

0. SITE HISTORY AND BACKGROUND

Intro Information: <https://pgdpvirtualmuseum.org/>

Why did the Federal Government need to develop processes to obtain nuclear material prior to and during World War II? (<https://pgdpvirtualmuseum.org/> ‘The Need for Uranium’)

Following World War II, the Soviet Union completed development of and detonated its first atomic weapon in what year? _____ (<https://pgdpvirtualmuseum.org/> ‘The Need for Uranium’)

The Korean War began in what year? _____ (<https://pgdpvirtualmuseum.org/> ‘The Need for Uranium’)

The Korean War involved what nations? North _____ supported by _____, South _____ supported by the _____ and United Nations and China. (<https://pgdpvirtualmuseum.org/> ‘The Need for Uranium’)

Following the start of the Korean War the U.S. had accumulated sufficient nuclear material to produce atomic weapons. True or False? (<https://pgdpvirtualmuseum.org/> ‘The Need for Uranium’)

In order to produce nuclear material in quantities needed to make weapons, the Federal Government decided to build the _____ (PGDP) in McCracken County, Kentucky. (<https://pgdpvirtualmuseum.org/> ‘The Need for Uranium’)

The PGDP is located in _____ County approximately 13 miles west of the city of Paducah. (<https://pgdpvirtualmuseum.org/began.html> ‘PGDP & Vicinity Maps’)

The PGDP occupies approximately 1 square mile of a Department of Energy (DOE) Reservation. True or False? (<https://pgdpvirtualmuseum.org/began.html> ‘PGDP & Vicinity Maps’)

In what year did the construction of the PGDP begin? (<https://pgdpvirtualmuseum.org/life-at-the-plant.html> ‘Timeline: History of PGDP – Construction and Operations’)

Enrichment is the process of increasing the amount of the uranium-235 isotope in uranium compared to the amount of uranium-235 in naturally-occurring uranium. True or False? (<https://pgdpvirtualmuseum.org/whatis.html>)

The PGDP used the process of _____ which required uranium to be mixed with fluorine to produce gaseous uranium hexafluoride (UF₆). (<http://www.ukrcee.org/> ‘Paducah Gaseous Diffusion Plant: A Challenge in Progress’)

Gaseous uranium hexafluoride (UF₆) was passed thru membranes that contained holes less than 1/1 millionth of an inch in diameter which allowed the separation of atoms of uranium-235 from atoms of uranium-238. True or False? (<https://pgdpvirtualmuseum.org/whatis.html> ‘What is Enrichment’ and ‘The Gaseous Diffusion Process’)

The PGDP started enriching uranium in _____. (<https://pgdpvirtualmuseum.org/life-at-the-plant.html> ‘Timeline: History of PGDP – Construction and Operations’)

ASER PROJECT – Outlined ASER Text & Questions (Draft)

The PGDP stopped enriching uranium in _____. (<https://pgdpvirtualmuseum.org/life-at-the-plant.html> ‘Timeline: History of PGDP – Construction and Operations’)

The primary mission of the PGDP was _____ uranium for use in atomic weapons and for use as fuel to power the nuclear navy and nuclear power plants that produce electricity. (<https://pgdpvirtualmuseum.org/missions.html>)

PGDP Missions developed as the Site enriched uranium and later ceased enrichment of uranium and included 6 major activities: (<https://pgdpvirtualmuseum.org/missions.html>)

1. Uranium Enrichment
2. _____
3. _____
4. _____
5. _____
6. _____

Other missions of the PGDP developed as the Site enriched and later ceased enrichment of uranium. Those activities are broadly referred to as “Deactivation, Decontamination, and Decommissioning”. Deactivation is the removal of radioactive and hazardous materials from _____, _____, and _____. (<https://pgdpvirtualmuseum.org/decommissioning.html>)

The C-340 Metals Plant produced uranium metal that was milled, packaged and shipped to customers. (True or False)?

The first Federal environmental regulation, the _____ Act became law in 1948. (<https://pgdpvirtualmuseum.org/remediation.html> Focused Timeline: History of PGDP Environmental Accomplishments and the Evolution of Environmental Regulations).

The solvent trichloroethene (TCE) was used to clean process components prior to installation at the PGDP. PGDP TCE use began in _____. (<https://pgdpvirtualmuseum.org/remediation.html> Focused Timeline: History of PGDP Environmental Accomplishments and the Evolution of Environmental Regulations).

The United States Environmental Protection Agency (EPA) was formed in _____. (<https://pgdpvirtualmuseum.org/remediation.html> Focused Timeline: History of PGDP Environmental Accomplishments and the Evolution of Environmental Regulations).

The Resource Conservation and Recovery Act (RCRA) became law in 1976 and regulates the management and disposal of solid and hazardous waste from _____ to _____. (<https://pgdpvirtualmuseum.org/remediation.html> Focused Timeline: History of PGDP Environmental Accomplishments and the Evolution of Environmental Regulations).

Groundwater Pump and Treat operations at PGDP were implemented to remove _____ groundwater at the PGDP. More than 4 _____ gallons of contaminated groundwater have been extracted and treated at the PGDP. (<https://pgdpvirtualmuseum.org/remediation.html> ‘Environmental Remediation’)

1. INTRODUCTION

1.0 Purpose of the Document (From Executive Summary)

What drives the environmental actions and monitoring at the PGDP?

What are the major environmental monitoring activities?

What are the goals of the Environmental Management Program?

What companies managed the PGDP work in 2016?

1.1. THE PGDP SITE

1.1.1. The area surrounding the PGDP is generally _____. (Page 1-1. ‘Site Location’ and Figure 1.1. Location of the Paducah Site)

1.1.2. Why was the location in McCracken County chosen? _____

1.1.3. The Paducah Gaseous Diffusion Plant (PGDP) industrial site occupies approximately one square mile of a 3,556 acre Department of Energy (DOE) Reservation. True or False?

1.1.4. Surrounding Land Ownership includes the West Kentucky Wildlife Management Area (WKWMA) which is operated by the Commonwealth of Kentucky, Department of Natural Resources. (True or False?)

1.1.5. What industrial facility occupied the area of the PGDP during WWII? _____

1.1.5.1. What did the facility produce? _____

1.2. GENERAL ENVIRONMENTAL SETTING

1.2.1. Climate (Describe)

1.2.2. Surface Water Drainage

1.2.2.1. The PGDP is located on a divide between the watersheds of _____ and _____ Creeks which discharge into the Ohio River (Figure).

1.2.3. Wetlands

1.2.3.1. Describe local wetlands (Figure)

<https://eic.pad.pppo.gov/Search.aspx?accession=I-04502-0003> <https://eic.pad.pppo.gov/>

1.2.3.2. Cite the wetlands document that MCHS 2014 and 2015 helped to develop

1.2.4. Soils and Hydrogeology

1.2.4.1. Describe the local soil types

1.2.4.2. Describe local Hydrogeology (groundwater flow system) and reference to more information in this doc.

1.2.4.3. Vegetation

1.2.4.3.1. Has vegetation been impacted by human activity? Yes or No?

1.2.4.3.2. Describe vegetation types found DOE Reservation and surrounding areas.

1.2.5. Habitats

1.2.5.1. What habitats are found on the DOE Reservation and surrounding areas?

1.2.6. Wildlife

1.2.6.1. What wildlife habitats are found at PGDP, DOE Reservation and WKWMA?

1.2.6.2. What species are present?

1.2.7. Threatened and Endangered Species

1.2.7.1. What threatened and endangered species potentially might exist in habitats ID'ed at the PGDP, WKWMA and surroundings?

1.2.7.2. Have any of the federally listed threatened or endangered species been identified to inhabit the area?

1.3. SITE MISSION

1.3.1. The DOE's primary mission at the PGDP was _____.
(mission = focus of activities)

1.3.2. What DOE organization was formed to manage DOE's responsibilities at the PGDP?

1.4. PRIMARY OPERATIONS AND ACTIVITIES AT THE PADUCAH SITE

1.4.1. The two major programs DOE operates at the PGDP are the _____ and _____.

1.4.2. Other missions include: _____, _____, _____,
_____, _____. (Chapter 0 Text and Questions)

1.4.3. What missions are currently being addressed \and will continue at site in the future? (Chapter 0 Text and Questions)

2. REGULATION and COMPLIANCE SUMMARY

When did the Federal Government begin to pass and implement environmental regulations and why? (Timeline).

What are the two prominent regulatory agencies that have authority for environmental work at the PGDP?

What are the two main environmental/hazardous waste regulation programs that DOE must comply with at the PGDP?

What is the responsibility of each agency and how is regulatory authority between the two agencies handled?

What federal government agency is responsible for radiation protection at the PGDP?

What State of Kentucky Agency is responsible for off-site radiation protection at the PGDP?

2.1 ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT

2.1.1. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

What is CERCLA? (Page 2-1)

What is regulated under CERCLA? See <https://www.epa.gov/superfund/superfund-cercla-overview>

Under CERCLA what list is a site placed on when it needs the highest priority for remediation?

When a site is on the National Priorities List (NPL), the site must enter what agreement with the Environmental Protection Agency to establish a decision making process for site remediation?

2.1.2. Superfund Amendments and Reauthorization Act (SARA)

What is SARA? See <https://www.epa.gov/superfund/superfund-amendments-and-reauthorization-act-sara> (Page 2-1).

2.1.3. Resource Conservation and Recovery Act

What is the Resource Conservation and Recovery Act? (Page 2-2)

What is regulated under RCRA? See <https://www.epa.gov/rcra>

RCRA establishes regulatory standards for the _____, _____, _____, and _____ of solid and hazardous waste.

What is hazardous waste? See <https://www.epa.gov/hw>

What is mixed waste? Mixed waste contains _____ and _____ components. See

https://search.epa.gov/epasearch/epasearch?querytext=mixed+waste&areaname=&areacontacts=&areasearchurl=&typeofsearch=epa&result_template=2col.ftl

2.1.4. Resource Conservation and Recovery Act Hazardous Waste Permit

Who issues the hazardous waste permit for the PGDP?

2.1.5. Federal Facility Compliance Act (FFCA) – Site Treatment Plan (STP)

What did the FFCA do to change the responsibility of Federal Facilities relative to RCRA?

See <https://www.epa.gov/enforcement/resource-conservation-and-recovery-act-rcra-and-federal-facilities>

Under the FFCA, efforts to minimize waste and pollution are based on what 5 goals? (Page 2-3)

2.1.6. National Environmental Policy Act (NEPA)

Under NEPA, a site must evaluate the _____ of certain Federal activities related to the environment. (Page 2-3)

What actions taken by the site require a NEPA review?

2.1.7. Toxic Substances Control Act (TSCA)

What are the two purposes of TSCA? (Page 2-4)

What chemical specific Act applies to the following two chemicals/mixtures used in the construction and operation of the PGDP: 1) Asbestos that was used at PGDP to insulate buildings and equipment and 2) polychlorinated biphenyls (PCBs) were widely used as a component of electrical equipment.

What is the name of an update to TSCA that specifically applies to the PGDP and its historical role enriching uranium?

2.2. RADIATION PROTECTION

What Federal Act gives DOE regulatory authority over the atomic (radioactive) material it handles? (Page 2-5)

DOE implements DOE _____ that establish requirements for 1) protection of the public and environment from radiation as well as 2) the management of radioactive wastes associated with its activities?

DOE Order _____ is implemented to provide radiation protection of the public and environment.

DOE Order _____

Authorized _____ for radiation have been developed for the PGDP's C-746-U Landfill and DOE property outside of the industrial (limited) area.

Additional _____ are in place for lube and transfer oils that will be destroyed thermally, other materials that will be released for re-use, and materials that will be shipped to off-site disposal facilities.

2.2.1. DOE Order 458.1, Radiation Protection of the Public and the Environment

An Environmental Radiation Protection Program (ERPP) was implemented at the PGDP by _____, the primary contractor in charge of site environmental and decommissioning for the Department of Energy (DOE).

The goals of the ERPP are:

- 1) _____.
- 2) _____.
- 3) _____.
- 4) _____.
- 5) _____.

2.2.2. DOE Order 435.1, Radioactive Waste Management

Radioactive waste is waste that contains _____ material. (Radiation 101 Presentation)

The PGDP manages three types of radioactive waste under procedures established by DOE Order 435.1: (Page 2-6)

- 1) _____.
- 2) _____.
- 3) _____.

2.3. AIR QUALITY AND PROTECTION

2.3.1. Clean Air Act

The Clean Air Act was established in _____.

(<http://pgdpvirtualmuseum.org/remediation.html> ‘Focused Timeline: History of PGDP Environmental Accomplishments and the Evolution of Environmental Regulations’)

Enforcing compliance with the Clean Air Act and its amendments is the responsibility of what Federal and State Agencies? (Page 2-6)

Radioactive and hazardous materials that could impact air quality at the PGDP are monitored at _____ points.

2.3.2. National Emission Standards for Hazardous Air Pollutants Program (NESHAPS)

Airborne emission of radionuclides at DOE facilities is regulated under what regulation? (Page 2-7)

What are the potential sources (activities) at PGDP that require management of air releases of radionuclides?

Local background air quality data is collected at nine _____ air monitoring stations surrounding the PGDP.

Air monitors surrounding the PGDP are _____ powered.

2.3.3. Pollutants and Sources Subject to Regulation

The process of dismantling the industrial enrichment process equipment, the buildings, and support facilities that house the equipment is referred to as the _____ Project which is a source of pollutants subject to regulation. (Page 2-7)

Spent uranium hexafluoride from the enrichment process is referred to as ‘depleted’ uranium hexafluoride (DUF6) because some portion of uranium-235 has been removed compared to the amount of uranium-235 in _____ occurring uranium.

The process of reclaiming uranium and fluorine from uranium hexafluoride that will no longer be enriched is referred to as _____.

The conversion process is considered a potential source of _____ pollution and is permitted by the Kentucky Division of Air Quality (KDAQ).

Uranium is prepared for disposal in a stable form that does not interact with the environment and hydrogen fluoride is re-used by industry. True or False?

2.3.4. Stratospheric Ozone Protection

Approximately 6.3 _____ pounds of R-114 refrigerant, a potential ozone depleting substance if released, were utilized in a PGDP cooling system. (Page 2-8)

Releases of the R-114 refrigerant and sources of releases are tracked under permit and _____ Part _____ requirements.

2.4. WATER QUALITY AND PROTECTION

2.4.1. Clean Water Act

The Federal Water Pollution Control Act Amendments of 1972 established four major programs for control of water pollution: (Page 2-8)

- 1) _____.
- 2) _____.
- 3) _____.
- 4) _____.

2.4.2 Kentucky Pollutant Discharge Elimination System (KPDES)

The Clean Water Act applies to DOE discharges to waters of the United States that do not contain

radiation components and PGDP effluent discharges to Bayou and Little Bayou Creek are regulated under the _____ (_____) permit system. (Page 2-8)

KPDES permits require the implementation of a _____ Plan to prevent or minimize the potential for release of pollutants. (Page 2-9)

Outfalls are locations where PGDP releases water from the industrial site and support facilities to Bayou and Little Bayou Creeks. There are approximately ___ outfalls permitted at the PGDP.

During 2016 there were ___ exceedances of permit criteria at the PGDP. (Page 2-9, Table 2.2)

2.4.3 Storm Water Management and the Energy Independence and Security Act of 2007

2.4.4 Safe Drinking Water Act (SDWA)

The PGDP obtains water from the _____ and treats it for use (drinking and industrial) in an on-site water treatment plant. (Page 2-9)

The PGDP is permitted to withdraw _____ million gallons per day (mgd) of water from the Ohio River.

The _____ Act sets limits for contaminants in treated water that is distributed through the sanitary water distribution systems.

2.5 OTHER ENVIRONMENTAL STATUTES

2.5.1 Endangered Species Act

The Endangered Species Act designates and protects endangered _____ and _____. (Page 2-10)

The Endangered Species Act also protects the _____ where endangered plants and animals are likely to occur.

How many endangered mammal, clam, and bird species potentially occur in the vicinity of the PGDP? (Page 2-10, Table 2.3)

2.5.2 National Historic Preservation Act

The National Historic Preservation Act is the law that sets the criteria for the identification and preservation of historical and archeological sites. At the PGDP there have been _____ properties/locations identified as eligible for the National Register of Historic Places. (Page 2-11)

The limited or _____ area of the DOE reservation encompasses the PGDP historic district.

2.5.3 Migratory Bird Treaty Act

The DOE and the _____. _____ Agency have a formal agreement, or Memorandum of Understanding, that outlines actions to be taken at the PGDP to protect migratory birds. (Page 2-11)

2.5.4 Asbestos Program

Asbestos was used as an _____ material in many facilities at the PGDP. (Page 2-11)

2.5.5 Floodplain/Wetlands Environmental Review Requirements

Two Federal Regulations, 1) _____, 2) _____ and Executive Order _____ require the PGDP to comply with management and protection of floodplains and wetlands. (Page 2-11)

2.5.6 Underground Storage Tanks Managed under RCRA Kentucky Underground Storage Tank Regulations

Underground storage tanks are regulated under the _____ & _____ Act. (Page 2-11)

2.5.7 Solid Waste Management

Paducah disposes of some of its solid waste on-site in the C-____-U Landfill, a facility permitted by the Kentucky Division of Waste Management. (Page 2-12)

2.6 DEPARTMENTAL SUSTAINABILITY; FEDERAL LEADERSHIP IN ENVIRONMENTAL, ENERGY, AND ECONOMIC PERFORMANCE

2.6.1 Departmental Sustainability

DOE Order _____, _____ commits the DOE to pursue the U.S. Green Building Council Leadership in Energy and Environmental Design. (Page 2-12)

2.6.2 Federal Leadership in Environmental, Energy, and Economic Performance

Executive Order 13693, enacted in 2011, requires Federal agencies to establish goals to reduce _____ gases. (Page 2-12)

2.7 EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT (EPCRA) AND TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT

Under EPCRA, the PGDP is required to report to the public emergency planning information, _____ inventories and _____ to the environment. (Page 2-12)

Releases to the environment include _____ gases. (Page 2-13)

2.8 OTHER MAJOR ENVIRONMENTAL ISSUES AND ACTIONS

2.8.1 Green and Sustainable Remediation

Green and sustainable remediation may offer opportunities to reduce _____ and _____ impacts of remedial cleanup. (Page 2-13)

2.8.2 Adapting to Climate Change

The majority of greenhouse gases emitted at the PGDP are related to what activities? (Page 2-13)

2.9 CONTINUOUS RELEASE REPORTING

The PGDP had ___ continuous releases of hazardous substances during 2016. (Page 2-14)

2.10 UNPLANNED RELEASES

Storm water containing _____ was released through KPDES 011 in 2016 and a courtesy report detailing the incident was provided to the KDWM. (Page 2-14)

2.11 SUMMARY OF PERMITS

EPA issued _____ permit to the DOE and its site contractor FFS during 2016. (Page 2-14, Table 2.5)

KDWM (Kentucky Division of Waste Management) issued _____ permits to the DOE and its contractors during 2016.

The Kentucky Division of Air Quality (KDAQ) issued _____ permits to PGDP site contractors during 2016.

Permits issued to the DOE and its PGDP contractors during 2016 under three (3) Acts administered:

- 1) _____.
- 2) _____.
- 3) _____.

3. REGULATION and COMPLIANCE SUMMARY

The Environmental Management System (EMS) integrates _____, _____, _____, _____ & _____.

What organizations are required to implement the EMS at the PGDP?

3.1 ENVIRONMENTAL OPERATING EXPERIENCE AND PERFORMANCE MEASUREMENT

The Environmental Monitoring Program (EMP) at the PGDP has the following components: _____, _____ & _____.

During 2016 the DOE, through site contractor FPDP, documented the EMP in the document titled _____.

3.1.1 Site Sustainability Plan

What is environmental stewardship? https://en.wikipedia.org/wiki/Environmental_stewardship

What is the definition of sustainability? <https://www.epa.gov/sustainability/learn-about-sustainability#what>

DOE manages sustainability at the PGDP relative to DOE Order _____ and Executive Order _____.

DOE's PGDP Site Sustainability Plan outlines ten (10) major categories of activities that are managed for sustainability. The ten categories are:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

3.1.2 Waste Minimization/Pollution Prevention

The PGDP Waste Minimization/Pollution Prevention Program provides guidance for _____.

The PGDP Waste Minimization/Pollution Prevention Program applies to _____ Site activities that generate or have the potential to generate waste.

List four (4) goals of the PGDP Waste Minimization/Pollution Prevention Program.

1. _____
2. _____
3. _____
4. _____

In CY 2016 PGDP reported five (5) waste minimization and pollution prevention accomplishments. What were the accomplishments?

1. _____
2. _____
3. _____
4. _____
5. _____

3.1.3 Depleted Uranium Hexafluoride Cylinder Program

What is DUF6?

How is DUF6 stored at the PGDP?

The purpose of the Depleted Uranium Hexafluoride Cylinder Program is?

3.1.4 Environmental Restoration, Waste Disposition, and Deactivation and Decommissioning

What is Deactivation and Decommissioning (D&D)?

Environmental investigations, environmental response actions, D&D (deactivation and decommissioning) of unused facilities and other programs for the protection of human health and the environment are part of the PGDP _____.

List two (2) of the seven (7) reported PGDP environmental restoration, D&D and waste disposition activities accomplished during 2016.

1. _____
2. _____

3.1.5 Emergency Management

The PGDP has its own security force, _____, and _____.

The general public is informed of emergency situations through the PGDP _____ Center.

3.1.6 Facility Stabilization, Deactivation, and Infrastructure Optimization

3.2 ACCOMPLISHMENTS, AWARDS, AND RECOGNITION

DOE interacts with the public and provides information to the public through the Paducah _____ Board, the DOE Environmental Information Center, and educational outreach programs.

3.2.1 Public Awareness Program

DOE interacts with the public through a comprehensive PGDP _____ and _____ Program which supports public involvement with Site environmental decision making.

3.2.2 Community/Educational Outreach

DOE and its contractors engaged local Kentucky High School students with two (2) activities:

1. _____
2. _____

MCHS students participate in an educational outreach program about environmental issues at the PGDP through a program centered on the review of the PGDP _____.

As part of the MCHS ASER Program 2018 students were provided access to the PGDP _____ which contains extensive history and documentation of the DOE's activities at the PGDP.

Interactive maps showing environmental monitoring locations and data for the PGDP can be accessed through the _____, the Paducah Environmental Geographic Analytical Spatial Information System developed by the UK Kentucky Research Consortium for Energy and Environment and operated by DOE site contractors. <https://pegasis.pad.pppo.gov/>

3.2.3 Citizens Advisory Board

The _____ (CAB) is composed of members representing business, academia, labor, local government, environmentalists, special interest groups, and the general public from western Kentucky and surrounding areas.

3.2.4 Environmental Information Center

Documents produced for environmental activities and projects at the PGDP can be accessed at the PGDP _____ <https://eic.pad.pppo.gov/>

ENVIRONMENTAL RADIOLOGICAL PROTECTION PROGRAM AND DOSE ASSESSMENT

4.1 ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

What is radioactive decay? <http://www.pgdvirtualmuseum.org/whatis.html>

Ionizing radiation is? https://en.wikipedia.org/wiki/Ionizing_radiation

Material that contains atoms that undergo radioactive decay is referred to as _____ material.

A radionuclide is an atom of an element or element's isotope(s) that exhibits _____ decay.

Radioactive decay is a _____ reaction.

When radioactive decay occurs it results in the formation of a new _____ of the parent element or lighter elements.

Radioactive decay is capable of releasing vast amounts of _____.

The isotope of an element is “fissile” when it is capable of a self-sustained, or chain, nuclear reaction.
True or False

At PGDP, an industrial process was used to increase the amount of the _____ isotope in uranium compared to the amount in naturally occurring uranium.

U-235 was a desirable material because it an _____ isotope of uranium capable of sustaining and chain nuclear reaction that releases energy.

Routine DOE operations at the Paducah Site may result in releases of radioactive materials to the environment by _____ and _____ pathways.

A _____ occurs when an individual or organism is exposed to radioactive material.

What are two sources of radiation exposure that we all experience?

1. _____
2. _____

When a person or organism is exposed to radioactive material, the amount of exposure is measured as _____ (a four letter word).

Dose is the amount of _____ absorbed by the body as a result of exposure to _____.

DOE monitors radiation exposure through DOE Order _____, *Radiation Protection of the Public and the Environment*.

DOE Order 458.1 limits radiation dose to the public to 100 _____ per year.

4.1.1 What Is Dose?

When a person or organism is exposed to radioactive material, the amount of exposure is measured as _____ (a four letter word).

An _____ exposure occurs when a person receives a dose from a radioactive material source outside of the body.

An _____ exposure occurs when a person receives a dose from a radioactive material source that has been ingested or is inside of the body.

Routine exposure to ionizing radiation results in an annual effective dose to individuals of _____ mrem/yr.

Naturally occurring cosmic and terrestrial sources of ionizing radiation result in an average dose to individuals of _____ mrem/yr.

4.1.2 Radioactive Materials at the Paducah Site

The PGDP processed uranium to increase the amount of uranium's _____ isotope relative to the amount of U-235 in naturally occurring uranium.

U-235 is a _____ radionuclide (meaning it is capable of a sustained nuclear reaction resulting in a continuous release of energy)

Radioactive materials present at the Paducah Site are the result of processing raw and recycled uranium. True or False?

The half-life of a radionuclide is? <https://www.britannica.com/science/half-life-radioactivity>

Radionuclides processed at the PGDP include:

1. _____
2. _____
3. _____

Other Radionuclides that may be present at the PGDP include:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

When a parent radioactive material undergoes decay, the new isotopes of the radionuclide that are formed are referred to as _____ products.

4.1.3 What is an Exposure Pathway?

An exposure pathway is how a radioactive material is _____ to the environment, _____ to a receptor (person, animal, or plant), and comes into contact with a receptor.

Five potential radioactive material exposure routes are identified in the ASER:

1. _____
2. _____
3. _____
4. _____
5. _____

4.1.4 Dose Assessment Methodology

Specific methods for assessing dose at the PGDP are required under DOE Order 458.1 and identified in the document *Methods for Conducting Risk Assessments and Risk Evaluations (at the PGDP)*. True or False?

4.1.5 Air Monitoring and Estimated Dose from Airborne Effluents

DOE remedial actions and other activities could possibly release radionuclides into the atmosphere. Airborne releases may result from _____ or _____ sources (any two of 5 listed sources).

4.1.6 Liquid Discharge Monitoring and Estimated Dose from Liquid Effluents

4.1.6.1 Surface water

Radioactive materials released to surface water as radioactive contaminants may leave the PGDP and be deposited in _____, deposited on ground or vegetation by _____, taken up by plants, ingested by animals, or may infiltrate to _____.

DOE Order 458.1 requires the _____ and control of radionuclides in surface water releases from the PGDP.

Water released through PGDP ditches and industrial activities to off-site surface waterways is known as effluent. True or False?

Environmental monitoring of surface water for radionuclides is conducted at _____ locations including background locations or locations upstream of PGDP impacts. (Figure 4.4)

Effluent surface water leaves the PGDP site at 15 locations known as _____. (Figure 4.4)

4.1.6.2 Drinking water

Surface water from the PGDP is used as a drinking water source. True or False?

Surface water from the PGDP discharges to _____ Creek and _____ Creek which discharge to the Ohio River.

Cairo, Illinois utilizes the Ohio River as a drinking water source. Because Cairo, Illinois is downstream of the confluence of Bayou and Little Bayou Creeks with the Ohio River the withdrawal point for drinking water is monitored for radionuclides. True or False?

4.1.6.3 Incidental ingestion of surface water

DOE calculates the dose that could be accidentally or incidentally received from a person swimming in Bayou or Little Bayou Creeks. True or False?

4.1.6.4 Landfill leachate

Radionuclides in landfill leachate are monitored under DOE Order 458.1 and are not monitored under the landfill operating permit. True or False?

4.1.6.5 Groundwater

Groundwater downgradient (downstream) of the PGDP site is not considered in dose calculations because it is not utilized as a drinking water source. True or False?

The DOE provides water to residents downgradient of the PGDP under its Water Policy which began when groundwater contamination was found in drinking water wells. True or False?

4.1.7 Sediment Monitoring and Estimated Dose

Sediment is a portion of the aquatic ecosystem? True or False.

Sediments can act as a repository of contaminants released from source areas? True or False?

4.1.7.1 Sediment surveillance program

Approximately ___ locations (including background locations) are monitored for accumulations of undissolved radionuclides in sediment. (Figure 4.5)

4.1.7.2 Sediment dose

Incidental _____ is the pathway evaluated for sediment dose to an individual.

The highest annual dose to a potentially exposed individual from sediment ingestion was _____ mrem/yr at station _____ in Bayou Creek.

Sediment sampling station S1 is a background location. True or False?

4.1.8 Terrestrial Environment Monitoring and Estimated Dose

Terrestrial dose could potentially occur from PGDP activities and include the following pathways:

1. _____
2. _____
3. _____

Irrigation of crops in areas potentially impacted by PGDP activities utilizes municipal water instead of utilizing local groundwater. True or False?

4.1.9 Wildlife

Raccoons and deer in the vicinity of the PGDP have been evaluated (historically) for uptake of radionuclides. True or False?

In general, _____ were not routinely detected in tissue from deer harvested in the vicinity of the PGDP. True or False?

4.1.10 Direct Radiation Monitoring and Estimated Dose

4.1.10.1 Direct radiation surveillance

The public is potentially impacted by external radiation from the PGDP. True or False?

Radioactive sources outside the body are responsible for _____ radiation exposure.

Three (3) potential sources of external radiation at the PGDP include:

1. _____
2. _____
3. _____

Thermoluminescent dosimeters, or _____ are used to monitor direct radiation exposure on individuals and in locations where individuals might be exposed to external radiation sources.

4.1.10.2 Direct radiation dose

In areas accessible to the public the estimated external radiation dose to an individual was _____ mrem/yr.

The maximum allowable radiation dose to an individual under DOE Order 458.1 is _____ mrem/yr.

At _____ locations, dosimeters indicated that external radiation dose to an individual slightly exceeded background levels? (Figure 4.6)

4.1.10.3 Cumulative dose calculation

Cumulative dose represents the calculated dose of individuals from both atmospheric and liquid releases. True or False?

The cumulative dose to a hypothetical most exposed individual from PGDP activities was _____

mrem/yr.

4.1.11 Biota Monitoring and Estimated Dose

4.1.11.1 Biota surveillance

Radionuclides and other contaminants can _____ in fish if they consume contaminated food sources or ingest contaminated materials in the aquatic environment.

4.1.11.2 Biota dose

Dose is evaluated for aquatic and terrestrial biota utilizing methods in a DOE guidance document. True or False?

4.2 CLEARANCE OF PROPERTY CONTAINING RESIDUAL RADIOACTIVE MATERIAL

DOE and its contractors must use limits material radioactivity limits identified in DOE Order 458.1 before releasing potentially impacted items or materials for re-use, re-cycling or disposal. True or False?

4.3 UNPLANNED RADIOLOGICAL RELEASES

There were ____ unplanned releases of radionuclides at the PGDP during 2016.

ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

5.1 AIR MONITORING

No active non-radiological air monitoring was required at the PGDP during 2016. True or False?

5.2 SURFACE WATER MONITORING

The _____ applies to discharge of PGDP's surface water to surface water of the _____.

The Kentucky Division of _____ (KDOW or KDW) administers surface water regulations in the State of Kentucky.

Discharge of site runoff and industrial-process effluents requires permits and monitoring. True or False.

The Kentucky Division of Waste Management (_____) issues permits for the operation of landfills in the State.

KDWM landfill operating permits require surface water monitoring for ____-_____ constituents from landfills. (Section 2.4.2)

There are ___ KPDES-permitted Outfalls at the PGDP where surface water leaves the PGDP and comingles with the surface waters of Kentucky. (Figure 4.4.)

During 2016 there were _ exceedances of non-radiological constituents at PGDP surface water monitoring locations. (Table 2.2)

Table 5.1 summarizes the monitoring and reporting for non-radiological _____ monitoring locations at the PGDP.

___ analytes were detected in PGDP-monitored surface water during 2016. (Table 5.2)

Identify the potential source(s) for one of the analytes listed in Table 5.2 and what impact an excessive amount of the analyte in surface water could have.

5.3 SEDIMENT MONITORING

Polychlorinated biphenyls (PCBs) were used extensively at the PGDP because of their electrical and cooling properties. True or False?

PCBs were detected as contaminants in routine PGDP sediment monitoring during 2016. True or False?

Many of the sediment sample PCB results exceeded levels requiring a response action as defined by Action and No Action Levels in the PGDP *Methods for Conducting Risk Assessments and Risk Evaluations* guidance document. True or False?

5.4 BIOTA MONITORING

Biological Monitoring was required for surface water at the PGDP in 2016. True or False?

5.4.1 Aquatic Life

What is chronic and acute toxicity monitoring?

<https://www3.epa.gov/region1/npdes/permits/generic/freshwaterchronictoxtest-rev.pdf>

Warning signs are posted along Bayou and Little Bayou Creeks to warn members of the public about the _____ risks posed by recreational contact with these waters, stream sediments, and fish caught in the creeks.

5.5 FIRE PROTECTION MANAGEMENT AND PLANNING

Fire protection management on the DOE reservation follows Federal interagency guidance *Wildland Fire Management Plan*, CP2-EP-1005. True or False?

<https://www.frames.gov/files/8514/9797/5268/fedwildlandpolicy.pdf>

5.6 RECREATIONAL HUNTING AND FISHING

Hunting and fishing is allowed by permit on DOE-owned lands that are leased by the Kentucky Department of Fish and Wildlife (KDFW) West Kentucky Wildlife Management Area. True or False?

GROUNDWATER PROTECTION PROGRAM

The Regional Gravel Aquifer is the primary aquifer for local groundwater users in the vicinity of the PGDP. True or False?

There are two primary off-site contaminants that impact Regional Gravel Aquifer (RGA) groundwater which are an industrial degreaser _____ and the radionuclide technetium-99.

Trichloroethylene (TCE) was used until 1993 as an industrial degreasing solvent to clean enrichment process equipment and hundreds of miles of enrichment process piping. True or False?

Nuclear fission is the process that releases energy from fuel rods in nuclear reactors that produce electricity. True or False? (VM: Nuclear Energy and the Atom)

Technetium-99 is a fission by-product contained in nuclear power reactor returns (spent nuclear fuel rod material) processed at the PGDP for re-enrichment of their uranium-235 content. True or False?

Two large groundwater plumes containing TCE and technetium-99 originate at the PGDP and occur in the RGA. They are referred to as the _____ and _____ groundwater plumes.

Cumulatively, the Northeast and Northwest Groundwater Plumes are amongst the largest areas of groundwater contamination in the U.S. and the World that originate from a single facility. True or False?

One of the two large groundwater plumes comprises the largest TCE/technetium-99 in the DOE Complex (all DOE facilities nationwide). True or False.

Re-enrichment of uranium-235 from spent nuclear fuel containing technetium-99 ended in Calendar Year _____.

Known or potential sources of TCE and technetium-99 include:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Groundwater locations monitored during 2016 are identified in Figure _____.

Groundwater monitoring is conducted to detect the _____ and _____ of groundwater contamination

The nature of groundwater contamination is defined by the detection of _____ and their concentrations at given locations in the Regional Gravel Aquifer.

Groundwater monitoring is utilized to determine the movement of groundwater (rate and direction) in the vicinity of the PGDP. True or False?

Historical groundwater data and interactive maps showing groundwater monitoring locations can be

viewed and downloaded from the PEGASIS (Paducah Environmental Geographic Analytical Spatial Information System; <https://pegasis.pad.pppo.gov/>). True or False?

6.1 GEOLOGIC AND HYDROGEOLOGIC SETTING

There are several groundwater components to the groundwater flow system at the PGDP:

1. _____
2. _____
3. _____
4. _____

Groundwater flow through loess and shallow soils, the Upper Continental Recharge System is primarily _____ and provides recharge to the RGA.

Regional Gravel Aquifer groundwater flows _____ toward the Ohio River and discharges to the Ohio River and _____ in the vicinity of the Ohio River.

Most contaminant sources at the PGDP are in the RGA. True or False?

The primary area of recharge for the McNairy Flow System, which occurs beneath the RGA, is along the western side of Kentucky Lake and includes _____ and Graves Counties.

6.2 USES OF GROUNDWATER IN THE VICINITY

Historically, _____ was the primary source of agricultural irrigation water and residential drinking water in the vicinity of the PGDP.

Contamination of groundwater by contaminants related to the PGDP was first identified by the Kentucky Radiation Control Program and the McCracken County Public Health Department in 1988. True or False?

When off-site groundwater contamination associated with PGDP was identified, the DOE provided access to and paid for municipal water for individuals, farms and businesses in areas potentially impacted by PGDP groundwater contamination. True or False?

The DOE provides water to potentially impacted individuals through the DOE _____ Program.

6.3 GROUNDWATER MONITORING PROGRAM

The primary objective of the PGDP groundwater monitoring program is to ensure protection of public health and the environment.

Five additional objectives of the DOE groundwater monitoring program are:

1. _____
2. _____
3. _____
4. _____

5. _____

Table ___ summarizes PGDP groundwater monitoring, groundwater flow system components that are monitored, and the frequency of monitoring.

6.4 GROUNDWATER MONITORING RESULTS

Table ___ summarizes the analytes that were detected in PGDP groundwater samples during 2016.

The maximum contaminant level for TCE in groundwater is _____ ug/L.

The maximum extent of TCE groundwater contamination shown in Figure 6.1 is _____ ug/L.

The maximum concentration of TCE in groundwater during 2016 was _____ ug/L.

In 2016, the maximum TCE groundwater concentration was found in samples collected in the vicinity of the C-400 _____.

TCE was delivered by railroad tank cars, transferred, stored and used to clean enrichment process components at the C-400 Cleaning Building.

During the cleaning process in the C-400 Building, TCE vapors were withdrawn from cleaning processes and discharged to the atmosphere thru stacks on the east side of the building. True or False?

Cleaning water used to rinse and remove TCE during cleaning processes was discharged to the PGDP sanitary sewer system for treatment at an PGDP's on-site water treatment plant. True or False?

In 2016, the maximum PGDP technetium-99 groundwater activity was found in the vicinity of the C-400 Cleaning Building. True or False?

Table ___ summarizes the cumulative gallons of TCE removed from PGDP groundwater over the course of year that the removal activities were conducted.

Remedial Actions, ongoing groundwater pump and treat actions and remedial method demonstrations have removed _____ gallons of TCE from PGDP groundwater.

Rail tankers can transport up to _____ gallons of chemicals.

QUALITY ASSURANCE

The PGDP Site maintains a Quality Assurance (QA) /___ __ (_) Program to _____ the integrity of data generated by the Environmental Monitoring Program.

The QA/QC Program addresses each aspect of the Environmental Monitoring Program from _____ collection to _____.

What 7 sources for QA/QC Program requirements and guidelines are cited in the ASER?

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

7.1 FIELD SAMPLING QUALITY CONTROL

7.1.1 Data Quality Objectives and Sample Planning

The DQO Process is a step-by-step planning approach to develop sampling designs for **data** collection activities that support decision making. https://vsp.pnnl.gov/help/vsample/Data_Quality_Objectives_DQO_process.htm

Data Quality Objectives are used in project planning to determine 6 components of project sampling and analysis:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Samples collected at PGDP are each assigned a unique sample _____.

The PGDP uses an electronic database, the _____, to manage its environmental data.

7.1.2 Field Measurements

Field measurements are measurements made in the _____.

Groundwater and surface water monitoring require field measurements be collected including:

1. _____

2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____

7.1.3 Sampling Procedures

Sample media refers to (four categories):

1. _____
2. _____
3. _____
4. _____

Sampling methods are _____ specific.

A ‘_____ of _____’ is established track the collection and handling of each sample collected.

7.1.4 Field Quality Control Samples

The PGDP Quality Control Program targets what percent of total samples be collected as QC samples?

Analytical results of QC samples are evaluated to determine if sampling methods biased sample results. True or False.

Identify 3 types of Field QC samples.

1. _____
2. _____
3. _____

7.2 ANALYTICAL LABORATORY QUALITY CONTROL

7.2.1 Analytical Procedures

A sample matrix is the component of specific media that is being analyzed in the laboratory. True or False?

The sediment media type may have a liquid and solid component that require chemical analysis. True or False?

Groundwater and surface water samples may require chemical specific analytical methods for total, dissolved and suspended chemical(s). True or False?

The primary EPA issued guidance document that identifies matrix and chemical specific laboratory analytical methods is SW-_____. <https://www.epa.gov/hw-sw846>

7.2.2 Laboratory Quality Control Samples

Identify 4 types of analytical laboratory QC samples.

1. _____
2. _____
3. _____
4. _____

7.2.3 Independent Quality Control

The Paducah Site is required by DOE and EPA to participate in independent QC programs. True or False?

7.2.4 Laboratory Audits/Sample and Data Management Organization

Laboratory audits are performed annually by the DOE Consolidated Audit Program to ensure that the laboratories are in compliance with regulations, methods, and procedures. True or False?

7.3 DATA MANAGEMENT

7.3.1 Project Environmental Measurements System (PEMS)

PGDP field, sample and laboratory data is entered into and maintained in the _____ database.

PGDP field, sample and laboratory data used for reporting is maintained in the Oak Ridge Environmental Information System (OREIS) database. True or False?

7.3.2 Paducah OREIS

Paducah PEMS data is archived for future use in the OREIS database. True or False?

7.3.3 PEGASIS

PGDP's OREIS environmental data is accessible to site personnel, regulators, and the general PUBLIC through the Paducah Environmental Geographic Analytical Spatial Information System (PEGASIS). True or False?

On your phone or computer go to Pegasis.pad.pppo.gov
(Best on Edge, IE and iPhone Safari. Some functions on Chrome may/may not work based on Chrome security settings)

1. Choose 'What is PEGASIS' link in right hand column
2. What organization developed the data and GIS system that eventually became PEGASIS?

Next use this link to look at the GIS map of the site:

ASER PROJECT – Outlined ASER Text & Questions (Draft)

<https://pegasis.pad.pppo.gov/portal/apps/webappviewer/index.html?id=1923382d7e944d19b50db8bad354baa8>

The default map shows the PGDP Site, The DOE Reservation, WKWMA, TVA and surrounding areas.

1. On layer list (right side of map), expand the 'GIS Layers'
2. Page Down the layer list and find the 'Flora Species' (tree cover) and 'Habitat' layers
3. Turn each specific layer on and off to see the extent of areas in each layer.

Next use this link to the GIS map to view locations and media types where chemical and radionuclide samples were collected and to download data you are interested in:


<https://pegasis.pad.pppo.gov/analyticaldataENH/>

Page will load with map in background and Analytical Data Filter box.

Page may take a minute to load 'Analytical Data Filter' box that you will use to identify environmental data you are interested in)

The Analytical Data Filter box gives you choices for: media, location, chemical or radionuclide analytical results, depth, date, and/or timeframes.

In the Analytical Data Filter dropdowns:

- Choose "Starting" and enter 01/01/89
- Choose "Ending" and keep the current date that is already showing
- Choose "Detects" and keep 'all'
- Choose "Fractions" and leave blank
- Choose "Locations" and leave blank
- Choose "Analytes by Name" and enter 'Technetium-99'
- Choose "Analytes by CAS" and leave blank
- Choose "Media" and leave blank
- Choose "Ending Depth" and leave blank
- Click on Map and zoom in or out. The map will refresh showing locations where technetium-99 was sampled
 - Icons indicate which media type a 99-Tc sample was collected from at a location.
- On screen go to the dark gray navigation bar at top of page and click the  symbol to show the legend.
 - The legend identifies the media type associated with sample location icons on the map.
 - HOW MANY MEDIA TYPES WERE 99-Tc SAMPLES COLLECTED FROM?
- There are more than 51,500 technetium-99 samples in the database.
- Choose 'Export CSV' to download the technetium-99 records (BEWARE – This may be a file too large for your device)

7.3.4 Electronic Data Deliverables

Each laboratory provides the PGDP with _____ electronic data for all samples analyzed by the laboratory.

7.3.5 Data Packages

No questions. This section is incomplete? Ignore this section for the Student ASER.

7.3.6 Laboratory Contractual Screening

Laboratory contractual screening is the process of evaluating a set of data against the requirements specified in the analytical statement of work to ensure that all requested information is received. True or False?

7.3.7 Data Verification, Validation, and Assessment

Data verification is the process of comparing a data set against standards or contractual requirements. True or False?

Data validation is the process performed by a qualified individual for a data set, independent from sampling, laboratory, project management, or other decision making personnel. True or False?

Data assessment is the process for assuring that the type, quality, and quantity of data are appropriate for its intended use based on the data quality objectives.