



Independent Assessment of the U-233 Processing All-Hazards Planning Basis at the Oak Ridge National Laboratory

March 2022

Office of Enterprise Assessments
U.S. Department of Energy

Table of Contents

Acronyms.....	ii
Executive Summary.....	iii
1.0 Introduction.....	1
2.0 Methodology.....	1
3.0 Results.....	2
3.1 Procedures.....	2
3.2 All-Hazards Survey.....	3
3.3 Emergency Planning Hazards Assessment.....	3
4.0 Best Practices.....	4
5.0 Findings.....	5
6.0 Deficiencies.....	5
7.0 Opportunities for Improvement.....	5
Appendix A - Supplemental Information.....	A-1

Acronyms

DOE	U.S. Department of Energy
DSA	Documented Safety Analysis
EA	Office of Enterprise Assessments
EAL	Emergency Action Level
EPHA	Emergency Planning Hazards Assessment
EPZ	Emergency Planning Zone
HS	All-Hazards Survey
IPC	Initial Processing Campaign
Isotek	Isotek Systems, LLC
OFI	Opportunity for Improvement
OREM	DOE Oak Ridge Office of Environmental Management
ORNL	Oak Ridge National Laboratory
PA	Protective Action
U-233	Uranium-233

Independent Assessment of the U-233 Processing All-Hazards Planning Basis at the Oak Ridge National Laboratory

Executive Summary

The U.S. Department of Energy (DOE) Office of Enterprise Assessments (EA) conducted an independent assessment of the all-hazards planning basis for the upcoming uranium-233 (U-233) processing operations at the Oak Ridge National Laboratory (ORNL) from November to December 2021. This assessment evaluated the effectiveness of both the Oak Ridge Office of Environmental Management (OREM) and its management and operating contractor, Isotek Systems, LLC (Isotek), in developing and maintaining the all-hazards planning basis. The all-hazards planning basis includes development and maintenance of an all-hazards survey and an emergency planning hazards assessment (EPHA). DOE Order 151.1D, *Comprehensive Emergency Management System*, identifies requirements for the all-hazards planning basis, and the associated emergency management guides provide guidance for implementing the requirements. EA primarily focused on hazards identification and screening and the documented analysis for supporting the development of response plans, emergency action levels, predetermined protective actions, and sizing of the emergency planning zone. Also evaluated was the utility of the EPHA as a reference for a consequence assessment team when conducting dispersion modeling of the analyzed release scenarios.

EA identified the following strengths:

- Isotek has developed procedures that are accurate, complete, and compliant and that also define an adequate process for effectively implementing the all-hazards planning basis requirements of DOE Order 151.1D.
- Isotek has prepared an all-hazards survey for U-233 processing operations in Building 2026 and the Building 3019 Complex that effectively implements the applicable requirements of DOE Order 151.1D.
- Isotek has prepared an EPHA for U-233 transport and processing operations in Building 2026 that effectively implements the EPHA requirements of DOE Order 151.1D and follows the guidance provided in the DOE emergency management guide. The EPHA is technically accurate and provides information to support the development of response plans, emergency action levels, predetermined protective actions or protective action recommendations, and sizing of the emergency planning zone. In addition, the EPHA provides the data, methods, and assumptions needed for a consequence assessment team to replicate the analysis.

EA also identified a weakness related to the identification of scenarios evaluated in the EPHA. Although a comprehensive set of scenarios was identified and analyzed, a criticality incident was not included because it was inappropriately excluded based on low probability.

In summary, OREM and Isotek have developed a technically sound all-hazards planning basis that meets DOE requirements to support the development of response plans, emergency action levels, predetermined protective actions, and sizing of the emergency planning zone. Additionally, the EPHA provides pertinent information to support incident analysis by a consequence assessment team. The ORNL emergency management program was not included in this assessment; however, EA is scheduled to conduct an exercise evaluation at ORNL in 2023.

Independent Assessment of the U-233 Processing All-Hazards Planning Basis at the Oak Ridge National Laboratory

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Office of Emergency Management Assessments, within the independent Office of Enterprise Assessments (EA), conducted an assessment of the all-hazards planning basis for uranium-233 (U-233) processing at the Oak Ridge National Laboratory (ORNL). The all-hazards planning basis includes development and maintenance of an all-hazards survey (HS) and an emergency planning hazards assessment (EPHA). EA conducted the assessment in preparation for new operations at ORNL that involve this unique and significantly hazardous isotope of uranium. EA conducted the assessment during November and December 2021 in accordance with the *Plan for the Independent Assessment of the U-233 Transfer Emergency Planning Hazards Assessment at the Oak Ridge National Laboratory*.

The DOE Oak Ridge Office of Environmental Management (OREM) and its management and operating contractor, Isotek Systems, LLC (Isotek), are responsible for the development of the all-hazards planning basis for U-233 processing. The all-hazards planning basis supports UT-Battelle in its emergency planning and response. ORNL uses a “lead and event contractor” concept of operations for emergency planning and response. UT-Battelle is the lead contractor, while other onsite contractors, including Isotek, are event contractors. As an event contractor, Isotek provides the results of its EPHAs to UT-Battelle for use in preparing ORNL for a potential emergency response. The significant elements for UT-Battelle to develop include response plans, emergency action levels (EALs), predetermined protective actions (PAs) or PA recommendations, and the emergency planning zone (EPZ).

EA’s assessment evaluated the effectiveness of both OREM and Isotek in developing and maintaining the all-hazards planning basis for the next phase of U-233 processing operations, known as the Initial Processing Campaign (IPC). The IPC involves receiving selected canisters of U-233 oxide from the Building 3019 Complex, processing this material into a form suitable for disposal while extracting thorium-229 for use in medical research/treatment, and packaging the waste product and extracted thorium product for offsite shipment. The unique properties of U-233 and associated daughter products require that the IPC activities be conducted in heavily shielded hot cells in Building 2026.

2.0 METHODOLOGY

The DOE independent oversight program is described in and governed by DOE Order 227.1A, *Independent Oversight Program*, which is implemented through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides. This report uses the terms “best practices, deficiencies, findings, and opportunities for improvement (OFIs)” as defined in the order.

As identified in the assessment plan, this assessment considered requirements related to DOE Order 151.1D, *Comprehensive Emergency Management System*. EA also used section 4.2, *All Hazards Planning Basis*, of EA Criteria and Review Approach Document 33-09, Rev. 0, *DOE O 151.1D Emergency Management Program*. EA also considered the guidance provided in DOE Guide 151.1-2, *Technical Planning Basis*.

EA examined key documents, such as Isotek’s procedures for developing and maintaining the HS and EPHA, the HS and EPHA covering U-233 processing, the documented safety analysis (DSA) for the IPC in Building 2026, and other relevant programmatic documentation supporting the preparation of the

all-hazards planning basis. EA interviewed key personnel responsible for U-233 processing operations and the development of all-hazards planning basis documents and performed a walkdown of the Building 2026 operating spaces. Appendix A lists the members of the assessment team, the Quality Review Board, and management responsible for independent oversight assessments.

There were no previous findings for follow-up addressed during this assessment.

3.0 RESULTS

3.1 Procedures

The objective of this portion of the assessment was to determine whether Isotek's procedures provide clear and appropriate guidance for developing, documenting, and maintaining the HS and EPHA, including identifying roles and responsibilities for review and approval.

EA reviewed Isotek's procedures ISO-EMP-203, *Emergency Management – All-Hazards Survey Instructions*, and ISO-EMP-202, *Emergency Planning Hazards Assessment Instructions*. These procedures are compliant with DOE Order 151.1D and provide clear guidance for developing, documenting, and maintaining the HS and EPHA, including identifying roles and responsibilities for review and approval.

The Isotek HS development and maintenance procedure provides a comprehensive, systematic process to identify, record, and screen facility hazards. The procedure provides adequate guidance on identifying and estimating the hazardous material release scenarios, both man-made and natural, in terms of type, quantity, and form of radioactive and other hazardous materials. The procedure provides a clear description of the hazardous materials screening process and its application to the hazardous materials in the facility for HS and EPHA development. The hazardous materials screening process requires the identification of all hazardous materials (e.g., radiological, chemical, explosives, hazardous biological agents and toxins) in a facility for a qualitative assessment based on DOE screening criteria.

The Isotek EPHA development and maintenance procedure provides accurate, complete guidance for preparing an EPHA that defines the provisions of the emergency management hazardous materials program as required by DOE Order 151.1D. The EPHA procedure requires a quantitative analysis of all hazardous materials identified for further analysis in the HS, provides correct criteria for excluding hazardous materials from further analysis in the EPHA, identifies receptors of interest, and provides source term determination instructions that effectively provide guidance on the establishment of conservative material-at-risk quantities. In addition, the EPHA procedure appropriately defines conservative and average meteorological conditions, includes PA guides for both radioactive and chemical hazardous materials, and identifies an appropriate modeling program (HotSpot) for analyzing hazardous material releases. Finally, the EPHA procedure effectively describes the establishment of a spectrum of potential emergency incident scenarios for analysis in the EPHA.

Both procedures appropriately require facility management and suitable technical expert involvement in developing, reviewing, and approving the HS and EPHA. Additionally, both procedures appropriately require review and approval of the HS and EPHA by the applicable Facility Manager, Environment Safety and Health Manager, Emergency Preparedness Coordinator, Nuclear Safety Manager, and others as determined necessary (e.g., Safety Analysis, Radiological Control) prior to being approved by OREM.

Furthermore, both procedures have adequate maintenance provisions that require the HS and EPHA to be reviewed after any update to the Isotek safety basis documents and updated prior to significant changes to

the facility/site or to hazardous material inventories, but not less than every three years as per the requirements in DOE Order 151.1D, attachment 4, section 2, paragraph o.

In summary, Isotek has prepared procedures that are compliant with DOE Order 151.1D and provide accurate, clear guidance for developing, documenting, and maintaining the all-hazards planning basis.

3.2 All-Hazards Survey

The objective of this portion of the assessment was to determine whether the HS prepared by Isotek and approved by OREM identifies all hazards that are applicable to U-233 processing operations and establishes the planning basis for the emergency management program.

Isotek prepared, and OREM approved, an HS consistent with DOE Order 151.1D and procedural requirements. The HS, ISO-EMP-HAZ-005, *All Hazards Survey for Building 2026 and the Building 3019 Complex*, accurately describes the current and planned IPC operations and hazards at Building 2026 and the Building 3019 Complex. The results of the HS are informative and technically sound, consistent with DOE guidance.

The Isotek HS identifies all hazards applicable to the operation of Building 2026 and the Building 3019 Complex, including chemical and radiological hazards. The HS documents that neither Building 2026 nor the Building 3019 Complex contains any biological agents or toxins. In addition, the HS effectively identifies and documents the generic types – natural, technical, and human-caused incidents – of serious emergency incidents or conditions to which Building 2026 and the Building 3019 Complex may be exposed, and documents the emergency management requirements that constitute the basis for the emergency management program. The hazardous materials and emergency conditions identified in the HS are consistent with the DSA for the IPC in Building 2026.

The HS includes screening of hazardous materials to identify those requiring quantitative analysis in an EPHA. The screening criteria meet the DOE Order 151.1D and procedural exclusion requirements as described in the HS development and maintenance procedure. All chemical hazards in Building 2026 were appropriately screened out from further evaluation. Radioactive aqueous solutions, sealed sources, and down-blended uranyl nitrate tanks with solidified uranium waste product were also properly screened out. The HS accurately identifies the following hazardous materials in Building 2026 that must undergo a quantitative analysis in an EPHA:

- Legacy radiological materials
- IPC canisters received from the Building 3019 Complex
- IPC debris waste and thorium product.

In summary, Isotek has effectively prepared, and OREM has approved, an HS for U-233 processing operations in Building 2026 and the Building 3019 Complex that is complete and accurate, identifies all applicable hazards, establishes the planning basis for the emergency management program, and complies with DOE Order 151.1D requirements.

3.3 Emergency Planning Hazards Assessment

The objective of this portion of the assessment was to determine whether the EPHA defines the provisions of the emergency management hazardous materials program and provides the basis for establishing a graded approach that meets the program requirements in DOE Order 151.1D, attachment 4, section 2.

Isotek prepared, and OREM approved, an EPHA consistent with DOE Order 151.1D and procedural requirements. The EPHA, ISO-EMP-600, *Emergency Planning Hazards Assessment for Building 2026*, used a comprehensive, systematic process to produce an EPHA to identify and analyze hazards associated with the transport and conversion of U-233 oxides into a form suitable for disposal while extracting thorium-229 for offsite use as a source material for medical isotope production. The Isotek EPHA contains a quantitative analysis of all hazardous materials identified for further analysis in the HS, and the assumptions made in the EPHA are consistent with operational activities and DSAs.

The facility and process description in the EPHA is consistent with the HS and DSA, and the EPHA contains a current and accurate compilation of hazardous material maximum quantities associated with U-233 processing operations in Building 2026. For the identified hazardous materials, accident scenarios were postulated that may result in consequences that exceed the PA criterion at downwind receptor locations of interest. The postulated scenarios include those occurring outside the buildings while in transport and inside Building 2026. For each scenario, consequence assessment results and a corresponding emergency classification are provided.

EA reviewed the EPHA and determined that the results are consistent with DOE guidance and are accurate and technically sound. EA determined that conservative assumptions are used and the calculations are accurate based on EA's replication of a sample of seven of 26 scenarios presented in the document using the HotSpot dispersion-modeling program. The EPHA clearly identified hazardous materials that were analyzed, how the results were formulated, and how the results relate to facility operations and configurations in a way that can be replicated and effectively used by UT-Battelle consequence assessment personnel during an Operational Emergency response.

Isotek developed an EPHA that analyzes a nearly comprehensive set of scenarios based on IPC operations. Isotek evaluated 26 scenarios in the EPHA ranging from low consequence and high probability to high consequence and low probability; however, one high-consequence and low -probability scenario was not included. Isotek did not address the potential for nuclear criticality in the EPHA. IPC operations involve an increase in the total amount of U-233 allowed in Building 2026 from 525 grams to 1,500 grams. As a result, the potential for a criticality incident exists. Isotek has developed and implemented a robust suite of engineered and administrative controls to ensure that operations in Building 2026 remain subcritical. DOE guidance and the EPHA procedure both indicate that emergency incidents or conditions are not excluded from analysis in the EPHA based solely on calculated occurrence probabilities or arbitrarily defined delimiters (e.g., credible or incredible, likely or unlikely). (See **OFI-Isotek-1**.)

In summary, Isotek has prepared, and OREM has approved, an EPHA for U-233 processing operations in Building 2026 that is technically accurate; effectively implements the EPHA requirements in DOE Order 151.1D; provides sufficient information to support EALs, PAs, and EPZ development; and provides necessary information for a consequence assessment team to replicate the analysis. Isotek has provided the results of the EPHA to the UT-Battelle emergency management organization for use in developing response plans, EALs, PAs, and EPZ sizing for Building 2026. Although a comprehensive set of scenarios were identified, Isotek did not address the potential for nuclear criticality in the EPHA.

4.0 BEST PRACTICES

There were no best practices identified as part of this assessment.

5.0 FINDINGS

There were no findings identified as part of this assessment.

6.0 DEFICIENCIES

There were no deficiencies identified as part of this assessment.

7.0 OPPORTUNITIES FOR IMPROVEMENT

EA identified one OFI to assist cognizant managers in improving programs and operations. While OFIs may identify potential solutions to findings and deficiencies identified in assessment reports, they may also address other conditions observed during the assessment process. OFIs are offered only as recommendations for line management consideration; they do not require formal resolution by management through a corrective action process and are not intended to be prescriptive or mandatory. Rather, they are suggestions that may assist site management in implementing best practices or provide potential solutions to issues identified during the assessment.

Isotek Systems, LLC

OFI-Isotek-1: Consider including nuclear criticality in the set of scenarios evaluated in the EPHA to ensure that appropriate planning is conducted for this low-probability, high-consequence incident.

Appendix A Supplemental Information

Dates of Assessment

Onsite Assessment: December 3, 2021

Office of Enterprise Assessments (EA) Management

John E. Dupuy, Director, Office of Enterprise Assessments
William F. West, Deputy Director, Office of Enterprise Assessments
Kevin G. Kilp, Director, Office of Environment, Safety and Health Assessments
David A. Young, Deputy Director, Office of Environment, Safety and Health Assessments
Kevin M. Witt, Director, Office of Nuclear Safety and Environmental Assessments
Charles C. Kreager, Director, Office of Worker Safety and Health Assessments
Jack E. Winston, Director, Office of Emergency Management Assessments
Joseph J. Waring, Director, Office of Nuclear Engineering and Safety Basis Assessments

Quality Review Board

William F. West, Advisor
Kevin G. Kilp, Chair
Jacob M. Miller
Tammy E. Perry
Michael A. Kilpatrick

EA Assessors

Jack E. Winston
Terrance J. Jackson
Robert F. Gee
Tom Rogers