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10 CFR 50.36a

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

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

2024 Annual Radioactive Material Release Report

Please find as the Enclosure to this letter, a copy of NextEra Energy Duane Arnold, LLC's (hereafter, NextEra Energy Duane Arnold) 2024 Annual Radioactive Material Release Report for the Duane Arnold Energy Center (DAEC). This report satisfies the requirements of Defueled Offsite Dose Assessment Manual (DODAM) Section 8.2.1 and Technical Specification Section 5.6.3.

This letter makes no new commitments or changes to existing commitments.

Should you have any questions regarding this matter, please contact Michael Casey at (319) 851-7606.

A handwritten signature in blue ink that reads "Justin Both".

Justin Both
Decommissioning Director
NextEra Energy Duane Arnold, LLC

Enclosure

cc: Administrator, Region III, USNRC
Project Manager, DAEC, USNRC
Inspector, DAEC, USNRC

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NRR

Enclosure to NG-25-0006

Duane Arnold Energy Center
2024 Annual Radioactive Material Release Report



2024

Annual Radioactive Material Release Report

Duane Arnold Energy Center
Palo, Iowa
Docket No. 50-331

January 1, 2024, through December 31, 2024

Prepared By: John Dierickx Date: 4/23/25
John Dierickx, Westinghouse Radiological Engineer

Verified By: Mike Casey Date: 4/23/25
Mike Casey, Radiation Protection and Environmental Manager

Approved By: Justin Both Date: 4/28/25
Justin Both, Site Decommissioning Director

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Preface

The Annual Radioactive Material Release Report (ARMRR) covers the operation of the unit during the previous calendar year and shall be submitted prior to May 1 of each year in accordance with 10 CFR 50.36a. The report includes a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit. The material provided in the report is consistent with the objectives outlined in the DODAM and Process Control Program and in conformance with 10 CFR 50.36a and 10 CFR Part 50, Appendix I, Section IV.B.1.

The Duane Arnold Energy Center (DAEC) permanently shut down on August 10, 2020. NextEra Energy Duane Arnold (NEDA) informed the NRC by letter dated August 27, 2020 (Accession No. ML20240A067), certifying the permanent cessation of power operations at the DAEC.

In October 2020, NEDA certified by letter (ML20286A317) the permanent defueling of the reactor at DAEC. Therefore, as specified in 10 CFR 50.82(a)(2), the 10 CFR Part 50 license for DAEC no longer authorizes operations of the reactor or emplacement or retention of fuel into the reactor vessel.

In April 2022, all the nuclear fuel had been removed from the fuel pool and placed in dry cask storage at the site Independent Spent Fuel Storage Installation (ISFSI). There are no effluents from the ISFSI based on the design of the casks.

By December 2022, the plant was in SAFSTOR (a long-term storage condition for a permanently shut down nuclear power plant). During SAFSTOR, radioactive contamination decreases substantially, making subsequent decontamination and demolition easier and reducing the amount of low-level radioactive waste requiring disposal. All radioactive and service water systems were drained or placed in a stable condition. Plant systems are monitored, and adverse conditions are documented and addressed as needed.

The contribution of dose to a member of the public is most likely to be exposed from liquid and gaseous effluent releases. Calculation methods in the Defueled Offsite Dose Assessment Manual (DODAM) follow those prescribed by Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I".

Environmental data for the 2024 dose assessment can be found in the Duane Arnold Energy Center 2024 Annual Radiological Environmental Operating Report.

Regulatory Limits

Fission and Activation Gases

Dose Rate

- Less than 500 mrem/year to the whole body.
- Less than 3000 mrem/year to the skin.

Gamma Air Dose

- Less than or equal to 5 mrad/quarter.
- Less than or equal to 10 mrad/year.

Beta Air Dose

- Less than or equal to 10 mrad/quarter.
- Less than or equal to 20 mrad/year.

Airborne Particulates and Tritium

Dose Rate

- Less than 1500 mrem/year.

Dose

- Less than or equal to 7.5 mrem/quarter to any organ.
- Less than or equal to 15 mrem/year to any organ.

Liquid Effluents

Whole Body Dose

- Less than or equal to 1.5 mrem to the whole body during any calendar quarter.
- Less than or equal to 3 mrem to the whole body during any calendar year.

Organ Dose

- Less than or equal to 5 mrem to any organ during any calendar quarter.
- Less than or equal to 10 mrem to any organ during any calendar year.

Concentration

- Liquid effluents released from the site to unrestricted areas shall not exceed ten times (10x) the concentrations listed in Appendix B, Table 2, Column 2 to 10 CFR 20.1001 – 20.2402.

40 CFR 190 and 10 CFR 72

Dose

- Less than or equal to 25 mrem annual whole-body dose.
- Less than or equal to 75 mrem annual thyroid dose.
- Less than or equal to 25 mrem annual dose to any other critical organ.

Maximum Permissible Concentrations

- Liquid effluent concentrations are limited per DODAM OLCO 6.1.2 to ten times (10x) the concentration specified in 10 CFR 20 Appendix B, Table 2, Column 2.
- Dose rates, rather than effluent concentrations, are used to calculate permissible release rates for gaseous effluents. The maximum permissible dose rates for gaseous releases are defined in Duane Arnold DODAM Limiting Condition for Operation (OLCO) 6.2.2.

Gaseous Effluents

With the nuclear fuel stored at the ISFSI and the plant in SAFSTOR, the building ventilation is only operated to maintain a safe, comfortable working environment. The DODAM gaseous effluent sampling was revised to reflect current plant conditions. Gaseous Effluent from the Reactor Building Vents, Turbine Building and the Low Level Radwaste Processing and Storage Facility (LLRPSF), when operating, are continuously sampled for particulates and gross alpha. These ventilation systems were operated as necessary to maintain building habitability.

- There were no particulate radionuclides detected on the Turbine Building, Reactor Building or LLRPSF air filters. Filters were changed monthly when ventilation was in service.
- Tritium samples from Reactor Building Vents and LLRPSF were obtained quarterly when ventilation was in service.
- Particulate filters were composited quarterly and sent to an outside lab for analysis of hard-to-detect nuclides Fe-55, Ni-63, Sr-89 and Sr-90 analysis.
- All gaseous effluent releases were continuous and resulted in a small fraction of the 10 CFR 50, Appendix I dose limits.
- There were no abnormal releases of gaseous effluents during the period.

Table 1A includes total activity in Ci for particulate and tritium results. The hard-to-detect nuclides were all less than the lower limit of detection (<LLD) as reported by Microbac Environmental Inc.

Table 1A - Gaseous Effluents by Quarter

Nuclides Released	1 st Quarter	2 nd Quarter	3 rd Quarter	4 th Quarter	Annual
Tritium (Ci)	ND	ND	2.76E-02	3.91E-01	6.67E-01
Particulates					
Manganese-54 (Ci)	ND	ND	ND	ND	ND
Iron-55 (Ci)	ND	ND	ND	ND	ND
Iron-59 (Ci)	ND	ND	ND	ND	ND
Cobalt-58 (Ci)	ND	ND	ND	ND	ND
Cobalt-60 (Ci)	ND	ND	ND	ND	ND
Nickle-63 (Ci)	ND	ND	ND	ND	ND
Zinc-65 (Ci)	ND	ND	ND	ND	ND
Strontium-89 (Ci)	ND	ND	ND	ND	ND
Strontium-90 (Ci)	ND	ND	ND	ND	ND
Molydeneum-99 (Ci)	ND	ND	ND	ND	ND
Cesium-134 (Ci)	ND	ND	ND	ND	ND
Cesium-137 (Ci)	ND	ND	ND	ND	ND
Cerium-141 (Ci)	ND	ND	ND	ND	ND
Cerium-144 (Ci)	ND	ND	ND	ND	ND
Total for Period (Ci)	ND	ND	2.76E-02	3.91E-01	6.67E-01

ND indicates the radionuclide was not identified in any samples using instrumentation that meets the lower limit of detection as required by the DODAM

In Table 1B, the receptor of the dose is described such that the dose to any resident near the station is not likely to be underestimated, although conditions more conservative than appropriate for the maximally exposed person may be assumed in the dose assessment. The dose calculations for total body and each organ are displayed for each quarter and the annual limits. Calculations for the release point are performed by the DODAM in accordance with Reg Guide 1.109.

Table 1B - Maximum Dose Rates for Gaseous Releases Effluents by quarter and for the Calendar Year

	1 st Quarter	2 nd Quarter	3 rd Quarter	4 th Quarter	Annual
Total Body Dose Limit (mrem)	7.5E+00	7.5E+00	7.5E+00	7.5E+00	1.5E+01
Total Body Actual Dose (mrem)	0.0E+00	0.0E+00	1.05E-04	1.49E-04	2.54E-04
Total Body % of Limit	0.0%	0.0%	<0.1%	<0.1%	<0.1%
Organ Dose Limit (mrem)	7.5E+00	7.5E+00	7.5E+00	7.5E+00	1.5E+01
GI-LLI Actual Dose (mrem)	0.0E+00	0.0E+00	1.1E-04	1.5E-04	2.5E-04
GI-LLI % of Limit	0.0%	0.0%	<0.1%	<0.1%	<0.1%
Bone Actual Dose (mrem)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bone % of Limit	0.0%	0.0%	0.0%	0.0%	0.0%
Liver Actual Dose (mrem)	0.0E+00	0.0E+00	1.0E-04	1.5E-04	2.5E-04
Liver % of Limit	0.0%	0.0%	<0.1%	0.0%	<0.1%
Kidney Actual Dose (mrem)	0.0E+00	0.0E+00	1.0E-04	1.5E-04	2.5E-04
Kidney % of Limit	0.0%	0.0%	<0.1%	<0.1%	<0.1%
Thyroid Actual Dose (mrem)	0.0E+00	0.0E+00	1.0E-04	1.5E-04	2.5E-04
Thyroid % of Limit	0.0%	0.0%	<0.1%	<0.1%	<0.1%
Lung Actual Dose (mrem)	0.0E+00	0.0E+00	1.0E-04	1.5E-04	2.5E-04
Lung % of Limit	0.0%	0.0%	<0.1%	<0.1%	<0.1%
Skin Actual Dose (mrem)	0.0E+00	0.0E+00	1.1E-04	1.5E-04	2.5E-04
Skin % of Limit	0.0%	0.0%	<0.1%	<0.1%	<0.1%

Liquid Effluents

The sewage treatment facility has been shut down and the Iowa Department of Natural Resources in Manchester, Iowa was informed in May of 2023. The influent pipes from the plant sources outside the security building were cut and plugged, the influent pumps were shut off, the discharge pipe was plugged, and the system was emptied. Prior to May 2023, sewage treatment plant samples were collected bi-weekly; there were no plant by-products identified in the samples. The maximum value for the lower limit of detection (LLD) for environmental sample analysis are noted in the DODAM Table 6.3-3. The effluent releases were sampled as part of the Groundwater Protection Program. All other Groundwater Protection Program analyses and results can be found in the Duane Arnold Energy Center 2023 Annual Radiological Environmental Operating Report.

The possibility of plant process systems leaking water to the floor drains and sumps exists. Groundwater that has leaked into the buildings through the pipe and conduit penetrations collect in the floor drains and sumps. This water picks up radioactive nuclides and is collected and treated prior to discharge for ALARA purposes. The water is collected and sampled prior to release to ensure the dose to the public is minimized.

In 2024, there were 33 batch releases of liquids from plant radwaste system. Volume of liquid effluent released (prior to dilution) was $1.3\text{E}+05$ L and $9.1\text{E}+07$ L of dilution water.

Table 2A lists the principal radionuclides and presents a quarterly summation of the total activity released (batch mode) and average concentration for all liquid effluents.

Table 2A – Liquid Effluents – Summation of All Releases

Nuclides Released	1 st Quarter	2 nd Quarter	3 rd Quarter	4 th Quarter	Annual
Tritium (Ci)	1.2E-03	5.2E-04	1.1E-03	5.3E-04	3.3E-03
Manganese-54 (Ci)	2.1E-05	1.4E-05	9.1E-06	1.2E-05	5.5E-05
Iron-55 (Ci)	ND	ND	ND	ND	ND
Iron-59 (Ci)	ND	ND	ND	ND	ND
Cobalt-58 (Ci)	ND	ND	ND	ND	ND
Cobalt-60 (Ci)	6.7E-05	3.6E-05	4.5E-05	1.2E-04	2.7E-04
Nickel-63 (Ci)	4.4E-05	7.7E-06	5.4E-6	ND	5.7E-05
Zinc-65 (Ci)	ND	ND	ND	ND	ND
Strontium-89 (Ci)	ND	ND	ND	ND	ND
Strontium-90 (Ci)	4.8E-07	2.5E-07	6.4E-7	ND	1.4E-06
Molybdenum-99 (Ci)	ND	ND	ND	ND	ND
Cesium-134 (Ci)	1.9E-06	1.4E-06	2.4E-05	2.0E-05	4.8E-05
Cesium-137 (Ci)	9.2E-06	7.4E-06	1.5E-04	1.4E-04	3.0E-04
Cerium-141 (Ci)	ND	ND	ND	ND	ND
Cerium-144 (Ci)	ND	ND	ND	ND	ND
Total for Period (Ci)	1.3E-3	5.9E-04	1.3E03	8.1E-04	4.0E-03

ND indicates the radionuclide was not identified in any samples using instrumentation that meets the lower limit of detection as required by the DODAM

In Table 2B, the receptor of the dose is described such that the dose to any resident near the station is not likely to be underestimated, although conditions more conservative than appropriate for the maximally exposed person may be assumed in the dose assessment. The dose calculations for total body and each organ are displayed for each quarter and the annual limits. Calculations for the release point are performed by the DODAM in accordance with Reg Guide 1.109.

**Table 2B - Maximum Dose Rates for Liquid Effluents by Quarter
and for the Calendar Year**

	1 st Quarter	2 nd Quarter	3 rd Quarter	4 th Quarter	Annual
Total Body Limit (mrem)	1.5E00	1.5E00	1.5E00	1.5E00	3.0E00
Total Body Actual Dose(mrem)	5.1E-03	3.9E-03	7.5E-02	6.9E-02	1.5E-01
Total Body % of Limit	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%
Dose Limit (mrem)	5.0E00	5.0E00	5.0E00	5.0E00	10.0E00
GI-LLI Actual Dose(mrem)	1.4E-03	6.8E-4	2.7E-03	3.3E-3	8.0E-03
GI-LLI % of Limit	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%
Bone Actual Dose(mrem)	7.3E-03	4.5E-03	7.5E-02	6.8E-02	1.6E-01
Bone % of Limit	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%
Liver Actual Dose(mrem)	7.5E-03	5.7E-03	1.1E-01	1.0E-01	2.2E-01
Liver % of Limit	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%
Kidney Actual Dose(mrem)	2.7E-03	1.9E-03	3.7E-02	3.4E-02	7.5E-02
Kidney % of Limit	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%
Thyroid Actual Dose(mrem)	1.3E-04	3.0E-06	6.2E-06	3.1E-06	1.4E-04
Thyroid % of Limit	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%
Lung Actual Dose(mrem)	7.7E-04	6.2E-4	1.2E-02	1.1E-02	2.5E-02
Lung % of Limit	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%
Skin Actual Dose(mrem)	4.0E-05	0.0E+00	0.0E00	0.0E00	4.0E-05
Skin % of Limit	<0.1%	0.0%	0.0%	0.0%	<0.1%

Radioactive Solid Waste

No radioactive waste shipments occurred during 2024; therefore no classification of waste is declared.

ADDITIONAL REPORTING REQUIREMENTS

There were no revisions to the DODAM in 2024.

The potential for any off-site consequences from radiological accidents has been evaluated and been determined to be unobtainable. Therefore, there is no longer a need for on-site meteorological data accumulation. During the final decommissioning and dismantling phases, administrative controls over radiological source accumulation will preempt any significant radiological release to the environment. Past meteorological data for the general area can be obtained from the National Weather Service.

There were no sample analyses/conditions for which communications were made to State and Local officials due to exceeding the applicable DODAM reporting levels.

There were no spills or leaks of radioactive material that were communicated to State and Local stakeholders.