modifications | $50 | $0 | $0 | $0 | $7 | $57 |
| **Distributed** | **Subtotal** | **$151** | **$1** | **$0** | **$0** | **$20** | **$172** |
| **Undistributed** | | | | | | | |
| 2.01 | Utility Staff | $240 | $0 | $0 | $0 | $31 | $271 |
| 2.13 | Workers Comprehensive Insurance | $0 | $0 | $0 | $0 | $0 | $0 |
| **Undistributed** | **Subtotal** | **$240** | **$0** | **$0** | **$0** | **$31** | **$272** |
| **SNF Pd 1** | **Subtotal** | **$391** | **$1** | **$0** | **$0** | **$51** | **$443** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **SNF Pd 2** | **Spent Fuel Cooling During Zirc Fire Window** | | | | | | |
| **Distributed** | | | | | | | |
| 13.01 | Implement Spent Fuel Pool Security Modifications | $50 | $250 | $0 | $0 | $45 | $345 |
| **Distributed** | **Subtotal** | **$50** | **$250** | **$0** | **$0** | **$45** | **$345** |
| **Undistributed** | | | | | | | |
| 2.01 | Utility Staff | $524 | $0 | $0 | $0 | $68 | $592 |
| 2.02 | Utility Staff HP Supplies | $0 | $171 | $0 | $0 | $26 | $197 |
| 2.03 | Security | $5,679 | $0 | $0 | $0 | $852 | $6,531 |
| 2.04 | Spent Fuel Pool Operations Staff | $6,084 | $0 | $0 | $0 | $791 | $6,875 |
| 2.05 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $812 | $122 | $934 |
| 2.09 | Materials and Services | $0 | $576 | $0 | $0 | $86 | $662 |
| 2.10 | Emergency Preparedness Fees | $0 | $0 | $0 | $961 | $144 | $1,105 |
| 2.11 | EPlan On-Call Shift Pay | $0 | $76 | $0 | $0 | $11 | $88 |
| 2.13 | Workers Comprehensive Insurance | $0 | $25 | $0 | $0 | $4 | $28 |
| 2.14 | Spent Fuel Maintenance | $0 | $0 | $0 | $500 | $75 | $575 |
| 2.15 | Energy | $0 | $0 | $0 | $431 | $65 | $495 |
| 2.17 | DAW Disposal | $0 | $0 | $4 | $0 | $1 | $5 |
| **Undistributed** | **Subtotal** | **$12,287** | **$848** | **$4** | **$2,704** | **$2,244** | **$18,087** |
| **SNF Pd 2** | **Subtotal** | **$12,337** | **$1,098** | **$4** | **$2,704** | **$2,289** | **$18,432** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **SNF Pd 3** | **Spent Fuel Transfer to Dry Storage** | | | | | | |
| **Distributed** | | | | | | | |
| 14.01 | Construct ISFSI Phase 2 and 3 Pad Expansion | $0 | $0 | $0 | $2,250 | $338 | $2,588 |
| 14.02 | Spent Fuel Pool to Pad Transfer | $0 | $49,208 | $0 | $16,948 | $9,923 | $76,079 |
| 14.03 | Construct ISFSI Monitoring Building | $0 | $0 | $0 | $2,000 | $300 | $2,300 |
| **Distributed** | **Subtotal** | **$0** | **$49,208** | **$0** | **$21,198** | **$10,561** | **$80,967** |
| **Undistributed** | | | | | | | |
| 2.01 | Utility Staff | $961 | $0 | $0 | $0 | $125 | $1,086 |
| 2.02 | Utility Staff HP Supplies | $0 | $315 | $0 | $0 | $47 | $362 |
| 2.03 | Security | $10,425 | $0 | $0 | $0 | $1,564 | $11,989 |
| 2.04 | Spent Fuel Pool Operations Staff | $11,167 | $0 | $0 | $0 | $1,452 | $12,619 |
| 2.05 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $509 | $76 | $585 |
| 2.09 | Materials and Services | $0 | $1,057 | $0 | $0 | $159 | $1,215 |
| 2.11 | EPlan On-Call Shift Pay | $0 | $140 | $0 | $0 | $21 | $161 |
| 2.13 | Workers Comprehensive Insurance | $0 | $45 | $0 | $0 | $7 | $52 |
| 2.14 | Spent Fuel Maintenance | $0 | $0 | $0 | $917 | $138 | $1,055 |
| 2.15 | Energy | $0 | $0 | $0 | $930 | $139 | $1,069 |
| 2.17 | DAW Disposal | $0 | $0 | $8 | $0 | $1 | $9 |
| **Undistributed** | **Subtotal** | **$22,554** | **$1,557** | **$8** | **$2,356** | **$3,729** | **$30,203** |
| **SNF Pd 3** | **Subtotal** | **$22,554** | **$50,765** | **$8** | **$23,554** | **$14,289** | **$111,169** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **SNF Pd 4** | **Dry Storage During Completion of SAFSTOR Preparations** | | | | | | |
| **Undistributed** | | | | | | | |
| 2.03 | Security | $2,031 | $0 | $0 | $0 | $305 | $2,336 |
| 2.05 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $219 | $33 | $252 |
| 2.08 | NRC Annual Fees - SNF | $0 | $0 | $0 | $33 | $5 | $38 |
| 2.09 | Materials and Services | $0 | $128 | $0 | $0 | $19 | $147 |
| 2.13 | Workers Comprehensive Insurance | $0 | $5 | $0 | $0 | $1 | $6 |
| 2.14 | Spent Fuel Maintenance | $0 | $0 | $0 | $115 | $17 | $132 |
| 2.15 | Energy | $0 | $0 | $0 | $26 | $4 | $30 |
| **Undistributed** | **Subtotal** | **$2,031** | **$133** | **$0** | **$393** | **$384** | **$2,941** |
| **SNF Pd 4** | **Subtotal** | **$2,031** | **$133** | **$0** | **$393** | **$384** | **$2,941** |
| **SNF Pd 5** | **Dry Storage During Dormancy** | | | | | | |
| **Distributed** | | | | | | | |
| 16.01 | Spent Fuel Transfer to DOE | $0 | $0 | $0 | $6,628 | $994 | $7,622 |
| **Distributed** | **Subtotal** | **$0** | **$0** | **$0** | **$6,628** | **$994** | **$7,622** |
| **Undistributed** | | | | | | | |
| 2.03 | Security | $77,828 | $0 | $0 | $0 | $11,674 | $89,502 |
| 2.05 | Nuclear Property and Liability Insurance | $0 | $0 | $0 | $8,393 | $1,259 | $9,651 |
| 2.08 | NRC Annual Fees - SNF | $0 | $0 | $0 | $1,265 | $190 | $1,455 |
| 2.09 | Materials and Services | $0 | $4,885 | $0 | $0 | $733 | $5,618 |
| 2.13 | Workers Comprehensive Insurance | $0 | $210 | $0 | $0 | $31 | $241 |
| 2.14 | Spent Fuel Maintenance | $0 | $0 | $0 | $4,406 | $661 | $5,067 |
| 2.15 | Energy | $0 | $0 | $0 | $2,109 | $316 | $2,426 |
| **Undistributed** | **Subtotal** | **$77,828** | **$5,095** | **$0** | **$16,172** | **$14,864** | **$113,959** |
| **SNF Pd 5** | **Subtotal** | **$77,828** | **$5,095** | **$0** | **$22,801** | **$15,858** | **$121,582** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **SNF Pd 7** | **ISFSI and Support Structure Clean Demolition** | | | | | | |
| **Distributed** | | | | | | | |
| 18.01 | Clean Demolition of ISFSI | $802 | $990 | $1,351 | $0 | $409 | $3,551 |
| 18.02 | Demolish ISFSI Support Structures | $137 | $110 | $115 | $0 | $47 | $409 |
| 18.03 | Backfill and Grade ISFSI Site | $23 | $18 | $0 | $0 | $5 | $46 |
| **Distributed** | **Subtotal** | **$962** | **$1,118** | **$1,466** | **$0** | **$461** | **$4,006** |
| **Undistributed** | | | | | | | |
| 2.01 | Utility Staff | $173 | $0 | $0 | $0 | $23 | $196 |
| 2.09 | Materials and Services | $0 | $6 | $0 | $0 | $1 | $6 |
| 2.13 | Workers Comprehensive Insurance | $0 | $0 | $0 | $0 | $0 | $0 |
| 2.15 | Energy | $0 | $0 | $0 | $45 | $7 | $52 |
| 2.16 | Decommissioning General Contractor Staff | $564 | $0 | $0 | $0 | $73 | $637 |
| **Undistributed** | **Subtotal** | **$737** | **$6** | **$0** | **$45** | **$103** | **$892** |
| **SNF Pd 7** | **Subtotal** | **$1,699** | **$1,124** | **$1,466** | **$45** | **$564** | **$4,898** |
| **B. Spent Fuel** | **Subtotal** | **$116,840** | **$58,216** | **$1,478** | **$49,496** | **$33,436** | **$259,466** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **C. Greenfield** | | | | | | | |
| **Grn Pd 1** | **Clean Building Demolition During Decommissioning** | | | | | | |
| **Distributed** | | | | | | | |
| 19.01 | Prepare Site Restoration Demolition Plan and Schedule | $108 | $15 | $0 | $0 | $16 | $140 |
| 19.02 | Obtain Required Demolition Permits | $28 | $5 | $0 | $10 | $6 | $49 |
| 19.03 | Clean Building Demolition Equipment | $0 | $1,086 | $0 | $0 | $163 | $1,249 |
| 19.04 | Perform Pre-Demolition Asbestos Abatement | $12 | $145 | $0 | $55 | $32 | $244 |
| 19.05 | Remove and Dispose of Underground Storage Tanks | $19 | $27 | $0 | $0 | $6 | $53 |
| 19.06 | Demolish Non-Essential Structures | $972 | $670 | $682 | $0 | $302 | $2,626 |
| 19.07 | Demolish Training Center | $91 | $46 | $47 | $0 | $24 | $208 |
| 19.08 | Demolish Plant Support Center and New Site Support Building | $249 | $159 | $162 | $0 | $74 | $644 |
| 19.09 | Demolish Cooling Towers and Related Structures | $741 | $450 | $249 | $0 | $187 | $1,627 |
| 19.10 | Demolish Existing Waste Water Treatment Plant | $27 | $7 | $4 | $0 | $5 | $43 |
| 19.11 | Demolish Intake and Discharge Structures | $128 | $187 | $33 | $0 | $45 | $393 |
| 19.12 | Demolish Data Acquisition and Technical Support Building | $212 | $157 | $147 | $0 | $67 | $584 |
| 19.13 | Demolish Guard Facility and Security Structures | $545 | $237 | $184 | $0 | $126 | $1,092 |
| 19.14 | Demolish Control and Administrative Buildings | $470 | $329 | $284 | $0 | $141 | $1,223 |
| 19.15 | Demolish Turbine Building | $2,366 | $1,162 | $206 | $0 | $485 | $4,219 |
| 19.16 | Demolish Low-Level Radwaste Building | $1,413 | $1,360 | $826 | $0 | $468 | $4,068 |
| 19.17 | Demolish HPCI and RCIC Building | $179 | $79 | $9 | $0 | $35 | $302 |
| 19.18 | Demolish Reactor Building | $3,078 | $1,902 | $401 | $0 | $699 | $6,080 |
| 19.19 | Demolish Off-Gas Stack | $78 | $96 | $24 | $0 | $26 | $224 |
| 19.20 | Demolish Misc Foundations | $61 | $78 | $126 | $0 | $34 | $300 |
| **Distributed** | **Subtotal** | **$10,779** | **$8,198** | **$3,383** | **$65** | **$2,941** | **$25,367** |
| **Undistributed** | | | | | | | |
| 3.01 | Utility Staff | $768 | $0 | $0 | $0 | $100 | $868 |
| 3.03 | Energy | $0 | $0 | $0 | $117 | $17 | $134 |
| 3.04 | Decommissioning General Contractor Staff | $6,837 | $0 | $0 | $0 | $1,026 | $7,863 |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| 3.06 | Workers Comprehensive Insurance | $0 | $1 | $0 | $0 | $0 | $1 |
| **Undistributed** | **Subtotal** | **$7,606** | **$1** | **$0** | **$117** | **$1,143** | **$8,866** |
| **Grn Pd 1** | **Subtotal** | **$18,384** | **$8,200** | **$3,383** | **$181** | **$4,084** | **$34,233** |
| **Grn Pd 2** | **Site Restoration** | | | | | | |
| **Distributed** | | | | | | | |
| 20.01 | Site Restoration Equipment | $0 | $171 | $0 | $0 | $22 | $193 |
| 20.02 | Remove Temporary Structures | $11 | $9 | $0 | $0 | $3 | $23 |
| 20.03 | Finish Grading and Re-Vegetate Site | $440 | $354 | $0 | $0 | $103 | $898 |
| **Distributed** | **Subtotal** | **$452** | **$535** | **$0** | **$0** | **$128** | **$1,114** |
| **Undistributed** | | | | | | | |
| 3.01 | Utility Staff | $147 | $0 | $0 | $0 | $19 | $167 |
| 3.02 | Security | $129 | $0 | $0 | $0 | $19 | $149 |
| 3.04 | Decommissioning General Contractor Staff | $681 | $0 | $0 | $0 | $102 | $783 |
| 3.06 | Workers Comprehensive Insurance | $0 | $1 | $0 | $0 | $0 | $1 |
| **Undistributed** | **Subtotal** | **$958** | **$1** | **$0** | **$0** | **$141** | **$1,099** |
| **Grn Pd 2** | **Subtotal** | **$1,409** | **$535** | **$0** | **$0** | **$269** | **$2,214** |
| **C. Greenfield** | **Subtotal** | **$19,794** | **$8,735** | **$3,383** | **$181** | **$4,353** | **$36,447** |

# Table 1
## Duane Arnold SAFSTOR, 2030 DOE Acceptance, Utility and DGC

| | | | | | |
|---|---|---|---|---|---|
| | | License Status | Early Shutdown | Unit 1Shut Down: | 10/30/2020 |
| Decommissioning Alternative | SAFSTOR | Fuel Pool Systems | Modified | Unit 2 Shut Down: | |
| Spent Fuel Alternative | Dry | Repository Opening Date: | 1/1/2030 | | |

**2018 Dollars in Thousands**

| No | Item Description | Labor | Equipment | Disposal | Other | Contingency | Total |
|---|---|---|---|---|---|---|---|
| **D. ISFSI D&D** | | | | | | | |
| **ISFSI D&D Pd 1** | **ISFSI D&D Planning** | | | | | | |
| **Distributed** | | | | | | | |
| 21.01 | Preparation of ISFSI Portion of LTP | $185 | $0 | $0 | $0 | $24 | $209 |
| 21.02 | NRC Review of ISFSI Portion LTP | $0 | $0 | $0 | $44 | $6 | $50 |
| **Distributed** | **Subtotal** | **$185** | **$0** | **$0** | **$44** | **$30** | **$259** |
| **Undistributed** | | | | | | | |
| 4.01 | Utility Staff | $556 | $0 | $0 | $0 | $72 | $628 |
| **Undistributed** | **Subtotal** | **$556** | **$0** | **$0** | **$0** | **$72** | **$628** |
| **ISFSI D&D Pd** | **Subtotal** | **$741** | **$0** | **$0** | **$44** | **$102** | **$887** |
| **ISFSI D&D Pd 2** | **ISFSI Final Status Survey** | | | | | | |
| **Distributed** | | | | | | | |
| 22.01 | Final Status Survey of ISFSI | $144 | $50 | $0 | $0 | $25 | $220 |
| 22.02 | Preparation of FSS Report and NRC Review | $101 | $0 | $0 | $33 | $17 | $151 |
| **Distributed** | **Subtotal** | **$245** | **$50** | **$0** | **$33** | **$43** | **$371** |
| **Undistributed** | | | | | | | |
| 4.01 | Utility Staff | $338 | $0 | $0 | $0 | $44 | $382 |
| **Undistributed** | **Subtotal** | **$338** | **$0** | **$0** | **$0** | **$44** | **$382** |
| **ISFSI D&D Pd** | **Subtotal** | **$584** | **$50** | **$0** | **$33** | **$87** | **$754** |
| **D. ISFSI D&D** | **Subtotal** | **$1,324** | **$50** | **$0** | **$77** | **$189** | **$1,640** |
| | **Total** | **$450,444** | **$157,346** | **$133,138** | **$138,523** | **$142,789** | **$1,022,240** |

# Appendix E

## Annual Cost by Account Table

# Duane Arnold Annual Cost By Account

SAFSTOR, 2030 DOE Acceptance, Utility and DGC

**Unit No:** Unit 1

**2018 Dollars in Thousands**

| Year | License Termination | Spent Fuel | Site Restoration | ISFSI Demolition | Total |
|---|---|---|---|---|---|
| 2019 | $4,099 | $233 | $0 | $0 | $4,331 |
| 2020 | $36,182 | $3,324 | $0 | $0 | $39,506 |
| 2021 | $43,735 | $19,105 | $0 | $0 | $62,840 |
| 2022 | $15,949 | $57,546 | $0 | $0 | $73,495 |
| 2023 | $5,110 | $50,910 | $0 | $0 | $56,020 |
| 2024 | $14,895 | $3,222 | $0 | $0 | $18,117 |
| 2025 | $5,604 | $3,233 | $0 | $0 | $8,837 |
| 2026 | $2,201 | $3,233 | $0 | $0 | $5,434 |
| 2027 | $1,827 | $3,233 | $0 | $0 | $5,060 |
| 2028 | $1,827 | $3,233 | $0 | $0 | $5,060 |
| 2029 | $1,827 | $3,233 | $0 | $0 | $5,060 |
| 2030 | $1,884 | $3,233 | $0 | $0 | $5,117 |
| 2031 | $1,770 | $3,233 | $0 | $0 | $5,003 |
| 2032 | $1,770 | $3,504 | $0 | $0 | $5,274 |
| 2033 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2034 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2035 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2036 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2037 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2038 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2039 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2040 | $2,411 | $3,507 | $0 | $0 | $5,918 |
| 2041 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2042 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2043 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2044 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2045 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2046 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2047 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2048 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2049 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2050 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2051 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2052 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2053 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2054 | $2,055 | $3,507 | $0 | $0 | $5,562 |

# Duane Arnold Annual Cost By Account

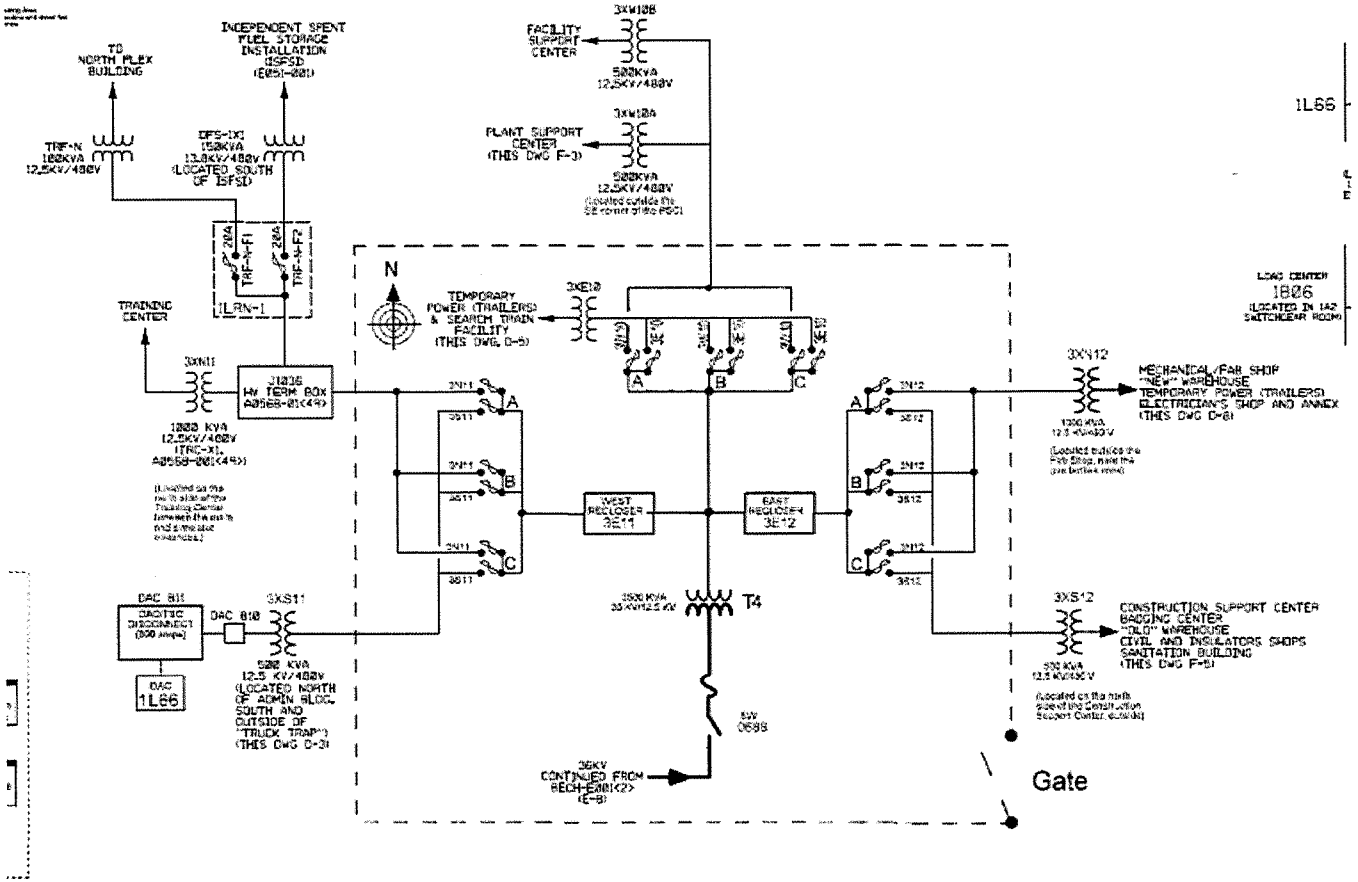
SAFSTOR, 2030 DOE Acceptance, Utility and DGC

**Unit No:** Unit 1

**2018 Dollars in Thousands**

| Year | License Termination | Spent Fuel | Site Restoration | ISFSI Demolition | Total |
|---|---|---|---|---|---|
| 2055 | $2,126 | $3,507 | $0 | $0 | $5,633 |
| 2056 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2057 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2058 | $1,770 | $3,507 | $0 | $0 | $5,277 |
| 2059 | $2,159 | $2,909 | $0 | $0 | $5,069 |
| 2060 | $3,077 | $0 | $0 | $0 | $3,077 |
| 2061 | $2,634 | $0 | $0 | $0 | $2,634 |
| 2062 | $2,634 | $0 | $0 | $0 | $2,634 |
| 2063 | $2,634 | $0 | $0 | $0 | $2,634 |
| 2064 | $2,634 | $0 | $0 | $0 | $2,634 |
| 2065 | $2,634 | $0 | $0 | $0 | $2,634 |
| 2066 | $2,634 | $0 | $0 | $0 | $2,634 |
| 2067 | $2,634 | $0 | $0 | $0 | $2,634 |
| 2068 | $2,634 | $0 | $0 | $0 | $2,634 |
| 2069 | $2,634 | $0 | $0 | $0 | $2,634 |
| 2070 | $2,634 | $0 | $0 | $0 | $2,634 |
| 2071 | $2,634 | $0 | $0 | $0 | $2,634 |
| 2072 | $2,634 | $0 | $0 | $0 | $2,634 |
| 2073 | $15,440 | $0 | $0 | $0 | $15,440 |
| 2074 | $32,608 | $0 | $0 | $0 | $32,608 |
| 2075 | $78,197 | $0 | $0 | $184 | $78,381 |
| 2076 | $94,001 | $0 | $0 | $403 | $94,404 |
| 2077 | $118,359 | $25 | $0 | $303 | $118,688 |
| 2078 | $101,052 | $4,873 | $6,212 | $731 | $112,868 |
| 2079 | $57,385 | $0 | $27,813 | $19 | $85,217 |
| 2080 | $4,828 | $0 | $2,422 | $0 | $7,250 |
| Total | $724,688 | $259,466 | $36,447 | $1,640 | $1,022,240 |

# DAEC CONSTRUCTION SUBSTATION DISTRIBUTION SCHEMATIC





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Attachment 2

Table 5.1 State and Federally Listed Species Potentially Occurring in the Vicinity of DAEC

Table 5.1 State and Federally Listed Species Potentially Occurring in the Vicinity of DAEC

| Common Name | Scientific Name | Class | State Status* | Federal Status |
|---|---|---|---|---|
| Blue-spotted Salamander | Ambystoma laterale | AMPHIBIANS | E | |
| Central Newt | Notophthalmus viridescens | AMPHIBIANS | T | |
| Bald Eagle | Haliaeetus leucocephalus | BIRDS | S | |
| Barn Owl | Tyto alba | BIRDS | E | |
| Henslow's Sparrow | Ammodramus henslowii | BIRDS | T | |
| American Brook Lamprey | Lampetra appendix | FISH | T | |
| Black Redhorse | Moxostoma duquesnei | FISH | T | |
| Blacknose Shiner | Notropis heterolepis | FISH | T | |
| Grass Pickerel | Esox americanus | FISH | T | |
| Lake Sturgeon | Acipenser fulvescens | FISH | E | |
| Orangethroat Darter | Etheostoma spectabile | FISH | T | |
| Weed Shiner | Notropis texanus | FISH | E | |
| Western Sand Darter | Ammocrypta clara | FISH | T | |
| Creek Heelsplitter | Lasmigona compressa | FRESHWATER MUSSELS | T | |
| Creeper | Strophitus undulatus | FRESHWATER MUSSELS | T | |
| Cylindrical Papershell | Anodontoides ferussacianus | FRESHWATER MUSSELS | T | |
| Ellipse | Venustaconcha ellipsiformis | FRESHWATER MUSSELS | T | |
| Higgin's-eye Pearly Mussel | Lampsilis higginsii | FRESHWATER MUSSELS | E | E |

*E: Endangered, T: Threatened, S: Special concern

Table 5.1 State and Federally Listed Species Potentially Occurring in the Vicinity of DAEC

| Common Name | Scientific Name | Class | State Status* | Federal Status |
|---|---|---|---|---|
| Pistolgrip | Tritogonia verrucosa | FRESHWATER MUSSELS | E | |
| Slippershell Mussel | Alasmidonta viridis | FRESHWATER MUSSELS | E | |
| Yellow Sandshell | Lampsilis teres | FRESHWATER MUSSELS | E | |
| Baltimore | Euphydryas phaeton | INSECTS | T | |
| Byssus Skipper | Problema byssus | INSECTS | T | |
| Pipevine Swallowtail | Battus philenor | INSECTS | S | |
| Swamp Metalmark | Calephelis mutica | INSECTS | S | |
| Wild Indigo Dusky Wing | Erynnis baptisiae | INSECTS | S | |
| Zabulon Skipper | Poanes zabulon | INSECTS | S | |
| Zebra Swallowtail | Eurytides marcellus | INSECTS | S | |
| Northern Long-eared Bat | Myotis septentrionalis | MAMMALS | | T |
| Plains Pocket Mouse | Perognathus flavescens | MAMMALS | E | |
| Southern Flying Squirrel | Glaucomys volans | MAMMALS | S | |
| Bent Milk-vetch | Astragalus distortus | PLANTS (DICOTS) | S | |
| Black Huckleberry | Gaylussacia baccata | PLANTS (DICOTS) | T | |
| Buckbean | Menyanthes trifoliata | PLANTS (DICOTS) | T | |
| Cleft Phlox | Phlox bifida | PLANTS (DICOTS) | S | |
| Flat Top White Aster | Aster pubentior | PLANTS (DICOTS) | S | |
| Hill's Thistle | Cirsium hillii | PLANTS (DICOTS) | S | |
| Kitten Tails | Besseya bullii | PLANTS (DICOTS) | T | |
| Lance-leaved Violet | Viola lanceolata | PLANTS (DICOTS) | S | |

*E: Endangered, T: Threatened, S: Special concern

Table 5.1 State and Federally Listed Species Potentially Occurring in the Vicinity of DAEC

| Common Name | Scientific Name | Class | State Status* | Federal Status |
|---|---|---|---|---|
| Large-leaf White Violet | Viola incognita | PLANTS (DICOTS) | E | |
| Northern St. John's-wort | Hypericum boreale | PLANTS (DICOTS) | E | |
| Pearly Everlasting | Anaphalis margaritacea | PLANTS (DICOTS) | S | |
| Pink Milkwort | Polygala incarnata | PLANTS (DICOTS) | T | |
| Prairie Bush Clover | Lespedeza leptostachya | PLANTS (DICOTS) | T | T |
| Pretty Dodder | Cuscuta indecora | PLANTS (DICOTS) | S | |
| Prince's Pine | Chimaphila umbellata | PLANTS (DICOTS) | T | |
| Purple Cress | Cardamine douglassii | PLANTS (DICOTS) | S | |
| Racemed Milkwort | Polygala polygama | PLANTS (DICOTS) | E | |
| Sage Willow | Salix candida | PLANTS (DICOTS) | S | |
| Scarlet Hawthorn | Crataegus coccinea | PLANTS (DICOTS) | S | |
| Shrubby Cinquefoil | Potentilla fruticosa | PLANTS (DICOTS) | T | |
| Small Sundrops | Oenothera perennis | PLANTS (DICOTS) | T | |
| Smooth Black-haw | Viburnum prunifolium | PLANTS (DICOTS) | S | |
| Spring Avens | Geum vernum | PLANTS (DICOTS) | S | |
| Tunnel-formed Penstemon | Penstemon tubiflorus | PLANTS (DICOTS) | S | |
| Veined Skullcap | Scutellaria nervosa | PLANTS (DICOTS) | S | |
| Violet | Viola macloskeyi | PLANTS (DICOTS) | S | |
| Water Shield | Brasenia schreberi | PLANTS (DICOTS) | S | |
| Water Starwort | Callitriche heterophylla | PLANTS (DICOTS) | S | |
| Winterberry | Ilex verticillata | PLANTS (DICOTS) | E | |

*E: Endangered, T: Threatened, S: Special concern

Table 5.1 State and Federally Listed Species Potentially Occurring in the Vicinity of DAEC

| Common Name | Scientific Name | Class | State Status* | Federal Status |
|---|---|---|---|---|
| Yellow Monkey Flower | Mimulus glabratus | PLANTS (DICOTS) | T | |
| Deep Green Sedge | Carex tonsa | PLANTS (MONOCOTS) | S | |
| Eastern Prairie Fringed Orchid | Platanthera leucophaea | PLANTS (MONOCOTS) | E | T |
| Field Sedge | Carex conoidea | PLANTS (MONOCOTS) | S | |
| Fringed Sedge | Carex crinita | PLANTS (MONOCOTS) | S | |
| Glomerate Sedge | Carex aggregata | PLANTS (MONOCOTS) | S | |
| Grass Pink | Calopogon tuberosus | PLANTS (MONOCOTS) | S | |
| Great Plains Ladies'-tresses | Spiranthes magnicamporum | PLANTS (MONOCOTS) | S | |
| Green's Rush | Juncus greenei | PLANTS (MONOCOTS) | S | |
| Hidden Sedge | Carex umbellata | PLANTS (MONOCOTS) | S | |
| Northern Panic-grass | Dichanthelium boreale | PLANTS (MONOCOTS) | E | |
| Oval Ladies'-tresses | Spiranthes ovalis | PLANTS (MONOCOTS) | T | |
| Pale Green Orchid | Platanthera flava | PLANTS (MONOCOTS) | E | |
| Purple Fringed Orchid | Platanthera psycodes | PLANTS (MONOCOTS) | T | |
| Richardson Sedge | Carex richardsonii | PLANTS (MONOCOTS) | S | |

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Table 5.1 State and Federally Listed Species Potentially Occurring in the Vicinity of DAEC

| Common Name | Scientific Name | Class | State Status* | Federal Status |
|---|---|---|---|---|
| Showy Lady's Slipper | Cypripedium reginae | PLANTS (MONOCOTS) | T | |
| Slender Sedge | Carex tenera | PLANTS (MONOCOTS) | S | |
| Small Green Woodland Orchid | Platanthera clavellata | PLANTS (MONOCOTS) | S | |
| Small White Lady's Slipper | Cypripedium candidum | PLANTS (MONOCOTS) | S | |
| Soft Rush | Juncus effusus | PLANTS (MONOCOTS) | S | |
| Tall Cotton Grass | Eriophorum angustifolium | PLANTS (MONOCOTS) | S | |
| Vasey Pondweed | Potamogeton vaseyi | PLANTS (MONOCOTS) | S | |
| Western Prairie Fringed Orchid | Platanthera praeclara | PLANTS (MONOCOTS) | T | T |
| Yellow-eyed Grass | Xyris torta | PLANTS (MONOCOTS) | E | |
| Crowfoot Clubmoss | Lycopodium digitatum | PLANTS (PTERIODOPHYTES) | S | |
| Leathery Grape Fern | Botrychium multifidum | PLANTS (PTERIODOPHYTES) | T | |
| Ledge Spikemoss | Selaginella rupestris | PLANTS (PTERIODOPHYTES) | S | |
| Little Grape Fern | Botrychium simplex | PLANTS (PTERIODOPHYTES) | T | |
| Northern Adder's-tongue | Ophioglossum pusillum | PLANTS (PTERIODOPHYTES) | S | |
| Prairie Moonwort | Botrychium campestre | PLANTS (PTERIODOPHYTES) | S | |

*E: Endangered, T: Threatened, S: Special concern

Table 5.1 State and Federally Listed Species Potentially Occurring in the Vicinity of DAEC

| **Common Name** | **Scientific Name** | **Class** | **State Status*** | **Federal Status** |
|---|---|---|---|---|
| Woodland Horsetail | Equisetum sylvaticum | PLANTS (PTERIODOPHYTES) | T | |
| Blanding's Turtle | Emydoidea blandingii | REPTILES | T | |
| Bullsnake | Pituophis catenifer sayi | REPTILES | S | |
| Ornate Box Turtle | Terrapene ornata | REPTILES | T | |
| Smooth Green Snake | Liochlorophis vernalis | REPTILES | S | |
| Bluff Vertigo | Vertigo meramecensis | SNAILS | E | |

*E: Endangered, T: Threatened, S: Special concern