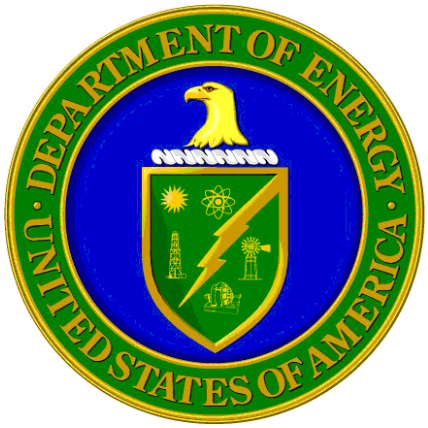
Waste Isolation Pilot Plant

Annual Change Report 2020/2021

From July 1, 2020, to June 30, 2021



November 2021

Waste Isolation Pilot Plant
Annual Change Report 2020/2021

U.S. Department of Energy
Carlsbad Field Office

November 2021

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Acronyms and Abbreviations

CBFO	Carlsbad Field Office
CCP	Central Characterization Program
CFR	Code of Federal Regulations
CH	contact-handled
CH-TRUCON	CH-TRU Waste Content Codes
CPR	cellulose, plastic, and rubber
CRA	Compliance Recertification Application
DOE	U. S. Department of Energy
DRZ	disturbed rock zone
DSA	Documented Safety Analysis
DTC	dose-to-curie
EPA	U. S. Environmental Protection Agency
EPHA	Emergency Planning Hazards Assessment
EXO	Enriched Xenon Observatory
ISOCS	*in-situ* object counting system
JHA	Job Hazard Analysis
KE	Key Element
kg	kilogram
LWA	Land Withdrawal Act
m^3	cubic meters
MEGA	Multiple Element Germanium Array
MgO	magnesium oxide
NMSU	New Mexico State University
NWP	Nuclear Waste Partnership LLC
PCB	polychlorinated biphenyl
PCS	panel closure system
QA	Quality Assurance
RH	remote-handled
ROM	run-of-mine
SAC	Safety Awareness Committee
SEGA	Segmented Enriched Germanium Assembly
SQA	Software Quality Assurance
TE	Transportation Engineer
TRAMPAC	TRU Waste Authorized Methods for Payload Control
TRU	transuranic
VSDS	Visual Survey Data System
WDS	Waste Data System
WIPP	Waste Isolation Pilot Plant

1.0 INTRODUCTION

As a requirement of Title 40 Code of Federal Regulations (CFR) Part 194.4(b)(4) (EPA 1996), the U. S. Environmental Protection Agency (EPA) requires the U. S. Department of Energy (DOE) to provide information on any change in conditions or activities pertaining to the disposal system since the most recent compliance application. This requirement states:

> Not later than six months after the Administrator issues a certification, and at least annually thereafter, the Department shall report to the Administrator, in writing, any changes in conditions or activities pertaining to the disposal system that were not required to be reported by paragraph (b)(3) of this section and that differ from information contained in the most recent compliance application.

Each November, the DOE provides the required annual report of applicable changes at the Waste Isolation Pilot Plant (WIPP) facility. Applicable changes include non-significant changes to information in the most recent compliance application, i.e., the 2019 Compliance Recertification Application (DOE 2019). The reporting year for the annual report is July 1 to June 30.

In a June 17, 2002, letter to the DOE, the EPA provided examples of routine operations and maintenance activities for the WIPP facility that are considered to be non-significant to the Compliance Certification/Recertification. Examples of these activities include mining a ventilation overcast, installation of equipment/instruments related to geo-mechanical and groundwater monitoring as required by the EPA, and installation of ground control monitoring devices.

Significant planned changes are reported by the DOE to the EPA prior to implementation. Significant changes include those that would result in crucial information contained in the Compliance Certification/Recertification no longer being valid or would result in noncompliance with the requirements in 40 CFR 191 and the criteria in 40 CFR 194. Planned changes are submitted on an individual basis. Significant unplanned changes are reported to the EPA within 24 hours, or 10 days, in accordance with Title 40 CFR 194.4(b)(3) (EPA 1996).

Proposed changes in activities or conditions are reviewed to determine if 40 CFR Part 194.4(b)(3) reporting is necessary. The annual report summarizes the items identified as requiring reporting under 40 CFR Part 194.4(b)(4) (EPA 1996). The majority of the items reported are inspections, reports, and modifications to written plans and procedures for WIPP facility operations.

This report captures the description of each change for the period July 1, 2020, through June 30, 2021, in the seven tables described below:

Information required by 40 CFR Part 194.4(b)(4):

Table 1: Changes in WIPP Conditions or Activities Reportable Under Title 40 CFR Part 194.4(b)(4) documents EPA and DOE interactions during the reporting period, with a high-level summary of each correspondence.

Table 2: Procedure/Plan Revision documents changes to relevant plans and procedures during the reporting period.

Table 3: Waste Emplacement Summary Report documents the transuranic (TRU) waste

disposed inventory for the waste parameters. The summary provides the total emplaced inventory in the repository as of June 30, 2021.

Table 4: Performance Assessment, Software, and Hardware Changes documents the changes to relevant codes, software, and hardware that have occurred during the reporting period.

Extra-regulatory information requested by the EPA:

Table 5: Passive Institutional Controls Activity documents activities applicable to the development of Passive Institutional Controls. This table was added at the request of the EPA (Reyes to Moody, 2008a).

Table 6: EPA Waste Characterization Inspections - July 1, 2020, to June 30, 2021, documents inspections performed by the EPA pertaining to Tier 1 changes to the baseline approvals at generator and storage sites for TRU waste. This table was added to the Annual Change Report at the request of the EPA during the EPA/DOE management meeting held July 29, 2010.

Table 7: EPA Quality Assurance Audits by Site - July 1, 2020, to June 30, 2021, documents audits performed by the EPA for generator and storage sites for TRU waste. This table was added to the Annual Change Report at the request of the EPA during the EPA/DOE management meeting held July 29, 2010.

In accordance with the EPA's requests[1] and feedback, this report incorporates suggestions and guidance for capturing the appropriate level of detail and the layout of information with respect to the WIPP certification criteria. This report does not include administrative changes to procedures such as editorial changes, reformatting, correcting references, correcting inconsistency within a procedure, and other changes that do not alter the substance or intent of the document.

The changes reported in this WIPP Annual Change Report do not represent significant changes pertaining to the disposal system.

[1] EPA to McFadden, 1998; Page to Klein, 1999a; Page to Triay, 1999b; Marcinowski to Triay, 2000; Marcinowski to Triay, 2001; Marcinowski to Triay, 2002a; Marcinowski to Triay, 2002b; Marcinowski to Triay, 2002c; Marcinowski to Triay, 2002d; Marcinowski to Triay, 2003b; Marcinowski to Triay, 2003c; Gitlin to Detwiler, 2004; Gitlin to Triay, 2005a; Gitlin to Piper, 2005b; Gitlin to Moody, 2006a; Gitlin to Moody, 2006b.

2.0 INFORMATION REQUIRED BY TITLE 40 CFR PART 194.4(b)(4)

Table 1: Changes in WIPP Conditions or Activities Reportable Under 40 CFR Part 194.4(b)(4) July 1, 2020, to June 30, 2021		
Regulatory Requirements	**Implementing Document or Activity that Changed**	**Description of the Change and DOE Assessment of the Impact of the Change**
40 CFR 194.4(b)(3), Conditions of Compliance Certification	Planned Change Notices and Planned Change Requests	EPA to DOE, September 28, 2020 Response to DOE Planned Change Notice dated September 29, 2017, regarding the excavation and construction of a new ventilation shaft and associated access drifts at WIPP. DOE to EPA, November 2, 2020 Planned Change Request for Alternative Panel Closure for Panels 1 and 2. DOE to EPA, June 23, 2021 Planned Change Notice to excavate the west mains access drifts. DOE to EPA, August 10, 2020 Response to EPA correspondence from L. Veal dated May 4, 2020, Subject: Shaft PCN-CRA.
40 CFR 194.4(b)(4), Conditions of Compliance Certification	2019/2020 Annual Change Report	DOE to EPA, November 16, 2020 Transmission of the *WIPP 2019-2020 Annual Change Report*.
40 CFR 194.8, Approval Process for Waste Shipment from Waste Generator Sites for Disposal at the WIPP facility	Advanced Mixed Waste Treatment Project	None to report.
40 CFR 194.8, Approval Process for Waste Shipment from Waste Generator Sites for Disposal at the WIPP facility	Argonne National Laboratory	None to report.
40 CFR 194.8, Approval Process for Waste Shipment from Waste Generator Sites for Disposal at the WIPP facility	Idaho National Laboratory	None to report.
40 CFR 194.8, Approval Process for Waste Shipment from Waste Generator Sites for Disposal at the WIPP facility	Lawrence Livermore National Laboratory	DOE to EPA, May 24, 2021 Tier 1 request for the visual examination process of summary category group S3000 solids at LLNL/CCP.
40 CFR 194.8, Approval Process for Waste Shipment from Waste Generator Sites for Disposal at the WIPP facility	Los Alamos National Laboratory	None to report.

Table 1: Changes in WIPP Conditions or Activities Reportable Under 40 CFR Part 194.4(b)(4) July 1, 2020, to June 30, 2021		
Regulatory Requirements	**Implementing Document or Activity that Changed**	**Description of the Change and DOE Assessment of the Impact of the Change**
40 CFR 194.8, Approval Process for Waste Shipment from Waste Generator Sites for Disposal at the WIPP facility	Oak Ridge National Laboratory	None to report.
40 CFR 194.8, Approval Process for Waste Shipment from Waste Generator Sites for Disposal at the WIPP facility	Sandia National Laboratories	None to report.
40 CFR 194.8, Approval Process for Waste Shipment from Waste Generator Sites for Disposal at the WIPP facility	Savannah River Site	DOE to EPA, October 7, 2020 Formal request for an EPA baseline inspection for SRS laboratory CH TRU waste characterization in Area E.
40 CFR 194.8, Approval Process for Waste Shipment from Waste Generator Sites for Disposal at the WIPP facility	Waste Acceptance Criteria	None to report.
40 CFR 194.8, Approval Process for Waste Shipment from Waste Generator Sites for Disposal at the WIPP facility	Tier 2 Reports	DOE to EPA, August 11, 2020 Notification of Tier 2 changes for Advanced Mixed Waste Treatment Project and CCP activities for FY 2020 third quarter. DOE to EPA, February 10, 2021 Notification of Tier 2 changes for Advanced Mixed Waste Treatment Project and CCP activities for FY 2021 first quarter. DOE to EPA, May 24, 2021 Notification of Tier 2 changes for AMWTP and CCP activities for FY 2021 second quarter. DOE to EPA, May 25, 2021 Response to EPA request for documents from the CBFO Notification of Tier 2 Changes for the FY 2020 Fourth Quarter and FY 2021 First Quarter.

40 CFR 194.11-15, Compliance Certification and Re-Certification Applications	Certification/Recertification	DOE to EPA, June 10, 2020 Response 1 to EPA's 2019 CRA completeness comments letter dated March 23, 2020. DOE to EPA, July 9, 2020 Response 2 to EPA's 2019 CRA completeness comments letter dated March 23, 2020. DOE to EPA, August 13, 2020 Response 3 to EPA's 2019 CRA completeness comments letters dated March 23, 2020, and May 6, 2020. DOE to EPA, September 15, 2020 Response 4 to EPA's 2019 CRA completeness comments letter dated May 6, 2020. DOE to EPA, October 19, 2020 Response 5 to EPA's 2019 CRA completeness comments letter dated May 6, 2020. DOE to EPA, October 26, 2020 Response 6 to EPA's 2019 CRA completeness comments letter dated May 6, 2020. DOE to EPA, December 1, 2020 Response 7 to EPA's 2019 CRA completeness comments letter dated May 6, 2020. DOE to EPA, January 17, 2021 Response 8 to EPA's 2019 CRA completeness comments letter dated May 6, 2020. DOE to EPA, March 5, 2021 Response 9 to EPA's 2019 CRA completeness comments letter dated May 6, 2020. DOE to EPA, March 30, 2021 Response 10 to EPA's 2019 CRA completeness comments letters dated September 11, 2020, and November 13, 2020, letter dated May 6, 2020. DOE to EPA, April 23, 2021

Table 1: Changes in WIPP Conditions or Activities Reportable Under 40 CFR Part 194.4(b)(4) July 1, 2020, to June 30, 2021		
Regulatory Requirements	**Implementing Document or Activity that Changed**	**Description of the Change and DOE Assessment of the Impact of the Change**
		Response 11 to EPA's CRA completeness comments letter dated September 11, 2020,and email dated January 7, 2021. DOE to EPA, May 27, 2021 Response 12 to EPA's 2019 CRA completeness comments letter dated September 11, 2020. DOE to EPA, May 18, 2021 Response 13 to EPA's 2019 CRA completeness comments received via email dated April 15, 2021. DOE to EPA, May 20, 2021 Response SOTERM-3 to EPA's 2019 CRA completeness comments the letter dated March 23, 2020. DOE to EPA, July 8, 2021 Transmittal of GEOCHEM-1 supplement document as requested by EPA during technical exchange meeting on June 22, 2020.

40 CFR 194.14(b), Design of the Disposal System	Status of Experiments in the WIPP Underground July 1, 2020, to June 30, 2021.	**Enriched Xenon Observatory (EXO)** July 1 - September 30, 2020 • EXO cleanroom modules have been configured and equipment staged so that the EXO-200 detector, shielding, and modules can be removed from the underground. October 1, 2020, to March 31, 2021 • EXO cleanroom modules have been configured, equipment staged, and approximately half the shielding has been removed from the top of the time projection chamber. April 1, 2021, to June 30, 2021 • EXO cleanroom modules, equipment staged, and all of the shielding has been removed from the NExA drift in the WIPP underground. **Low Background Radiation Experiment** July 1 - September 30, 2020 • NMSU Low Background Radiation Experiment summer activities were completed in September 2020. • NMSU conducted experiments on isolates extracted from WIPP brine that include Chromohalobacter (bacteria) and Halobacterium noricense (archaea) this quarter. In addition, NMSU researchers conducted experiments on Deinococcus radiodurans and E. coli. October 1, 2020, to March 31, 2021 • There have been no activities at the NMSU Low Background Radiation Experiment since September 2020. April 1, 2021, to June 30, 2021 • The NMSU Low Background Radiation Experiment (LBRE) has been conducting research at the WIPP facility (surface and underground) since June 2021. The research consists

		of growing, handling, culturing, and testing organisms in a low background radiation environment. **Salt Disposal Investigations /Salt Defense Disposal Investigations** July 1 - September 30, 2020 • Borehole Heater Test monitoring equipment continue to operate without heating due to the COVID-19 unknowns pertaining to WIPP underground access and principal investigator(s) travel restrictions due to COVID-19. While the heater was not operating, maintenance was performed. Savannah River Site Residual Gas Analyzer (Mass Spectrometer), additional Acoustic Emission nodes were installed, fiber optic equipment was removed, and permeability tests were conducted on select boreholes. October 1, 2020, to December 31, 2020 • Borehole Heater Test monitoring equipment continue to operate without heating due to the COVID-19 unknowns pertaining to WIPP underground access. While the heater was not operating, permeability tests were run, and the test was prepared for tracer gas to be added to the test array in 2021. January 1, 2021, to March 31, 2021 • Borehole Heater Test monitoring equipment continues to operate without heating. Heating will resume following the delay related to COVID-19 in calendar year 2020 and the completion of tracer tests which were designed to test the array in an unheated condition. For this quarter there have been four tracer tests. One tracer test was completed on the unheated array and three tracer tests

Table 1: Changes in WIPP Conditions or Activities Reportable Under 40 CFR Part 194.4(b)(4) July 1, 2020, to June 30, 2021		
Regulatory Requirements	**Implementing Document or Activity that Changed**	**Description of the Change and DOE Assessment of the Impact of the Change**
		were initiated in the heated array (the heated array was tested in an unheated state). The third test is ongoing and upon completion heating will start. April 1, 2021, to June 30, 2021 • Borehole Heater Test monitoring equipment continues to operate. For the April through June 2021 time period there have been multiple gas tracer tests, heating periods followed by cool down periods, and brine tracer tests. Currently the borehole heater test is in a cooling phase and the liquid tracer test is ongoing. **Segmented Enriched Germanium Assembly (SEGA) and Multiple Element Germanium Array (MEGA)** July 1, 2020 – June 30, 2021 • The SEGA/MEGA activities are currently on hold and the Q-room area of S-90 is partitioned off pending evaluation of the status of ground stability.
40 CFR 194.21, Inspections	WIPP Facility and Generator Site Inspections	None to report.
40 CFR 194.22, Quality Assurance (QA)	Quality Assurance Audit	See Table 7: EPA Quality Assurance Audits by Site.
40 CFR 194.22(a)	Quality Assurance	None to report.
40 CFR 194.23, Models and Computer Codes	Performance Assessment, Software, and Hardware Changes	See Table 4: Performance Assessment, Software, and Hardware Changes.
40 CFR 194.24(a)	Waste Characterization	DOE, December 18, 2020 Issuance of DOE/TRU-20-3425, Rev. 0 *Annual Transuranic Waste Inventory Report*.

Table 1: Changes in WIPP Conditions or Activities Reportable Under 40 CFR Part 194.4(b)(4) July 1, 2020, to June 30, 2021		
Regulatory Requirements	**Implementing Document or Activity that Changed**	**Description of the Change and DOE Assessment of the Impact of the Change**
40 CFR 194.24(b)	Waste Characterization	None to report.
40 CFR 194.24(c)	Waste Characterization	See Table 3: Waste Emplacement Summary Report
40 CFR 194.25	Future States Assumptions	None to report.
40 CFR 194.26	Expert Judgment	None to report.
40 CFR 194.27	Peer Review	None to report.
40 CFR 194.31	Application of Release Limits	None to report.
40 CFR 194.32	Scope of Performance Assessments	None to report.
40 CFR 194.33	Consideration of Drilling Events in Performance Assessments	DOE, December 18, 2020 Issuance of the *WIPP Delaware Basin Monitoring Annual Report*.
40 CFR 194.34	Results of Performance Assessments	None to report.
40 CFR 194.41	Active Institutional Controls	None to report.
40 CFR 194.42(a), Monitoring	Ground Water Monitoring	DOE to EPA, November 24, 2020 Notification to Plug and Abandon Monitoring Well WIPP-13 at the WIPP site. DOE, November 19, 2020 Issuance of *WIPP 2020 Annual Culebra Groundwater Report*.

Table 1: Changes in WIPP Conditions or Activities Reportable Under 40 CFR Part 194.4(b)(4) July 1, 2020, to June 30, 2021		
Regulatory Requirements	**Implementing Document or Activity that Changed**	**Description of the Change and DOE Assessment of the Impact of the Change**
40 CFR 194.42(c)	Pre-closure Monitoring	DOE, September 23, 2020 Issuance of DOE/WIPP-20-3591, Rev. 0, *WIPP Annual Site Environmental Report for 2019*. DOE, October 13, 2020 Issuance of DOE/WIPP-20-3557, Rev. 0, *Mine Ventilation Rate Monitoring Annual Report*. DOE, October 29, 2020 Issuance of DOE/WIPP-20-3610, *Geotechnical Analysis Report Volumes 1 and 2 for July 2018 – June 2019*. DOE, November 6, 2020 Issuance of DOE/WIPP-20-3557, Rev. 1, *Mine Ventilation Rate Monitoring Annual Report*. DOE, January 7, 2021 Issuance of DOE/WIPP 20-3613, *WIPP Subsidence Monument Leveling Survey 2020*. DOE to EPA, June 29, 2021 Submittal of the *2020 Annual Periodic Confirmatory Measurement Compliance Report*.
40 CFR 194.42(d)	Post-closure Monitoring	None to report.
40 CFR 194.42(e)	Pre-closure and Post-closure Monitoring Plans	None to report.
40 CFR 194.43	Passive Institutional Controls	See Table 5: Passive Institutional Controls Activity.
40 CFR 194.44	Engineered Barriers	None to report.
40 CFR 194.45	Consideration of the Presence of Resources	None to report.

Table 1: Changes in WIPP Conditions or Activities Reportable Under 40 CFR Part 194.4(b)(4) July 1, 2020, to June 30, 2021		
Regulatory Requirements	**Implementing Document or Activity that Changed**	**Description of the Change and DOE Assessment of the Impact of the Change**
40 CFR 194.46	Removal of Waste	None to report.
40 CFR 194.51-55	Individual and Groundwater Protection Requirements.	US DOE, February 16, 2021 Issuance of SNL *Compliance Monitoring Parameter Assessment for 2020*.

Table 2: Procedure/Plan Revision July 1, 2020, to June 30, 2021		
Procedure/Plan	**Revision, Effective Date**	**Description of Change**
NP 9-1, *Analyses*	Revision 11, 09/15/2020	Added and removed appropriate definitions; clarified responsibilities and processes.
NP 17-1, *Records*	Revision 11, 09/17/2020	Added provisions that allow a signature on file to be used for approvals due to COVID-19 remote working conditions.
NP 19-1, *Software Requirements*	Revision 19, 07/28/2020	Added and removed appropriate definitions; clarified responsibilities and processes; modified Software Problem Reporting process.
NP 20-1, *Test Plans*	Revision 6, 09/16/2020	Minor editorial changes were made to clarify revising and issuing a test Plan.
SP 12-9, *Calibration, Use, and Maintenance of the Perkin Elmer Optima 8300 Dual View ICP-AES*	Revision 6, 09/29/2020	Changes were made to clarify how calibration standards are to be made, and how the calibration blank is to be used. Statement about the blank was added. Added a description for use of the "T" adapter during sample preparation and scandium solution concentration.
SP 12-23, *Rainfall Measurements Using an Onset Brand Data-Logging Rain Gauge*	Revision 5, 08/26/2020	The procedure was revised to change the Figure in Appendix A to be an example of format rather than an official form.
10-AD3028, *Calibration and Control of Measurement and Test Equipment*	Revision 19, 07/07/2020	• Added statement from WP 13-1, Nuclear Waste Partnership LLC Quality Assurance Program Description, calibration and control measures for rulers, tape measures, levels, and other such devices. • Added Abbreviations and Acronyms list.
10-AD3029, *Calibration and Control of Monitoring and Data Collection Equipment*	Revision 16, 07/07/2020	• Added statement from WP 13-1, Nuclear Waste Partnership LLC Quality Assurance Program Description, calibration and control measures for rulers, tape measures, levels, and other such devices.

Table 2: Procedure/Plan Revision July 1, 2020, to June 30, 2021		
Procedure/Plan	**Revision, Effective Date**	**Description of Change**
		• Revised section 5.4 "If equipment has not been returned to Metrology Office personnel in 30 days after calibration due date, then Metrology Office Notify M&DC Owners requesting status or disposition of the equipment. • Revised section 5.3 Warehouse does not prepare equipment for shipment. Metrology personnel prepare equipment for shipment.
12-HP1325, *Station B Canberra iCAM Alpha Continuous Air Monitor Technical Procedure*	Revision 10 7/16/2020	Full revision. No change bars displayed. • Added/modified Precautions. • Added new Section 5.8, adjusting the iCAM Flow Rate. • Streamlined steps throughout to update requirements and send user to new Section 5.10, Abnormal Conditions. • Removed unneeded 'go to' steps before conditional steps. • Modified Attachment 1, Example of iCAM Alpha Continuous Air Monitor.
05-WH1058, *CH Waste Handling Abnormal Operations*	Revision 26, 07/30/2020	Full revision; no change bars displayed. • Deleted: - Section 4.0, Equipment pertaining to Section 5.6. - Section 5.6, Evaluation and Recovery of Noncompliant TDOP; related precaution and 4.1 Equipment; and Attachment 1 data sheet. - Section 5.12, Removal of TDOP Pipe Plugs and Attachment 4 data sheet.

Table 2: Procedure/Plan Revision July 1, 2020, to June 30, 2021		
Procedure/Plan	**Revision, Effective Date**	**Description of Change**
12-ER3906, *Categorization and Classification of Operational Emergencies*	Revision 21, 08/03/2020	Complete rewrite; no change bars displayed: • Addition of unfiltered underground release Emergency Action Levels for 700 fan use. • Revised text on categorization and classification to correspond with criteria in DOE O 151.1D. • Added a new Section 2 – Emergency Action Levels, and Section 3 – Dose Consequence Tables. • Combined all beyond design basis events for the WHB into one bounding Emergency Action Level (RD-WHB-BDBE). • Revised receptors of interest.
08-NT.03, *Waste Stream Profile Form Review and Approval Program*	Revision 20, 08/25/2020	Updated CBFO form in Section 2.3. • Updated records generated in Section 9.0. • Updated references in Section 10.0. • Added Attachment 1, Example Recommendation of Approval Letter to DOE.
05-WH1025, *CH Waste Downloading and Emplacement*	Revision 26-FR1 09/17/2020	Field revision to remove caution about stacking three drum and four drum assemblies adjacent to each other within a stack.
04-VU2001, *Interim Ventilation System Operation*	Revision 13 10/07/2020	Incorporate Long Term Timely Order 20:012, Notifications for Changes to Underground Ventilation.
12-HP1305, *Air Sampling Equipment*	Revision 18 11/23/2020	• Added RCS (Radiological Control Supervisor) step to contact Site Environmental Compliance in “securing power” Sections 5.1, 5.3, 5.5, 5.7, and 5.9.

Table 2: Procedure/Plan Revision July 1, 2020, to June 30, 2021		
Procedure/Plan	**Revision, Effective Date**	**Description of Change**
12-HP3700, *Radiological Event Reporting*	Revision 7 10/28/2020	• Updated references. • Moved Precautions and Limitations statement to Scope. • Assigned requirements to updated personnel titles. • Also revised the following electronic forms: - EA12HP3700-2-0, Gamma Spectroscopy Data. - EA12HP3700-3-0, Raw Alpha Spectroscopy Data. - EA12HP3700-4-0, Additional Analysis Data. - EA12HP3700-5-0, Emergency Sample Logic Matrix.
SP 12-39, *Calibration, Use, and Maintenance of the MS6 Transmission Iron-57 Mossbauer Spectrometer*	Revision 0 11/20/2020	This new procedure describes the SNL, Waste Isolation Pilot Plant (WIPP) procedure for use of the MS6 Transmission Iron-57 Mossbauer Spectrometer manufactured by SEE Co. Calibration and operation guidelines are included in the procedure. This SP is in support of activities described in several WIPP Test Plans (TPs) with the majority of the activities for the experimental work in support of WIPP-related studies. This document is not meant to substitute for the manufacturer instruction manuals for the instrument.
12-RL3002 *Radiochemistry Laboratory Data Validation and Verification*	Revision 13 11/23/2020	• Removed references to LSA (Liquid Scintillation Analyzer) and ICP-MS (Inductively Coupled Plasma-Mass Spectrometry) systems; deleted Sections 5.4 and 5.5. • Removed references to EA12RL3002-6-0 and EA12RL3002-7-0. • Put into procedure template. • Changed from Reference Use to Information Use. • Editorial changes throughout.

DOE/WIPP-02-3122, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*	Revision 10 08/14/ 2020	Changes included typographical corrections, additions to the list of acronyms, removal of the exclusion of pipe overpack containers containing combustible waste from being shipped to WIPP, update to the list of definitions in Appendix C, and the addition and deletion of text in Appendices H and I for consistency with Page Change 1 to Revision 6a of the DSA. The changes to Appendix H and I are due to an assessment performed February 27, 2017, through March 3, 2017, to confirm the readiness of the CBFO and NTP to effectively execute a set of responsibilities described in the WIPP DSA, Chapter 18. Changes to this document are global and include the following: • Incorporation of remote-handled (RH) transuranic (TRU) waste acceptance requirements/criteria taken from the Remote-Handled TRU Waste Characterization Program Implementation Plan, thus harmonizing CH and RH waste acceptance criteria on a single platform. • Consolidation of Chapter 4 of the WAC (titled “Waste Acceptance Requirements and Criteria for RH Waste”) into Chapter 3 (retitled “Waste Acceptance Requirements for TRU Waste”). • Modifications to Figure 1.0 and Tables 1, 2, 3, 4, 5, A-1, A-3, and A-4. • A temporary suspension of receipt and processing of RH waste when containerized in either transport or facility casks. • A temporary delay in the shipment from SRS to WIPP of dilute and dispose PuO using CCOs. • Allowance for the receipt and processing of RH waste when containerized in a shielded container.

Table 2: Procedure/Plan Revision July 1, 2020, to June 30, 2021		
Procedure/Plan	**Revision, Effective Date**	**Description of Change**
		• Incorporation into Appendix A the use of figure of merit assessments used as an alternative for replicate gamma ray measurements using far field measurements. Addition into Appendix A the methodologies for performing dose-to-curie and gravimetric/dimensional measurements. • Addition of fissile equivalent mass for uranium into Table A-1. • Title change of Table A-3. • Updates to the list of definitions in Appendix C. • Changes to titles and text in Appendices A, F, G, and I. • Text changes and the addition of Figure H-1 in Appendix H. • Additions and deletions in the list of acronyms. • Typographical error corrections and updates to the internet links.
DOE/WIPP-06-3339, *WIPP Groundwater Protection Program Plan*	Revision 8 10/01/2020	Changes to align with proposed DP-831 revision: • Updated Figure 2.3, WIPP Well Location Map. • Updated Table 6.1, MOC and SA Roles and Responsibilities. • Updated Section 9.2, Well P & A. • Updated Section 13.2, Priority List and Program Change. • Updated References. • Document updated to align with the latest WIPP EMS (Environmental Management System).

Table 2: Procedure/Plan Revision July 1, 2020, to June 30, 2021		
Procedure/Plan	**Revision, Effective Date**	**Description of Change**
DOE/WIPP-11-3384, *CBFO Approved Filter Vents*	Revision 18 12/03/2020	• Revised to include new filter vent Nuc-Fil-019-HCRDS. • Attachment II, added shading to all empty cells in CCO (Criticality Control Overpack) column. • Attachment II, correct minimum hydrogen diffusivity value of Nuc-Fil-016 SS HP filter • Attachment II, add clarifying note "2" to Nuc-Fil-016LPDS filter.
02-EM1029, *Special Soil Sampling*	Revision 2 12/10/2020	• Updated JHA number in References. • Updated to incorporate Timely Order 20:013.
12-HP1304, *Canberra iCAM Alpha/Beta Continuous Air Monitor*	Revision 16 1/05/2021	• Updated restore and secure power sections: - Corrected Step 5.1.6 and removed note above. - Removed Step 5.1.7 and 5.1.7 [A]. - Added Step 5.1.2. - Deleted 5.10.5 and removed note above. • Updated JHA and affected precautions. • Added temperature controls to Limitations, bullet 5. • Minor editorial corrections and clarifications throughout.

Table 2: Procedure/Plan Revision July 1, 2020, to June 30, 2021		
Procedure/Plan	**Revision, Effective Date**	**Description of Change**
12-RL.01, *Radiochemistry Quality Assurance Plan*	Revision 24 01/11/2021	• Updated requirements for Source Custodian Training. • Removed references to obsolete procedures. • Added new Gas Proportional Counter (GPC) instrument to equipment list. • Removed Liquid Scintillation Analyzer instrument (LCA). • Removed LCA. • Inserted reference to new GPC. • Added clarification about completion of training process. • Updated Table 1, WIPP Laboratories Organizational Chart. • Added responsibilities for Science and Development Director. • Added out-of-tolerance information to Section 3.4.1. • Other minor changes throughout.
12-HP2001, *Abnormal Radiological Conditions*	Revision 13 01/11/2021	Complete rewrite. No change bars displayed. • Detailed all section steps. • Added purpose, scope, and reference sections. • Updated to current abnormal operating procedure template and format.

Table 2: Procedure/Plan Revision July 1, 2020, to June 30, 2021		
Procedure/Plan	**Revision, Effective Date**	**Description of Change**
12-HP1307, *Portable Instrument Operability Checks*	Revision 19 02/25/2021	Complete rewrite to address WF20-166. No change bars displayed. • Added Attachment 2, Ludlum 2241/REM Ball Neutron Dose Survey Meter K Value Calculation. • Updated EA12HP1307-1-0, Source Reference Reading Determination Worksheet. • Changed equipment on EAs: - EA12HP1307-2-0, Portable Radiological Equipment Operability Check Sheet. - EA12HP13073-0, Portable Alpha/Beta Radiological Equipment Operability Check Sheet. - EA12HP1307-4-0, Portable Alpha/Beta Bench Counter Operability Check Sheet • Added new check sheets: - EA12HP1307-5-0, Model 78 Stretch Scope Survey Meter Operability Check Sheet. - EA12HP1307-6-0, Model 9DP Pressurized Ion Chamber Survey Meter Operability Check Sheet. - EA12HP1307-7-0, Thermo-Scientific Tissue Equivalent Micro-Rem Survey Meter Operability Check Sheet.
12-HP4000, *Emergency Radiological Control Responses*	Revision 11 01/13/2021	Change history not reported for this document.
SP 9-4, *Performing FEPs Baseline Impact Assessments for Planned or Unplanned Changes*	Revision 5 3/22/2021	This procedure has been updated to identify a new records package for placement of analyses performed under this procedure and to reference CRA-2019 as the current baseline (from previous baseline of CRA-2014).
SP 9-13, *Data Thinning and Removal of Barometric and Earth Tide Effects from Water-Level Data*	Revision 1 03/30/2021	This revision updates the brand and types of transducers we use to capture pressure data.

Table 2: Procedure/Plan Revision July 1, 2020, to June 30, 2021		
Procedure/Plan	**Revision, Effective Date**	**Description of Change**
SP 12-40, *Calibration and Use of the Gamry Interface 1010E Potentiostat/Galvanostat*	Revision 1 03/03/2021	Subsections 2.8.7.1, 2.8.7.2, and 2.8.7.3 were added to this procedure to describe detail steps and parameter inputs for performing single Electrical Impedance Spectroscopy (EIS) and Potentiodynamic Polarization Spectroscopy (PDS) tests and setting up a sequence of EIS measurements.
SP 12-41, *Rainfall Measurements Using a Texas Electronics Tipping-Bucket Rain Gauge and Campbell Scientific CR300 Datalogger*	Revision 0 02/09/2021	This new SP is to prescribe the process for the collection of rainfall data, and to describe the operation and maintenance of the Texas Electronics tipping-bucket rain gauge.
12-RL1010, *Sample Preparation*	Revision 18 03/29/2021	Revised in response to WIPP Forms S20-247, S20-249, and S20-250.
12-ER3906, *Categorization and Classification*	Revision 22 02/22/2021	Added initial two Protective Actions to Table 1-15.
DOE/WIPP-09-3427, *Waste Data System User's Manual*	Revision 21 June 22, 2021	• Replaced Figure 6D – Waste Handling Operations Dashboard screen shot. • Removed contact information telephone number from section 2.1 and 4.2.

Table 2: Procedure/Plan Revision July 1, 2020, to June 30, 2021		
Procedure/Plan	**Revision, Effective Date**	**Description of Change**
02-EC3506, *Environmental Incident Reporting*	Revision 11 March 25, 2021	• Updated procedure format. • Updated Section 1.3 to add direction to maintain records in accordance with departmental RIDS. • Updated Section 2.0 References to add marks as Key steps for regulatory requirements. • Add Section 2.1 Abbreviations and Acronyms. • Deleted reference to SAF-109, in Section 3.0. • Updated Steps 5.3.1(G) and 5.3.1(H) to change URS to N&E Technical Services LLC. • Clarified Step 5.3.3 to reflect RFD is for hazardous material spills. • Editorial updates to Attachments 1 and 4.
12-HP1100, *Radiological Surveys*	Revision 26 March 31, 2021	• Complete rewrite; no change bars displayed. Addresses WF 20-866. • Added Section 5.5, Visual Survey Data System Survey (VSDS) Number Generation and Section 5.6, VSDS Documentation. • Revised: - EA12HP1100-0-0, Table of Contents – Radiological Survey Reports and Maps. - EA12HP1100-1-0, Radiological Survey Report - EA12HP1100-2-0, Radiological Survey Map - EA12HP1100-3-0 through EA12HP1100-42-0 to reflect changes in EA12HP1100-1-0 and EA12HP1100-2-0

Table 2: Procedure/Plan Revision July 1, 2020, to June 30, 2021		
Procedure/Plan	**Revision, Effective Date**	**Description of Change**
12-RL1014, *Routine Laboratory Operation*	Revision 11 April 13, 2021	• Updates per WF 20-249. • Updated Section 5.6, General Laboratory Housekeeping. • Added Chemical Check to Attachment 1, Lab Housekeeping Form. • Added Clean Room 168 to Attachment 1. • Minor editorial changes throughout.
12-RL3003, *Data Reduction and Reporting*	Revision 18 April 13, 2021	• Revised to address WF 20-257. • Other minor edits as needed.
05-WH1025, *CH Waste Downloading and Emplacement*	Revision 27 April 20, 2021	• Updated references. DSA REV 7 Implementation: • Updated Key Element 7-5. • Added LCO 3.4.3.
12-HP1500, *Radiological Posting and Access Control*	Revision 25 April 20, 2021	DSA REV 7 Implementation: • Updated Key Element 7-5.
02-EM1027, *Shallow Subsurface Water Potentiometric Surface Map Construction*	Revision 4 April 21, 2021	• Changed name of procedure. • Editorial updates throughout.
02-1, *WIPP Groundwater Monitoring Program Plan*	Revision 16 May 6, 2021	• Updates throughout document for periodic review.
05-WH1011, *CH Waste Processing*	Revision 65 April 27, 2021	• DSA Rev 7a implementation.
	Revision 65-FR1 May 10, 2021	• Added step for WH to go to WP 05-WH1058 if activity on swipes is above contamination limits and less than RWP limiting conditions.
05-WH1058, CH Waste Handling Abnormal Operations	Revision 28 05/10/2021	• Rewrote Section 5.16 to include more detail.
13-1, *Nuclear Waste Partnership LLC Quality Assurance Program*	Revision 40 May 25, 2021	• Annual update to reflect current NWP Organization.
02-EM.02, *Integrated Sample Control Plan*	Revision 6 June 10, 2021	• Updates throughout the document from periodic review.

Table 2: Procedure/Plan Revision July 1, 2020, to June 30, 2021		
Procedure/Plan	**Revision, Effective Date**	**Description of Change**
12-RL1001, *Sample Tracking and Custody*	Revision 6 June 10, 2021	• Put into current procedure template. • Added note before Step 5.3.2 regarding air composite samples. • Minor editorial changes throughout.
02-EC3002, *Delaware Basin Drilling Database Upgrade Process*	Revision 11 June 14, 2021	• Added an acronym and a definition. • Updated TX well data collection practices. • Updated NM well data collection practices.
02-PC.02, *Delaware Basin Drilling Surveillance Plan (DBDSP)*	Revision 10 June 21, 2021	• Added the DBDSP Annual Report checklist for authors and reviewers as Attachment 1. • Updated acronyms.
05-WH1603, *CH TRU Underground Transporter, 52-H-008 A and B*	Revision 21 June 22, 2021	• Update Attachment 1 –Leak Categorization.

Note: these procedural changes relate only to programs that are important to the demonstration of compliance with EPA's long-term disposal standards at 40 CFR Part 191, Subparts B and C. Changes to operational procedures that are unrelated to long-term compliance are not considered in this report.

Table 3: Waste Emplacement Summary Report, July 1, 2020, to June 30, 2021

TRU Waste Inventory		
	Reporting Period[1] Emplaced Volume (m^3)*	**Cumulative[3] Emplaced Volume (m^3)**
RH TRU	1.21 (LWA TRU Waste Volume)[2]	361.73 (LWA TRU Waste Volume)[2]
CH TRU	1,142.08 (LWA TRU Waste Volume)[2]	70,145.01 (LWA TRU Waste Volume)[2]

Waste Components Inventory				
	Reporting Period[1] Emplaced Mass (kg)*	**Cumulative[3] Emplaced Mass (kg)**	**Maximum Emplaced Limiting Value[4] (kg)**	**Percent of Limiting Value[4] Emplaced**
Cellulose, Plastic, Rubber Materials[5]	138,988	9,302,023	22,000,000	42.28%
Fe-Metals[6]	481,156	30,261,488	20,000,000	Minimum met
Non-Fe Metals	9,055	458,863	2,000	Minimum met

Emplaced Radiological Activity Inventory (curies)				
Radionuclide	**Cumulative Activity in FY 2019/2020 Annual Change Report[7]**	**CH Repository Reporting Period Activity[7]**	**RH Repository Reporting Period Activity[7]**	**Total Activity as of June 30, 2021[7]**
^{241}Am	2.673E+05	3.897E+03	5.237E-01	2.712E+05
^{137}Cs	1.448E+04	3.984E-01	6.072E+00	1.448E+04
^{238}Pu	4.951E+05	8.698E+03	2.181E-01	5.038E+05
^{239}Pu	3.388E+05	5.462E+03	1.139E+00	3.443E+05
^{240}Pu	8.397E+04	1.347E+03	6.457E-01	8.531E+04
^{242}Pu	2.846E+01	4.735E-01	1.525E-04	2.893E+01
^{90}Sr	7.715E+03	5.662E+00	4.270E+00	7.725E+03
^{233}U	7.253E+00	4.185E-01	7.731E-08	7.671E+00

Table 3: Waste Emplacement Summary Report, July 1, 2020, to June 30, 2021				
^{234}U	9.013E+01	1.239E+00	5.160E-03	9.137E+01
^{238}U	1.823E+01	2.914E-01	2.198E-05	1.852E+01
Total	**1.214E+06**	1.941E+04	1.287E+01	1.227E+06
Magnesium Oxide (MgO)[8] and Cellulose, Plastic and Rubber (CPR) Mass Emplaced Per Waste Panel				
Panel	**Room**	**MgO (kg)**	**CPR* (kg)**	**Excess Factor**
1	All	4,482,356	1,237,685	2.01[9]
2	2-7	5,972,300	1,242,279	2.27[9]
2	1	691,515	186,469	1.71
3	7	960,120	109,685	3.83
3	6	954,405	229,646	1.93
3	5	1,022,985	284,651	1.70
3	4	960,120	255,172	1.79
3	3	931,545	243,860	1.89
3	2	942,975	228,067	2.02
3	1	662,940	183,088	1.76
4	7	942,975	248,903	1.90
4	6	925,830	267,494	1.71
4	5	948,690	265,302	1.71
4	4	1,049,655	290,739	1.76
4	3	1,015,365	285,755	1.70
4	2	931,545	374,327	1.22[8]
4	1	668,655	265,884	1.23
5	7	937,260	353,286	1.28

Table 3: Waste Emplacement Summary Report, July 1, 2020, to June 30, 2021				
5	6	875,477	140,033	2.85
5	5	782,346	298,832	1.24
5	4	737,167	225,449	1.64
5	3	714,286	215,961	1.61
5	2	730,612	194,069	1.84
5	1	485,714	135,766	1.75
6	7	744,218	167,605	2.11
6	6	666,667	189,775	1.74
6	5	474,294	203,497	1.24
6	4	471,586	202,434	1.25
6	3	406,533	171,330	1.25
6	2	291,716	121,710	1.22
6	1	235,107	80,223	1.46
7	7	57,692	15,900	1.76
7	6	103,401	28,853	1.90
7	5	310,204	76,159	1.77
7	4	163,265	32,358	2.12
7	3	321,088	110,790	1.30
7	2	355,382	138,988	1.26

Footnotes

1. Reporting Period is July 1, 2020, through June 30, 2021.
2. Pursuant to the January 16, 2019, CBFO memorandum entitled Tracking and Reporting the Defense-Related Transuranic Waste Volume Against the Waste Isolation Pilot Plant Land Withdrawal Act Total Capacity Limit for Defense-Related Transuranic Waste, Land Withdrawal Act (LWA) volumes will now be reported. Cumulative period includes from the beginning of emplacement until June 30, 2021.
3. Cumulative period includes from the beginning of emplacement until June 30, 2021.
4. Limiting Value—Values from CRA 2019 Section 24. These values are based on inventory assumptions.
5. Cellulose, plastic, rubber (CPR) materials include the waste, container materials, emplacement materials, and non-containerized waste.

Table 3: Waste Emplacement Summary Report, July 1, 2020, to June 30, 2021

6. Fe-Metals include both materials in the waste and containers in total.
7. There is no decay correction for the listed isotope activities. Isotopic activities reported are from the time of the original assay. It is understood that some isotopes may have reached secular equilibrium after disposal.
8. New minimum value for excess factor of MgO to be implemented as approved by EPA (Reyes, J 2008b) reduces excess factor from 1.67 to 1.20 and ensures minimum reactivity of 94%.
9. MgO, CPR, and excess factor results for panel 1 and rooms 2-7 of panel 2 have been recalculated to replace averaged data with actual emplaced data.

Table 4: Performance Assessment, Software, and Hardware Changes, July 1, 2020, to June 30, 2021

WIPP Codes/Software and Code Version	Version Date	Date of Change	Description of Change
PREBRAG 9.01	10/29/2020	10/29/2020	This code was migrated to Linux.
PRECCDFGF 2.01	11/05/2020	11/05/2020	This code was modified to be able to accommodate additional panels to the repository design if needed.
SCREEN_NUTS 1.02	12/02/2020	12/02/2020	This code was migrated to Linux.
POSTBRAG 4.02	01/21/2021	01/21/2021	This code was migrated to Linux.
BRAGFLO 7.00	01/19/2021	01/19/2021	This code was migrated to Linux.
GROPECDB 2.13	01/19/2021	01/19/2021	This code was migrated to Linux.
GENMESH 6.10	03/29/2021	03/29/2021	This code was migrated to Linux.
ALGEBRACDB 2.36	03/29/2021	03/29/2021	This code was migrated to Linux.
MERGESPALL 1.02	04/07/2021	04/07/2021	This code was migrated to Linux.
MATSET 9.24	04/26/2021	04/26/2021	This code was migrated to Linux.
CUTTINGS_S 6.03	04/26/2021	04/26/2021	This code was migrated to Linux.
DRSPALL 1.23	04/26/2021	04/26/2021	This code was migrated to Linux.
EPAUNI 1.19	04/26/2021	04/26/2021	This code was migrated to Linux.

3.0 EXTRA-REGULATORY INFORMATION REQUESTED BY THE U. S. ENVIRONMENTAL PROTECTION AGENCY

Table 5: Passive Institutional Controls Activity, July 1, 2020, to June 30, 2021	
Date	**Description of Activity**
6/30/2021	None to report.

Table 6: EPA Waste Characterization Inspections, July 1, 2020, to June 30, 2021			
Generator Site	**Date of Inspection**	**EPA Inspection No./Tier 1 Evaluation**	**Docket Number/Approval Date**
Advanced Mixed Waste Treatment Project/Accelerated Retrieval Project	None to report.		
Argonne National Laboratory-Illinois	None to report.		
Hanford	None to report.		
Idaho National Laboratory	January 27-29, 2020	Tier 1 change to add containers of waste stream IN-NRF-SPC-103, consisting of remote-handled (RH) transuranic (TRU) waste, to the approved RH waste characterization program at INL.	December 8, 2020 EPA Air e-Docket: EPA-HQ-OAR-2001-0012-0495
Lawrence Livermore National Laboratory	None to report.		

Table 6: EPA Waste Characterization Inspections, July 1, 2020, to June 30, 2021

Generator Site	Date of Inspection	EPA Inspection No./Tier 1 Evaluation	Docket Number/Approval Date
Los Alamos National Laboratory	March 25-May 18, 2021	Tier 1 change due to the relocation of the High Energy Neutron Counter No. 1 (HENC No.1) to Technical Area-63 at LANL.	June 3, 2021 EPA Air e-Docket: EPA-HQ-OAR-2001-0012-0499
Oak Ridge National Laboratory	August 19, 2020	Tier 1 change for adding new population of RH TRU waste containers to previously approved waste stream OR-REDC-RH-HET.	CBFO submitted Tier 1 request on August 23, 2019. Final report and approval letter issued on August 19, 2020. EPA Air e-Docket: EPA-HQ-OAR-2001-0012-0496
Sandia National Laboratories	None to report.		
Savannah River Site)	None to report.		

Table 7: EPA Quality Assurance Audits by Site - July 1, 2020, to June 30, 2021

Site	Audit Date	Purpose
Advanced Mixed Waste Treatment Project	None to report.	
Argonne National Laboratory - East -CCP	July 28-30, 2020	Recertification audit. Audit # A-20-17
Carlsbad Field Office	May 4-6, 2021	CAST Transportation audit. Audit # A-21-04
Hanford-CCP	None to report.	
Idaho National Laboratory - CCP	January 26-28, 2021	Recertification audit. Audit # A-21-05

Table 7: EPA Quality Assurance Audits by Site - July 1, 2020, to June 30, 2021		
Site	**Audit Date**	**Purpose**
	February 23-35, 2021	Recertification audit. Audit # A-21-28
Lawrence Livermore National Laboratory	August 25-27, 2020	Recertification audit. Audit # A-20-18
Los Alamos National Laboratory -CCP	June 23-August 5, 2020	Recertification audit. Audit # A-20-15
	May 18-20, 2021	Recertification audit Audit # A-21-17
Los Alamos National Laboratory-Carlsbad Operations	None to report.	
Nuclear Waste Partnership LLC	March 16-18, 2021	Abatement plan audit. Audit # A-21-01
	April 27-May 3, 2021	NWP Environmental Audit (Including Meteorological, VOC.) Audit # A-21-18
	June 1-3, 2021	NWP Safety Software Audit (IRM and WDS WAC Rev 10 Requirements for SQA.) Audit # A-21-03
Oak Ridge National Laboratory-CCP	April 20-22, 2021	Recertification audit. Audit # A-21-15
Savannah River Site-CCP	October 20-22, 2020	Recertification audit. Audit # A-21-02
	December 8-10, 2020	Recertification audit. Audit # A-21-08
Sandia National Laboratories-CCP	June 22-24, 2021	Recertification audit. Audit # A-21-19
Sandia National Laboratories-Carlsbad Office	None to report.	

4.0 REFERENCES

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