TECHNICAL REVIEW OF ENVIRONMENTAL MONITORING PROGRAMS AT THE IDAHO NATIONAL LABORATORY IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

INTRODUCTION

Key Monitoring Area 4 (KMA 4) can be described as "environmental monitoring".

Technical Review Area for KMA 4

> "Closure and post-closure operations (until the end of active institutional controls, 100 years) will be monitored to ensure that the 10 CFR 61.43 performance objective (protection of individuals during operations) can be met. As part of this assessment radiation records, environmental monitoring, and exposure assessment calculations may be reviewed (NRC, 2007)."

KMA 4 in the NRC's Monitoring Plan for the Idaho Nuclear Technology and Engineering Center Tank Farm Facility (INTEC) addresses United States Department of Energy (DOE) compliance with the performance objective found in 10 CFR 61.43 related to protection of individuals during operations. To evaluate this performance objective the Idaho National Laboratory (INL) monitoring plan provides that NRC staff will review DOE worker radiation records, DOE's program to maintain worker doses as low as is reasonably achievable (ALARA), and offsite dose assessment methods and results. Technical review activities associated with protection of members of the public under KMA 4 discussed in this section include the review of information collected by various contractors monitoring the site, which is compiled and analyzed for DOE-Idaho by Gonzales-Stoller, LLC (GSS), as well as an independent monitoring program developed and executed by the Idaho Department of Environmental Quality (Idaho DEQ).

INTEC, established in the 1950s, was originally established for extracting reusable uranium from spent nuclear fuel. Reprocessing efforts, which ceased in 1992, ultimately recovered highly enriched uranium worth more than one-billion dollars. The highly radioactive liquid was solidified and is now stored in bins awaiting a final disposal location outside of Idaho. Although reprocessing activities are no longer performed on site, INTEC, operated by the Idaho Cleanup Project (ICP) contractor, continues to be involved in activities related to the storage and disposal of radioactive waste. Current activities focus on the storage of spent nuclear fuel (SNF) in a modern water basin and in dry storage facilities, management of high-level waste calcine- and sodium-bearing liquid waste, and the operation of the Idaho Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Disposal Facility (ICDF), which includes a landfill, evaporation ponds, and a storage and treatment facility.

INTEC includes multiple areas dedicated to various clean-up related tasks. These include:

- Fluorinel Dissolution Process and Fuel Storage Facility (FAST) – Consists of the SNF storage basin area and the Flourinel Dissolution Facility, which is currently being used for remote-handled transuranic waste management.

- Irradiated Fuel Storage Facility (IFSF) – Provides dry storage for SNF shipped from within the site as well as from offsite.

- Cask Pad and Rail Casks – Provides safe dry storage of SNF in transport casks staged on an asphalt pad and on a rail siding.

- TMI-2 Independent Spent Fuel Storage Installation – Also called the Independent Spent Fuel Storage Installation (ISFSI), this area is a U.S. Nuclear Regulatory Commission (NRC)-licensed dry storage area for SNF and debris from the Three Mile Island reactor accident. Fuel and debris from the accident were shipped to this location for examination, study, and storage. After examination, the SNF and debris were transferred to the ISFSI for safe, environmentally secure, above ground storage.

- Peach Bottom Fuel Storage Facility – This area consists of 193 below ground vaults of various sizes for dry storage of SNF.

- Sewage Treatment Plant and Percolation Ponds – The sewage treatment plant, located outside the INTEC security fence, treats and disposes of sanitary and other related wastes from INTEC using natural, biological, and physical processes (e.g., digestion, oxidation, photosynthesis, respiration, aeration, and evaporation). After treatment the effluent is combined with stormwater and stored in two unlined percolation ponds located at INTEC.

Independent monitoring programs developed and overseen by both GSS, a contractor to DOE, and Idaho DEQ survey the air, water, soil, vegetation, biota, and agricultural products to ensure that both past and current activities at INTEC do not adversely impact the environment or the health of humans or the biota on or around the site. Both programs develop quarterly and annual reports summarizing their findings. NRC staff reviewed these reports to confirm compliance with applicable laws and regulations. Since these reports cover the entire INL facility and are not focused specifically on the INTEC, NRC considers these to be a bounding analysis for the public.

Included below are summaries of the environmental monitoring reports from both GSS and Idaho DEQ for monitoring activities performed between January 2011 and September 2013.

SUMMARY OF THE IDAHO NATIONAL LABORATORY ANNUAL SITE ENVIRONMENTAL REPORTS COVERING CALENDAR YEAR 2011 AND CALENDAR YEAR 2012

INL's annual environmental monitoring report summarizes all of the monitoring activities performed by the different contractors at the various facilities throughout the site. Programs are set up throughout the site to monitor potential exposure pathways, including air, water, soil, plants, and animals that may transport radioactive material to nearby populations. Ultimately this report presents a general picture of the contamination throughout the entire INL site. Since this report includes data from other locations at INL beyond the INTEC any conclusions made from these findings should be considered bounding when evaluating the INTEC specifically.

AIR SAMPLING

An emphasis is placed on monitoring airborne radionuclides because air transport is considered to be the most likely pathway for exposing humans to INL site releases. These emissions, which include particulates and gaseous radionuclides (e.g., noble gases and iodines), are primarily associated with spent nuclear fuel management (e.g., fuel shipments, handling, and wet and dry storage) and liquid waste operations (e.g., Tank Farm Facility, Evaporator Tank System, Process Equipment Waste Evaporator, and Liquid Effluent Treatment and Disposal).

Air samples are collected and analyzed for gross alpha and gross beta activity. Charcoal cartridges are also collected and analyzed for radioiodine. Additional particulate samples are combined into composite samples to be analyzed for gamma-emitting radionuclides such as Cs-137 while particulate filters are composited and analyzed for specific alpha- and beta-emitting radionuclides like Sr-90, Pu-239/240, and Am-241.

Atmospheric moisture and precipitation samples are also collected throughout the site and analyzed for tritium. Although monitored, tritium is assumed to be present due to natural production in the atmosphere and is not the result of INL site releases.

In 2011 an estimated 3,520 curies of radioactivity was released as airborne effluents from INTEC. This release was primarily in the form of short-lived noble gas isotopes. The 2012 estimates were 2,930 curies. In both cases airborne releases from INTEC made up 47 percent of the annual airborne releases from INL. The radionuclide concentrations in ambient air samples were below DOE radiation protection standards and are consistent with measurements from previous years. No statistical differences were found between the gross alpha and gross beta concentrations measured in samples collected on the INL site, at the INL site boundary, and off the INL site. Further evaluation showed that trends appear to be seasonal in nature and are not impacted by current activities at INL.

Concentrations measured in atmospheric moisture and precipitation samples measured in 2011 and 2012 were also below DOE standards and consistent with past annual measurements. Tritium concentrations measured in these samples were also found to be consistent with natural production in the atmosphere and not the result of effluent releases.

Although not specific to INTEC, air sampling at INL did show increases in radionuclide concentrations that coincided with the passing of the contamination plume from the Fukushima reactor accident caused by the tsunami that struck the Fukushima Daiichi nuclear power plant in Japan on March 11, 2011. Positive I-131 detections were observed throughout INL starting the week of March 23, 2011 and ending April 20, 2011. All other I-131 sample concentrations reported during 2011 were below the measurement method detection limit. Site contractors also measured increases in Cs-134 and Cs-137 concentrations and found elevated weekly gross beta activity levels during the period from March 16, 2011 to March 30, 2011.

WATER SAMPLING

Water sampling is performed to ensure that effluents comply with DOE environmental regulations and objectives as well to support wastewater reuse permit requirements. Drinking water is regulated by the EPA and the state of Idaho and evaluated in the Idaho DEQ reports discussed below. Contractors monitor liquid effluents, drinking water, groundwater, and stormwater runoff at the INL site, primarily for nonradioactive constituents, to ensure compliance with applicable laws and regulations, DOE orders, and other requirements. Additional liquid effluent monitoring performed to comply with the environmental protection objectives of DOE Orders 458.1 (“Radiation Protection of the Public and the Environment”) showed all radioactive parameters below the health-based contaminant levels. Groundwater is primarily monitored in the vicinity of and downgradient of various liquid release locations on the site, which includes the percolation ponds located outside the INTEC fence. A groundwater plume of radionuclides resulting from wastewater injections that previously occurred at INTEC is also monitored. Surface water samples are collected when available.

Prior to 1984, INTEC used injection wells to dispose of wastewater containing elevated concentrations of numerous radionuclides, including H-3, Sr-90, and I-129. When direct injection ceased, INTEC wastewater was directed to shallow percolation ponds where the water infiltrated into the subsurface. These percolation ponds were replaced in 2002 with the new percolation ponds. Industrial wastewater associated with INTEC operations, which includes stream condensates, noncontact cooling water, water treatment effluents, boiler blowdown wastewater, stormwater, and volumes of other nonhazardous liquids, are also discharged to the new percolation ponds after being treated at the INTEC Sewage Treatment Plant.

As a result of these disposal activities groundwater monitoring is performed to evaluate the impacts associated with the wastewater that was either directed into the ground or seeped from the original percolation ponds. Results from analyses show that individual radionuclide concentrations remained constant or decreased from previous years. Groundwater samples collected in and around INTEC were found to have concentrations of Sr-90, Tc-99, and nitrate that, although showing stable or declining trends over the last few years, still exceeded drinking water maximum contaminant levels. Levels of U-235 have historically been at measured at levels slightly above background, which is consistent with the limited uranium impacts to groundwater associated with past operations at INTEC. Concentrations of I-129 and H-3 were also shown to be decreasing over time. In recent years two monitoring wells downgradient of INTEC have continually shown the highest tritium concentrations for the entire INL site. Although concentrations have been shown to be decreasing, these wells are considered to be representative of the maximum concentration for the entire aquifer.

Groundwater used for drinking water is evaluated separately. Drinking water for INTEC is supplied by two wells located north of the facility. All parameters monitored at INTEC were below their respective drinking water limits in 2011 and 2012. Based on the concentrations measured, a drinking water dose calculated for a worker who obtains all of their drinking water from groundwater on the site, an unlikely scenario, was 2.2×10^{-3} mSv/yr (0.22 mrem/yr) for 2011. In 2012 the drinking water dose was 2.1×10^{-3} mSv/yr (0.21 mrem/yr). Both of these doses are well below the EPA standard of 0.04 mSv/yr (4 mrem/yr) for public drinking water systems.

Surface water samples are also collected, when available, and analyzed. In 2011 surface water samples included concentrations Am-241, Pu-239/240, and Sr-90 that were within historical levels. Plutonium-238 was also questionably detected in three samples. However, the detected concentrations were at levels that do not pose a threat to human health or the environment. Samples collected in November 2012 were found to have gross beta activity, most likely due to natural decay products of thorium and uranium that dissolve into the water, and tritium. The tritium is assumed to be the result of atmospheric deposition. No gross alpha activity or human-made gamma-emitting radionuclides were detected from any of the surface water samples collected.

MONITORING ADDITIONAL EXPOSURE PATHWAYS

Other areas of monitoring include agricultural products (e.g., milk, lettuce, wheat, and potatoes), soil, and wildlife that may ultimately impact the dose to an individual. In the case of agricultural products and wildlife, not only do these analyses help to assess the impact of contaminants released to the environment by operations at INL but also provide assist in maintaining an understanding of the background concentrations for the site from year to year. Human-made radionuclides detected in the agricultural and wildlife samples were consistent with historical measurements and not directly linked to operations at the INL site. Measureable amounts of

Pu-238 and Sr-90 were reported in surface soil samples collected from several locations in the vicinity of the INTEC fence line. The ICP contractor has committed to monitoring these radionuclides to identify any trends.

CALCULATING DOSE

The Clean Air Act Assessment Package, 1988 (CAP-88) was used to calculate the dose to a hypothetical, maximally exposed individual (MEI) and demonstrate compliance with the Clean Air Act. The maximum calculated dose to the MEI was 4.6×10^{-4} mSv/yr (0.046 mrem/yr) and 3.6×10^{-4} mSv/yr (0.036 mrem/yr), respectively, for 2011 and 2012. Both values are well below the 0.1 mSv/yr (10 mrem/yr) standard established by the Clean Air Act. For comparison, the dose from natural background radiation was estimated to be 3.81 mSv/yr (381 mrem/yr) in 2011 and 3.90 mSv/yr (390 mrem/yr) in 2012.

The mesoscale diffusion (MDIFF) air dispersion model, which uses air dispersion estimates, was used to evaluate the dose to the population residing within an 80-km (50-mi) radius of any INL facility. In 2011 the calculated dose was 6.1×10^{-3} person-Sv (0.61 person-rem), which is below dose expected from an annual exposure to background radiation (1.164 person-Sv [116,399 person-rem]). In 2012 the calculated dose was 2.0×10^{-3} person-Sv (0.2 person-rem), which is below the expected annual exposure from background radiation of 1,208 person-Sv (120,795 person-rem)

The maximum potential individual doses from consumption of waterfowl and big game animals from INL for 2011, based on the highest concentrations of radionuclides measured in the samples collected on the site, were estimated to be 4×10^{-5} mSv/yr (0.004 mrem/yr) and 1.7×10^{-4} mSv/yr (0.017 mrem/year), respectively. When including the dose estimate for the air pathway (4.6×10^{-4} mSv/yr [0.046 mrem/yr]) the maximally exposed individual could potentially receive a total dose of 6.7×10^{-4} mSv/yr (0.067 mrem/yr). In 2012 the estimated dose from consumption of waterfowl and big game animals were 9×10^{-5} mSv/yr (0.009 mrem/yr) and 4.5×10^{-5} mSv/yr (0.045 mrem/yr), respectively. When including doses estimated for the air pathway the estimated dose to the MEI was 4.5×10^{-4} mSv/yr (0.045 mrem). Both doses are well below DOE's 1 mSv/yr (100 mrem/yr) health-based dose limit from all pathways for the INL site.

INTEC ONSITE ACTIVITIES

A wide range of activities occurred at the INTEC during 2011. These included:

- Decontamination and decommissioning crews completed demolition of seven facilities for a footprint reduction of 18,016 m^2 (193,923 ft^2), including the CPP-601 Fuel Reprocessing Complex and the CPP-602 Laboratory Building.

- The Irradiated Fuel Storage Facility (IFSF) received two shipments of spent nuclear fuel from domestic sources (one from onsite and one from Reed College) in 2011.

- Disposal of contaminated soil and debris in the landfill cell and liquid waste in the Idaho CERCLA Disposal Facility (ICDF) evaporation ponds.

- Remedial actions included reduction of approximately 10.5 million gallons of anthropogenic recharge to the northern perched water zones and installation of drainage ditches and low permeability pavement over the recharge control zone to direct surface runoff toward the Operable Unit 3.-14 evaporation pond and reduce water infiltration into the aquifer.

- Construction continued on the new Sodium-Bearing Waste Treatment Project facility with a goal of commencing steam reforming operations in fiscal year 2012.

Significant activities that occurred during 2012 include:

- ICP officially closed the D&D project, which included decontaminating and decommissioning 223 buildings and structures for a total footprint reduction of over 150,000 square meters (1.6 million square feet).

- The ICDF was put in standby mode until shipments of soil requiring disposal resume. The facility continued to receive liquid waste for disposal in the evaporation ponds.

- Remedial actions include reduction of approximately 9 million gallons of anthropogenic recharge to the northern perched water zones. Additional remedial actions were also taken to reduce the potential for water infiltration that could transport contaminants from the perched water to the underlying aquifer.

- ICP transferred 2 of 227 shipments of EBR-II SNF for processing.

- The Irradiated Fuel Storage Facility received shipments (one truck each) of foreign research reactor spent fuel from Mexico and Austria. One cask of lightly irradiated spent nuclear fuel was sent from storage at IFSF to Austria for reuse in a university reactor.

REPORTABLE RELEASES

On December 8, 2011, approximately 3.8 L (1 gal) of an oil/water mix was released to soil from a temporary air compressor used at the Idaho Waste Treatment Unit project at INTEC. The oil-stained soil was cleaned up and properly disposed. The volume of oil was less than the reporting threshold of 95 L (25 gal) but could not be cleaned up within twenty-four hours, as required by Idaho regulations. Therefore, the spill was reportable and notifications were made to external regulatory agencies.

There were no reportable releases in 2012.

SUMMARY OF THE IDAHO NATIONAL LABORATORY SITE OFFSITE ENVIRONMENTAL SURVEILLANCE PROGRAM REPORTS FOR QUARTERS 1, 2, AND 3 OF CALENDAR YEAR 2013

At the time that this report was developed INL had published the site's offsite environmental surveillance program quarterly reports for the first three quarters of the 2013 calendar year, covering January through September 2013. These reports document results from the monitoring program that evaluates the site's offsite environment. Specifically, these reports contain the results from:

- Atmospheric sampling, including atmospheric moisture,
- Water sampling, including precipitation, surface water, and drinking water,
- Environmental radiation measurements,
- Agricultural products such as milk, lettuce, and alfalfa, and
- Large game animals.

Findings to date are similar to those found previously. Radionuclide concentrations are comparable to concentrations measured at other locations throughout the western United States and were well below the standards set by DOE and the regulatory standards established by EPA for protection of the environment.

SUMMARY OF THE IDAHO NATIONAL LABORATORY ANNUAL SITE ENVIRONMENTAL REPORTS COVERING CALENDAR YEAR 2011 AND CALENDAR YEAR 2012

Idaho DEQ maintains an environmental surveillance program that analyzes samples (e.g., air, water [surface and groundwater], soil, and milk) on and around the INL site. This program helps to provide an independent evaluation of DOE's monitoring program as well as assesses potential environmental impacts from INL facilities.

Idaho DEQ found that radioactivity levels measured in air, soil, and milk samples during 2011 and 2012 were consistent with findings from previous years and were generally found to be typical of background values. The only exception was during March and April of 2011 when air and milk samples had elevated levels of some radionuclides (e.g., I-131) due to the Fukushima accident. As in previous years, groundwater samples collected near the southern boundary of the site were found to have elevated tritium concentrations. These elevated concentrations are the result of previous INL site operations and, although greater than the natural background levels, are less than 2 percent of the drinking water standard for tritium. No other contaminants attributable to past or current INL site operations were identified in groundwater samples collected outside the INL site. Water samples collected from locations near INL were found to have concentrations of Sr-90 and other contaminants that were greater than the drinking water standard but at concentrations consistent with historic trends. These water sources are not used by the public or INL workers and therefore are not considered to be an issue. Environmental measurements of radioactivity and direct radiation were generally consistent with background levels. Tritium was occasionally detected in atmospheric moisture samples collected both on-site and off-site at levels that were less than 1 percent of EPA regulatory limits. Radioactivity levels in the terrestrial environment and food chain remained at background based on soil and milk sampling results.

Other than the increase in radioactivity in air and milk samples associated with Fukushima, the environmental monitoring results for calendar year 2011 and calendar year 2012 were generally consistent with historic trends. These findings continue to be comparable with results provided in DOE's environmental monitoring reports for INL.

SUMMARY OF THE IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY ENVIRONMENTAL SURVEILLANCE PROGRAM REPORTS FOR QUARTERS 1 AND 2 OF CALENDAR YEAR 2013

At the time that this report was developed Idaho DEQ had published the 2013 environmental surveillance quarterly reports for quarters 1 and 2, covering January through June 2013. A

review of these reports showed that, in general, the monitoring results were similar to the trends discussed in the previous annual reports.

FINDINGS AND RECOMMENDATIONS

Other than some increases in radioactivity levels detected during March and April of 2011 due to the Fukushima accident, NRC finds the monitoring results presented in these monitoring reports to be consistent with monitoring reports reviewed in previous years. In general, radioactivity levels remained the same or continued to decrease. The consistency between the data collected by DOE and Idaho DEQ provides confidence that both programs can be used to evaluate offsite environmental impacts associated with both past and current INL operations.

Based on the findings from this review and those from previous years, NRC staff have decided that it is no longer necessary to perform a separate annual review of the environmental monitoring programs and exposure assessment calculations associated with INL. NRC staff will continue to include environmental monitoring and exposure assessments as part of the onsite observations. DOE should continue to provide information to the NRC on specific violations of requirements related to workers and the general public (10 CFR Part 835 or DOE Order 5400.5) during its waste disposal operations as well as other environmental monitoring issues that may be of concern. This includes information regarding worker or public dose exceedance within a reasonable timeframe of their occurrences.

REFERENCES

DOE/ID-12082(12) ISSN 1089-5469 GSS-ESER-171. Idaho National Laboratory Site Environmental Report Calendar Year 2012. Environmental Surveillance, Education and Research Program, U.S. Department of Energy Idaho Operations Office, September 2013. http://www.gsseser.com/Annuals/2012/ReportIndex.htm

DOE/ID-12082(11) ISSN 1089-5469 GSS-ESER-159. Idaho National Laboratory Site Environmental Report Calendar Year 2010. Environmental Surveillance, Education and Research Program, U.S. Department of Energy Idaho Operations Office, September 2012. http://www.gsseser.com/Annuals/2011/ReportIndex.htm

GSS-ESER-170. Idaho National Laboratory Site Offsite Environmental Surveillance Program Report: First Quarter 2013. Environmental Surveillance, Education and Research Program, U.S. Department of Energy Idaho Operations Office, September 2013. http://www.gsseser.com/Quarterlies/2013Q1/2013Q1Report.pdf

GSS-ESER-172. Idaho National Laboratory Site Offsite Environmental Surveillance Program Report: Second Quarter 2013. Environmental Surveillance, Education and Research Program, U.S. Department of Energy Idaho Operations Office, November 2013. http://www.gsseser.com/Quarterlies/2013Q2/2013Q2Report.pdf

GSS-ESER-173. Idaho National Laboratory Site Offsite Environmental Surveillance Program Report: Third Quarter 2013. Environmental Surveillance, Education and Research Program, U.S. Department of Energy Idaho Operations Office, February 2014. http://www.gsseser.com/Quarterlies/2013Q3/2013Q3Report.pdf

Idaho DEQ, 2012. DEQ-INL Oversight Program Annual Report 2011. Department of Environmental Quality, Idaho National Oversight Program.

http://www.deq.idaho.gov/media/935500-inl_oversight_program_annual_report_2011.pdf

Idaho DEQ, 2013. DEQ-INL Oversight Program Annual Report 2012. Department of Environmental Quality, Idaho National Oversight Program. http://www.deq.idaho.gov/media/1063129-inl_oversight_program_annual_report_2012.pdf

Idaho DEQ, 2013. Environmental Surveillance Program Quarterly Report, January – March 2013. Department of Environmental Quality, Idaho National Oversight Program. http://www.deq.idaho.gov/media/1041796-inl_oversight_program_quarterly_report_january_march_2013.pdf

Idaho DEQ, 2013. Environmental Surveillance Program Quarterly Report, April – June 2013. Department of Environmental Quality, Idaho National Oversight Program. http://www.deq.idaho.gov/media/1087847-inl_oversight_program_quarterly_report_april_june_2013.pdf

Idaho DEQ, 2013. Environmental Surveillance Program Quarterly Report, July – September 2013. Department of Environmental Quality, Idaho National Oversight Program. http://www.deq.idaho.gov/media/1112/inl-oversight-program-quarterly-report-july-september-2013.pdf