International Isotopes Fluorine Products

International Isotopes Fluorine Products, Inc. (IIFP)
A Wholly Owned Subsidiary of
International Isotopes, Inc. (INIS)

# Fluorine Extraction Process & Depleted Uranium De-conversion (FEP/DUP) Plant

# License Application

## Chapter 6
## Chemical Process Safety

Revision B
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# 6 CHEMICAL PROCESS SAFETY

International Isotopes Fluorine Products, Inc. (IIFP), a wholly owned subsidiary of International Isotopes, Inc. (INIS), will build and operate a depleted uranium processing facility near Hobbs in Lea County, New Mexico. The IIFP Facility that is also referred to as the FEP/DUP Plant is being licensed under Title 10 Code of Federal Regulations (CFR) Part 40. A summary description of the planned facility is provided in the IIFP License Application (LA), Revision B Chapter 1 “General Information.”

This Chapter 6 of the IIFP LA describes the chemical classification process, the hazards of process chemicals of concern, process interactions with chemicals affecting licensed materials and/or hazardous chemicals produced from licensed material. It also describes the methodology for evaluating hazardous chemical consequences and the chemical safety assurance features.

The IIFP Chemical Process Safety (CPS) Program has been developed consistent with the guidance in Chapter 6 of NUREG-1520, “Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility,” U.S. Nuclear Regulatory Commission (NRC, 2002), NUREG-1513, “Integrated Safety Analysis Guidance Document,” (NRC, 2001), NUREG-1601, “Chemical Process Safety at Fuel Cycle Facilities,” (NRC, 1997a), NUREG/CR-6410, “Nuclear Fuel Cycle Facility Accident Analysis Handbook,” (NRC, 1998) and NUREG/CR-6481, “Review of Models Used for Determining Consequences of $UF_6$ Release,” (NRC, 1997b). The CPS Program also complies with 10 CFR 70.61, “Performance Requirements,” (CFR, 2009a), 10 CFR 70.62, “Safety Program and Integrated Safety Analysis,” (CFR, 2009b), 10 CFR 70.64, “Requirements for New Facilities or New Processes at Existing Facilities,” (CFR, 2009c) and other applicable 10 CFR 70, Subpart H requirements.

## 6.1 PROCESS CHEMICAL HAZARDS

Throughout Chapter 6, in the discussion of the chemical aspects of uranium hexafluoride ($UF_6$), uranium tetrafluoride ($UF_4$) and uranium oxide ($UO_2$ or $U_3O_8$), the conventional chemical formula is used frequently rather than always referring to those as the “depleted” assay uranium compounds. The associated hazards are the same except that depleted uranium materials would exhibit lower radioactivity levels than would natural or enriched uranium materials.

The chemical process hazards associated with the IIFP Facility involve the processing, handling, packaging and storage of chemical materials, including:

- Depleted uranium hexafluoride ($DUF_6$)
- Depleted uranium oxides (likely a mix of $DUO_2$ and the higher oxide states including $DU_3O_8$)
- Depleted uranium tetrafluoride ($DUF_4$)
- Anhydrous hydrofluoric acid (AHF) and hydrofluoric acid (HF)
- Hydrogen ($H_2$)
- Potassium hydroxide (KOH)
- Diboron trioxide ($B_2O_3$) and Silicon dioxide ($SiO_2$)
- Calcium fluoride ($CaF_2$)
- Boron trifluoride ($BF_3$) and silicon tetrafluoride ($SiF_4$)
- Other hazardous chemicals such as depleted uranyl fluoride ($DUO_2F_2$) that could be produced during accident sequences.

The detailed chemical reaction processes are described in the IIFP LA, Revision B Integrated Safety Analysis (ISA) Summary Section 3. The process buildings are discussed in the LA, Revision B Chapter 1 Section 1.1.2.

At the IIFP Facility, the Fluorine Extraction Process (FEP) Product Storage and Packaging Building, the AHF Staging Containment Building and the Fluoride Products Trailer Loading Building and equipment within these buildings are separated physically from areas involving licensed materials. These buildings are also equipped with ventilation systems that are separate from the licensed material process building systems. The AHF, $SiF_4$ and $BF_3$ chemicals stored and handled in these buildings have been chemically separated from licensed materials through several process separation stages. The $BF_3$ and $SiF_4$ products, although produced from fluorine extracted from $DUF_4$, have been purified before being transferred to these storage and packaging areas. A Process Hazards Analysis (PHA) is conducted for chemicals and equipment in these areas to ensure safe design relative to industrial chemical safety, but the safety analysis and design for controls in these areas are outside the ISA envelope.

A summary of the major process hazardous chemicals is provided below. Detailed hazard data will be contained in the facility Material Safety Data Sheet (MSDS) information and documents and be available to employees and contractors prior to bringing hazardous chemicals onto the IIFP Site.

$DUF_6$ is source material received at the IIFP Facility and used to produce $DUF_4$. It is received at the IIFP Facility in approved shipping cylinders that contain the material in solid state. The cylinders are heated inside containment-type autoclaves to vaporize the $DUF_6$ that is fed to the reaction vessel used for $DUF_4$ production. The uranium component of the compound is radioactive and decays into a series of other radioactive elements emitting low levels of radiation. If $DUF_6$ is released to the atmosphere, the compounds $DUO_2F_2$ and HF are produced by reaction with moisture in the air. The chemical hazard of $UF_6$ greatly exceeds the radiation hazard. Uranium hexafluoride has a Threshold Limit Value (TLV) of 0.2 mg/m$^3$ as uranium and 2.5 mg/m$^3$ as fluoride and a Permissible Exposure Limit (PEL) of 0.05 mg/m$^3$ as uranium (soluble), 0.25mg/m$^3$ as uranium (insoluble) and 2.5 mg/m$^3$ as fluoride (NIH, 2011).

$DUO_2F_2$ (uranium oxyfluoride; often referred to as uranyl fluoride) is not a normally used chemical at IIFP but may be formed in the event of a $DUF_6$ accidental leak or release by the reaction of the $UF_6$ with moisture in the atmosphere. It usually forms as a dense white finely sized particle and resembles white smoke. It may collect around any leak area as a white-to-pale yellow powder. It is very soluble in water. The TLV is the same as $UF_6$ for uranium and fluoride. The PEL is 0.05 mg/m3 as soluble uranium (NIH, 2011).

Uranium oxides are a by-product solid generated at the IIFP Facility from the reaction of $SiO_2$ with $DUF_4$ or $B_2O_3$ with $DUF_4$. The depleted uranium oxides can be a mixture of the lower oxide uranium ($UO_2$) up to the higher oxide state ($U_3O_8$) depending on the formation reaction conditions. For the substance $UO_2$, very fine particles (0.2-0.3 micrometers) may spontaneously react and ignite in air at elevated temperatures (300-700$^o$C) to form the higher state $U_3O_8$. The rate of this reaction is a function of particle size. The temperature requirement for spontaneous reaction will change accordingly (ORNL, 2000). Uranium oxides can be irritating to the eyes and be absorbed into the body if inhaled or ingested. The lungs may be affected by repeated or prolonged exposure to the dust particles. The uranium oxides have similar TLV and PEL values of the uranium component of uranium hexafluoride (NIH, 2011).

$DUF_4$ is the intermediate product generated at the IIFP Facility from the reaction of $DUF_6 + H_2$. It is a green, nonvolatile odorless crystalline solid that is nearly insoluble in water. It is used in the IIFP Fluorine Extraction Process as a major raw material to generate $SiF_4$ and $BF_3$. It can be harmful by inhalation, ingestion and through prolonged skin contact. $DUF_4$ has similar TLV and PEL values as uranium hexafluoride (NIH, 2011).

AHF is a by-product generated at the IIFP Facility from the reaction of $DUF_6 + H_2$. Hydrofluoric acid can also be present in a form that is not anhydrous and containing different percentage amounts of water. The reaction of $DUF_6$, $SiF_4$ or $BF_3$ with moisture in the atmosphere or with water produces HF. HF is very toxic by inhalation. If HF comes in contact with the skin or if it is swallowed it causes severe burns. Inhalation of vapors in high concentration may cause shortness of breath (lung edema). HF is fibrogenic to the lungs in the context of an acute inhalation exposure complicated by potential of bronchiolitis obliterans. Ingestion causes burns of the upper digestive and respiratory tracts. When there is dermal exposure, HF penetrates the skin and without treatment can attack underlying tissues and bone. There is a risk of serious damage to eyes. Hydrogen fluoride is nonflammable. The gas has a pungent acid-like odor. MSDS information and medical treatment procedures for skin exposure are available and well known within the HF chemical industry. AHF has a TLV of 0.5 ppm as fluoride and a PEL of 3 ppm as fluoride (NIH, 2011).

$H_2$ gas is a feedstock chemical generated in a packaged unit on an as-demand basis at the IIFP Facility. It is reacted with $DUF_6$ in the de-conversion process to produce HF and $DUF_4$. Hydrogen poses a hazard to human safety from potential detonations and fires when mixed with air. Inhalation of air containing a high concentration of hydrogen can cause asphyxiation. Hydrogen is explosive and highly flammable (NIH, 2011).

$BF_3$ is a product generated at the IIFP Facility from the reaction of $B_2O_3 + DUF_4$. Boron trifluoride is a colorless gas with a pungent suffocating odor. It forms dense white fumes in moist air and is corrosive and can cause irritation of eye, nose, throat and skin. Acute toxicity may lead to hypoxemia or lung edema. It decomposes on contact with water forming toxic and corrosive hydrogen fluoride, fluoroboric acid and boric acid. The U.S. Occupational Safety and Health Administration (OSHA) PEL ceiling value is 1 ppm (NIH, 2011).

$SiF_4$ is a product generated at the IIFP Facility from the reaction of $SiO_2 + DUF_4$. The substance is a colorless gas with a pungent suffocating odor and fumes strongly in air. $SiF_4$ is noncombustible but decomposes on heating producing toxic and corrosive fumes including hydrogen fluoride. It reacts with water to form hydrogen fluoride and fluorosilicic acid. It attacks many metals in the presence of water releasing hydrogen. The substance is corrosive to the eyes, the skin and the respiratory tract. Inhalation of this gas may cause lung edema. The TLV and the PEL are both published at 2.5 $mg/m^3$ as fluoride (NIH, 2011).

$B_2O_3$ is a feedstock chemical received at the IIFP Facility and used to generate $BF_3$. The substance is colorless, semitransparent lumps or hard white odorless crystals. It is an eye, skin and respiratory irritant. The substance is very hazardous in case of ingestion. The boron component is considered to have hepatotoxin secondary effects. The TLV is 10 $mg/m^3$ and the PEL is 15 $mg/m^3$, total dust (NIH, 2011).

$SiO_2$ (either as amorphous or crystalline) is a feedstock chemical received at the IIFP Facility used to generate $SiF_4$. Amorphous $SiO_2$ is a transparent to gray color odorless powder. Inhaling finely divided crystalline silica dust in very small quantities over time can lead to silicosis, bronchitis or cancer. Amorphous silica has slightly different properties from those of crystalline silica and is generally considered to be less hazardous. The substance is non-flammable, inert and harmless (except for inhalation over time). The TLV for the more hazardous crystalline form is 0.02 $mg/m^3$; respiratory fraction (NIH, 2011).

Potassium hydroxide solution is used as a scrubbing media in the Plant KOH Scrubbing System with concentrations ranging from 2-20%. It is received in tank trucks as a solution at concentrations near 45% and loaded into the KOH inventory holding tank. It is diluted for recharging the scrubbing system when necessary. Most of the KOH in the inventory is from the regeneration of spent scrubber solution to a 15-25% concentration range for recycling back to the facility scrubbing system. Occasionally, a fresh charge of 45% KOH is made to the scrubbing system as needed and that material is transferred from the KOH inventory holding tank. KOH (45% solution) is a clear, colorless liquid with a boiling point of slightly above $212^{o}$F. It is stable under normal temperatures and pressures. It reacts with acids, organic materials, nitro compounds, acrolein, halogens, anhydrides, phosphorous and metals that react with water. Decomposition products are generally potassium oxide and hydrogen gas. KOH can cause severe eye and skin burns and if ingested can cause burns and perforations internally. Inhalation of the aerosol may lead to chemical pneumonitis and pulmonary edema. Prolonged or repeated skin contact may cause dermatitis. The American Conference of Governmental Industrial Hygienists (ACGIH) exposure assessment ceiling value is 2 $mg/m^3$ (NIH, 2011).

$CaF_2$ is produced in the Environmental Protection Process (EPP) as a result of treating fluoride bearing liquors with hydrated lime (calcium hydroxide). It is a gray to white powder that is only slightly soluble in water. It reacts with concentrated acids to liberate HF. The TLV and PEL are both published at 2.5 mg/m3 as fluoride. It is considered of “little acute toxicity” and is stable unless heated to $1200^{0}$C or mixed with concentrated acids (NIH, 2011).

## 6.2 PROCESS CHEMICAL RISK AND ACCIDENT SEQUENCES

The IIFP workplace environmental, safety and health programs are intended to minimize the risk of chemical exposure from licensed material and other hazardous chemicals to employees, the public and the environment. This is accomplished through the controls resulting from the ISA where licensed materials are involved and through the implementation of the CPS Program. The Program will be documented in an implementation plan and in written procedures that ensure processes and operations comply with applicable federal and state regulations pertaining to chemical safety. The CPS Program incorporates and satisfies the requirements of the OSHA, “Process Safety Management of Highly Hazardous Chemicals,” (PSM) (CFR, 2009f).

This section discusses chemical safety issues related to: 1) radiation risks of licensed materials, 2) chemical risks of licensed materials and hazardous chemicals produced from licensed material and 3) facility conditions that may affect the safety of licensed material resulting in an increased risk to workers, the public or the environment. In the PHA of the ISA, these chemical hazards, where applicable as part of licensed materials or affecting licensed materials, are treated with the same analysis rigor as radiological hazards and have included engineered controls or prevention measures to meet or exceed acceptable risk determined in the ISA Summary, Revision B.

### 6.2.1 Process Descriptions

The facility process descriptions are provided in the ISA Summary, Revision B Section 3. The descriptions provide a basic understanding of the chemical process hazards (including radiological hazards caused by, or involving, chemical accidents) and allow development of potential accident scenarios. Summaries of the process descriptions are also included in LA, Revision B Chapter 1.

### 6.2.2 Consequences and Likelihoods of Accident Sequences

An ISA has been performed as required by 10 CFR 70.62 (CFR, 2009b). The ISA Summary, Revision B provides a list of the accident sequences that have the potential to result in radiological and non-radiological releases of chemicals and provides estimates for the likelihood and consequence of each accident identified. The ISA Summary also identifies the engineering and/or administrative controls for each accident sequence of significance. These controls are intended to satisfy the Baseline Design Criteria (BDC) in 10 CFR 70.64 (CFR, 2009c) and performance requirements in 10 CFR 70.61 (CFR, 2009a) by applying defense-in-depth techniques to high-risk chemical release scenarios. The ISA provides sufficient quantities and types of controls so that engineered controls and prevention measures will satisfactorily perform their safety function and purpose when needed.

Accident sequences involving licensed materials and those chemicals that may impact licensed materials have been analyzed in the ISA and are presented in the ISA Summary, Revision B. The accident sequences identified by the ISA were categorized into one of three consequence categories (high, intermediate or low) based on their radiological, chemical and/or environmental impacts.

The radiological and chemical consequence severity limits for the high and intermediate categories, defined by 10 CFR 70.61 (CFR, 2009a), are presented in Table 6-1 “Chemical Consequence Severity Levels.” The ISA considers the potential interactions of process chemicals with confinement vessels and with process equipment in which initiating events incorporate releases of $DUF_6$ from equipment, including vessels, pipes, valves and cylinders. Interactions between process chemicals and personnel are considered both in the ISA and during the preparation of facility operating procedures to include industrial safety practices.

**Table 6-1 Chemical Consequence Severity Levels (Defined by 10 CFR 70.61)**

| Consequence | Workers | Offsite Public | Environment |
|---|---|---|---|
| **High** | Radiological dose greater than 1 Sv (100 rem)<br><br>Chemical exposure greater than AEGL-3 (for accident specific exposure time)<br><br>A criticality accident occurs | Radiological dose greater than 0.25 Sv (25 rem)<br>30 mg soluble uranium intake<br><br>Chemical exposure greater than AEGL-2 (30 minute exposure)<br><br>A criticality accident occurs | A criticality accident occurs |
| **Intermediate** | Radiological dose greater than 0.25 Sv (25 rem) but less than or equal to 1 Sv (100 rem)<br><br>Chemical exposure greater than AEGL-2 but less than or equal to AEGL-3 (for accident specific exposure time) | Radiological dose greater than 0.05 Sv (5 rem) but less than or equal to 0.25 Sv (25 rem)<br><br>Chemical exposure greater than AEGL-1 but less than or equal to AEGL-2 (30 minute exposure) | Radioactive release greater than 5,000 times 10 CFR 20, Appendix B, Table 2 (CFR, 2009d) |

The measures to mitigate the consequences of accident sequences identified in the ISA Summary are consistent with protective actions described in Revision B of the IIFP Emergency Management Plan (EMP) and its implementing procedures.

In addition to the chemical exposure criteria, the ISA considered the skin exposure to HF. In the absence of an authoritative quantitative standard for HF dermal exposure, the ISA considered that HF exposure consequences would be bounded by identification and use of Items Relied on for Safety (IROFS) for the consequences of the inhalation exposure pathway to the worker or the public.

The ISA basis for HF exposure consequence analysis, prevention and mitigation is discussed in Section 4.1.2 "Consequence Analysis" of the IIFP ISA Summary, Revision B.

### 6.2.3 Chemical Release Scenario Techniques and Assumptions

The techniques and assumptions used to estimate the concentrations or to predict the toxic "footprint" for potential releases of hazardous chemicals to workers and the public produced by licensed material, or by abnormal facility conditions that could affect the safety of licensed materials, are described in the following sections.

#### 6.2.3.1 Worker Exposure

Any release from $UF_6$ systems and/or cylinders at the IIFP Facility would predominately consist of HF, $UO_2F_2$ and potentially lesser quantities of $UF_6$. Other sources of HF could result from by-product reaction of $SiF_4$ and $BF_3$ with water following a release. These releases would cause a visible cloud and a pungent odor. HF has a strong irritating odor that is discernable at concentrations of about 0.04 ppm (ATSDR, 2009). The irritating effects of HF are typically intolerable at concentrations well below those that cause permanent injury or which produce escape impairing symptoms.

Workers are trained in proper response actions, i.e., escape a release upon sensing initial HF effects. For the purpose of evaluating personnel exposure in cases where a worker would be expected to be in the immediate proximity of a release, worker exposures were assessed based on the amount of time required for the worker to conservatively evacuate the airborne material released from a hazardous material leak.

Once a release is detected the worker is required by procedure and training to evacuate the area of concern. A conservative sufficient time is available for the worker to reliably detect and evacuate the area of concern to avoid permanent injury.

Public exposures were estimated to last for 30-minutes duration. Acute Exposure Guideline Levels (AEGL) values have been used for HF, $UF_6$ and hazardous chemical assessments (EPA, 2009a). Table 6-2, "Chemical Consequence Values" shows the numeric values used as chemical consequence thresholds.

**Table 6-2 Chemical Consequence Values**

| Consequence | Workers | Offsite Public | Environment |
|---|---|---|---|
| **Category 3 High** | Soluble U intake > 75 mg<br>HF > 170 ppm<br>$UF_6$ > 216 mg/m$^3$ | Soluble U intake > 30 mg<br>HF >34 ppm<br>$UF_6$ >19 mg/m$^3$ | N/A |
| **Category 2 Intermediate** | HF > 95 but ≤ 170 ppm<br>$UF_6$ > 28 but ≤ 216 mg/m$^3$ | HF> 1 but ≤ 34 ppm<br>$UF_6$ > 3.6 but ≤ 19 mg/m$^3$ | Radioactive release>5000 times of 10 CFR 20, Appendix B, Table 2 (CFR, 2009d) |
| **Category 1 Low** | Accidents of lower radiological and chemical exposures than those above. | Accidents of lower radiological and chemical exposures than those above. | Radioactive releases with lower effects than those above. |

#### 6.2.3.2 Public Exposure

Potential exposures to the public were evaluated using conservative assumptions for both exposure concentrations and durations. Exposure was evaluated for consequence severity against chemotoxic, radiotoxic and radiological dose. Public exposures were estimated for durations of thirty (30) minutes. This is consistent with self protection criteria for $UF_6$/HF plumes listed in NUREG-1140, "A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licensees," (NRC, 1988).

### 6.2.4 Source Term and Dispersion Models

The methodologies used to determine the source term are those prescribed in NUREG/CR-6410, "Nuclear Fuel Cycle Facility Accident Analysis Handbook," (NRC, 1998) and supporting documents. The specific modeling methods utilized follow consistent and conservative methods for source term determination, release fraction, dispersion factors and meteorological conditions. For releases inside of buildings, conservative leak path fractions were assumed as recommended by NUREG/CR-6410.

### 6.2.5 Description of Chemical Dispersion Models

The computer code used in chemical consequence analyses is HGSYSTEM version 3.0. (NTIS, 1995). It is widely accepted by the nuclear industry as appropriate for chemical dispersion modeling. A more detailed description of HGSYSTEM analysis is provided in the ISA Summary, Revision B.

### 6.2.6 Chemical Exposure Standards

To quantify criteria of 10 CFR 70.61 (CFR, 2009a) for chemical exposure, standards for each applicable hazardous chemical must be applied to determine exposure that could endanger the life of a worker, lead to irreversible or other serious long term health effects in an individual and cause mild transient health effects to an individual. Exposure standards include the AEGLs established by the "National Advisory Committee for Acute Exposure Guideline Levels for Hazardous Substance," (EPA, 2009a). The IIFP Facility uses the AEGL standard to assess the consequences of postulated chemical releases. The accident sequences resulting in chemical consequences exceeding the criteria in 10 CFR 70.61 involves the release of $UF_6$ and its hydrolysis products HF and $UO_2F_2$. These accident sequences are presented in the ISA Summary, Revision B.

In normal operations, AHF is produced as a result of the reaction between $DUF_6$ and $H_2$. The AHF product is transferred to storage vessels and ultimately to containers for sale of this by-product to customers. Potential exposure to HF for these processes is discussed in the ISA Summary, Revision B.

## 6.3 ITEMS RELIED ON FOR SAFETY AND MANAGEMENT MEASURES

This section describes the identification of chemical process IROFS and their associated management measures.

### 6.3.1 Chemical Safety Approach

The ISA Summary, Revision B describes the basis for providing successive levels of protection such that health and safety of employees and the public is ensured within the acceptable risks determined by the ISA structured risk analyses. Additionally, in many and most parts of the processes, safety is further assured by added measures through implementation of designed operational control features and the defense-in-depth engineering design philosophy. Section 6.3.2 below provides further description of defense-in-depth and operational control measures.

In addition to the safe design features, the schemes employed to ensure safe operation of the facility include management measures that provide for the reliability of IROFS. These measures include a risk-based graded approach for the application of configuration management (CM), maintenance, procedures, training, audits/ assessments, emergency planning, incident investigation, human factors, records and reporting. Management measures are fully described in LA, Revision B Chapter 11 “Management Measures.” The IIFP Facility management is committed to identifying and correcting any unacceptable performance deficiencies and to maintain chemical process safety records.

#### 6.3.1.1 Chemical Process Safety Program

The Chemical Process Safety (CPS) Program is applicable to the chemicals associated with the authorized activities described in LA, Revision B Chapter 1 and includes $UF_6$, HF, as well as other hazardous chemicals associated with licensed material activities. The CPS Program provides oversight of the handling, use and storage of chemicals at the IIFP Facility.

The CPS Program development, maintenance and oversight are the responsibility of the Environmental, Safety and Health (ESH) organization. Its implementation overlaps with several other disciplines including: Operations, Maintenance, Radiation Protection, Emergency Preparedness/Security, Environmental Protection and Industrial Safety/Industrial Hygiene. Prior to starting a new activity involving chemicals, a Job Hazards Analysis (JHA) is performed to ensure that the work is conducted safely and that appropriate training, authorizations and procedures are completed. This ensures that appropriate controls are in place for adequate protection of the general public and safe use by employees and that the use of chemicals does not create potential conditions that have not been evaluated in the ISA or could adversely affect the handling of licensed materials. Employees and contractors using hazardous materials are trained to ensure safe handling, use and disposal. The IIFP Site emergency response team is prepared to respond to various emergency conditions, including a chemical accident.

ESH management reviews and approves JHAs prior to initial issuance. The review and approval is to affirm that the radiation, chemical, process, fire and explosion risks associated with the process or facility under evaluation are understood and that proper safety measures are in place. LA, Revision B Chapter 2

“Organization and Administration” contains a description of the IIFP Facility Organization, including the responsibilities of the ESH Manager.

The IIFP Facility satisfies the OSHA Process Safety Management (PSM) initial requirement on process safety information through the ISA work for NRC licensing and the CPS Program. NRC requirements for maintaining and updating process safety information are also utilized to maintain compliance with this aspect of the PSM requirements. For chemical hazards associated with materials that have been separated from licensed materials, the IIFP Facility will apply standard OSHA PSM requirements to evaluate and control the hazard and risk associated with these chemicals. The IIFP Facility uses a graded approach in meeting requirements of the PSM standard by identifying applicable areas requiring PSM and applying the program to those specific areas based on the process safety information.

The IIFP Facility will develop a thorough, orderly, systematic approach for identifying, evaluating and controlling processes involving highly hazardous chemicals. An implementation plan will be prepared and used by the IIFP Facility to develop procedures for meeting requirements in each of the program elements and applicable plant process areas. The program development and implementation will be incorporated into other plant-related systems, such as emergency procedures and response, contractor orientation/training and change management as appropriate.

Procedures and training programs will be developed and utilized by the IIFP Facility for process safety, plant operations and maintenance. CPS requirements will be addressed in plant ESH procedures and incorporated into specific operation and maintenance procedures.

The mechanical integrity element of OSHA PSM requires that equipment used to process, store or handle highly hazardous chemicals be designed, installed and maintained to minimize the risk of release of such chemicals. The IIFP Facility will have a mechanical integrity program in place to assure the continued integrity of process equipment. The components of the mechanical integrity program include:

- Identification and categorization of equipment and instrumentation
- Development of written maintenance procedures
- Training for process maintenance activities
- Inspection and testing
- Correction of deficiencies in equipment that are outside acceptable limits defined by the process safety information
- Use of the appropriate level of quality assurance to maintain mechanical integrity for safety controls and process systems

Portions of OSHA PSM mechanical integrity requirements are met through implementation of programs designed to comply with the IIFP ISA, Revision B requirements. Specific baselines and periodic tests and inspections for mechanical integrity are included in the facility Preventive Maintenance Program and procedures.

The IIFP Facility takes immediate action when there is a leak or accident involving highly hazardous chemicals. The IIFP Facility establishes and implements an Emergency Management Plan in accordance with the provisions of 29 CFR 1910.38(a), “Emergency Action Plans,” (CFR, 2009h) including procedures for handling small releases. The IIFP Facility incorporates applicable provisions of the “Hazardous Waste and Emergency Response Standard,” 29 CFR 1910.120(a), (p) and (q) (CFR, 2009i) into the EMP through the Emergency Management Plan Implementing Procedures (EPIPs).

A Spill Prevention, Control and Countermeasure (SPCC) Plan will be implemented during construction to minimize both the possibility of spills of hazardous substances and to minimize the environmental impact in the event that spills occur. The SPCC Plan will continue to be in effect throughout the operation of the facility.

The IIFP Facility maintains an active Cylinder Management Program to maintain optimum storage conditions in the cylinder yard to monitor cylinder integrity by conducting routine inspections for breaches and to perform cylinder maintenance and repairs to cylinders and the storage yard as needed. Handling and storage procedures and practices are adopted at the IIFP Facility to mitigate adverse events by either reducing the probability of an adverse event or reducing the consequence should an adverse event occur.

**Chemical Evaluation and Approval**

Prior to new hazardous materials being brought onsite or being used in an activity, the materials are approved through a formal process initiated when a request for procurement of a new chemical is submitted. Before a new chemical is ordered, the requester must obtain approval from the Chemical Review team which is comprised of a representative of the ESH Organization, an area manager and others as deemed appropriate by the ESH representative. The ESH representative leads the review and is a qualified chemical safety reviewer. The process for approval includes reviewing the health and safety risks of the chemical as well as appropriate handling, storage and disposal information. Every effort is made to limit the amount of hazardous chemicals used, including identifying feasible alternative chemicals or processes. The ESH representative coordinates this effort with representatives from Environmental Protection, Industrial Safety/Industrial Hygiene and Radiation Protection. The formal approval process consists of evaluations for the physical, health and fire/explosive hazards as well as the potential impact on handling of licensed material. The results of this approval process may dictate the implementation of some or all of the following for assurance of chemical process safety:

- New procedures or changes to existing procedures
- Maintenance programs for equipment
- Configuration Management controls
- Addition of Material Safety Data Sheet(s) to safety information database
- Emergency planning modifications
- Training requirements

The procedure for approving new hazardous materials being brought on-site or used in a process is applicable to both employees and contractors. If a contractor desires to use a new chemical, the contractor must notify the IIFP Facility point of contact and the IIFP Facility new chemical approval procedure is initiated. If an existing hazardous chemical is to be used in a new plant process or affects an existing process involving an IROFS where that chemical has not been used previously, the change would also be evaluated through the 10 CFR 70.72, "Facility Changes and Change Process," (CFR, 2009e), as described in LA, Revision B Chapter 11.

**Labeling and Identification**

Hazardous materials containers or conveyance systems are labeled and identified to comply with applicable regulations. The proper identification of hazardous materials decreases the likelihood and potential negative consequences of improper use, handling or disposal of those materials.

The hazards of chemicals are identified for personnel through the MSDSs. These documents will be available in the workplace.

**Chemical Inventories**

Where feasible, chemical inventories at the IIFP Facility are maintained below the threshold quantities set forth in OSHA 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals," (CFR, 2009f) and the Environmental Protection Agency (EPA) 40 CFR 68, "Chemical Accident Prevention Provisions," (CFR, 2009g). Inventories of chemicals are tracked through the procurement process. In addition, the EMP contains an inventory, including amounts and locations, of bulk chemicals as required by EPA's "Emergency Planning and Community Right-to-Know Act," (EPCRA) Section 312, Tier II (EPA, 2009b). The EMP which is updated annually and the MSDSs are provided to applicable offsite responders. Process chemicals such as HF and other fluorine bearing chemicals are typically at inventory levels above threshold quantities and are controlled under the provisions of "Process Safety Management," defined in 29 CFR 1910.119 (CFR, 2009f). Additionally, the IIFP Facility has an agreement with the State of New Mexico that limits the maximum amount of certain depleted uranium materials and certain containers that are permitted to be held in on-site inventories (NMED, 2009). A copy of the agreement has been provided to the NRC to be incorporated into Revision B of the IIFP Facility LA.

**Hazardous Chemicals and Chemical Interactions**

Chemicals utilized at the IIFP Facility that contain licensed material or have the potential to affect licensed material, either directly or indirectly, are evaluated to determine the consequence level for a particular accident sequence. The main chemicals of concern at the IIFP Facility are $DUF_6$, $BF_3$, $SiF_4$ and AHF. If $UF_6$ is released into the atmosphere, the uranium compounds and HF that are formed by reaction with moisture in the air are chemically toxic. Uranium is a heavy metal that, in addition to being radioactive, can have toxic chemical effects primarily on the kidneys if it enters the bloodstream by means of ingestion or inhalation. HF is an extremely corrosive gas that can damage the lungs and cause death if inhaled at sufficiently high concentrations (see Section 6.1). Similarly, the formation of HF occurs with releases of $SiF_4$ and $BF_3$ but no radiological component or uranium toxicity is associated with such releases.

### 6.3.1.2 Materials of Construction, Sizing of Equipment, System Fabrication and Process Control Schemes

The design of the chemical process systems includes numerous controls for maintaining safe conditions during operations. These controls include but are not limited to the following:

- Managing the arrangement, size and physical integrity of material containers and processes

- Selecting and using materials compatible with process chemicals
- Providing inherently safe operating conditions (such as $UF_6$ confinement)
- Providing process interlocks, controls and alarms within the chemical processes

These facility and equipment features help prevent chemical releases. Process piping and components (such as reaction vessels, conveyors, traps, vents, etc.) is maintained safe by limits placed on their operating parameters.

**Materials of Construction**

Interactions between process equipment and process fluids are considered in the design of the IIFP Facility. The IIFP Facility will utilize materials of construction throughout the process and operations areas that are compatible and/or are corrosion resistant to $UF_6$, HF, $SiF_4$ and $BF_3$. The materials of construction are also compatible with the process operational physical parameters of pressure and temperature accordingly. The materials of construction meet the applicable standard engineering specifications required by the International Building Code (IBC, 2009) and/or other building codes and their use is consistent with standard industry practice for processing $UF_6$, HF, $SiF_4$ and $BF_3$.

Standard steel or Monel containers, valves and piping are used at the IIFP Facility for transport, processing and storage of $UF_6$ (ANSI, 2001). These containers are appropriate due to the resistance of the materials to corrosion by $UF_6$. The $DUF_6$ cylinders, used for transport and storage, are painted to resist corrosion from atmospheric conditions. The cylinders are also inspected on a routine basis to assess corrosion. The storage and transport containers for HF, $SiF_4$ and $BF_3$ are specified to be corrosion-resistant to these chemicals under all normal and anticipated abnormal environments.

**Sizing of Equipment**

The sizing of process equipment is based on the amount of material to be used in the process. The design of preventive and/or mitigation features is based on conservative assumptions to allow for unusual conditions. For example, tanks that contain bulk chemicals are designed for more capacity than the maximum volume expected during normal operations. In addition, overflow alarms and mitigation devices (such as curbs, sumps, overflow tanks), are available for use during upset conditions and provide conservative margins of safety for spill containment.

**System Fabrication**

Within the IIFP Facility, systems are fabricated with safety and physical integrity as a priority. Materials of construction are chosen to avoid or minimize corrosion. Fabrication operations such as machining, drilling, welding, heating and grinding are established to prevent and/or mitigate hazards to the worker and minimize releases to the public and the environment. Preventive maintenance is routinely scheduled for replaceable parts. The systems are designed to provide easy access for maintenance.

**Process Control Schemes**

Process control schemes are chosen with safety as a priority. The process control schemes that are associated with IROFS are described in the ISA Summary, Revision B. Minimum impacts to the environment, safety and health are addressed through an engineering design philosophy that includes:

- Minimum necessary inventories of chemicals and subsequent minimum source terms
- Secondary containment of potential chemical hazards
- Redundancy on selected key safety systems
- Defense-in-depth layers of protection with first priority on engineered controls
- Multi-stage treatment devices configured in series

### 6.3.2 Chemical Process Safety Controls

The IIFP ISA accident analysis methodology considers and evaluates the likelihood and consequences of accident sequences involving hazardous chemicals that contain licensed materials or affect licensed materials. Where unmitigated accidents are unacceptable risks, IROFS are identified and developed including engineered controls and administrative controls to prevent or mitigate chemical process risks. The IIFP ISA Summary, Revision B describes the accident sequence, chemical consequence evaluation the hazard being mitigated, risk category and the function of the IROFS.

In addition to IROFS, many operational control features (safeguards which are not considered IROFS) are incorporated as defense-in-depth to support worker safety. Some of the more important operational control safeguards are identified in Section 3.1 of the ISA Summary Revision B. Items such as lab hoods, eye wash stations and safety showers are established as part of a standard industrial safety program and were assumed to be available as part of the evaluations conducted in the ISA. Safeguards are also applied to process systems that involve hazardous chemicals that have been separated from licensed materials.

A defense-in-depth approach is followed during the design of chemical process systems. The ISA Summary, Revision B identifies a number of IROFS and inherent safeguards for protecting against or mitigating process material releases. Many of these reduce the likelihood or severity of hazardous material releases from process equipment. Others help the operators respond more quickly and/or efficiently to limit the effects of releases of hazardous material. These IROFS and safeguards include, in order of preference, passive controls (such as curbs around chemical tanks), active engineered controls (such as high temperature shutdown interlocks) and administrative controls (such as operator training and approved written procedures). Some safeguards, such as gas alarm systems, provide a mitigation function by alerting operators to evacuate the facility, thus limiting radiation and chemical worker exposure during an event. Examples of chemical hazard design, including both IROFS and safeguard level controls, include the following:

- $UF_6$ cylinders are locked inside a containment-type autoclave when being heated or fed to the process.
- $UF_6$ cylinders are not lifted or transported when the material inside the cylinder is in a liquid state.

- Areas where HF is collected or stored and where significant HF potential source terms are involved, such as storage tanks and loading equipment, are in a containment-type building. The containment building is not totally leak tight, but provides for substantial mitigation of released vapors by initiation of water spray inside the building.

- Exhaust hood and capture systems are located in selected general areas where there are hazardous materials to provide back-up emergency control and evacuation in the event of a leak.

- Process areas where chemicals or hazardous materials are stored or used are provided with sealed concrete pads, including containment dike walls, to contain any one full storage or process vessel.

- Lab hoods and sinks are provided to drain/vent hazardous chemicals.

- Area eye wash stations and showers are installed in strategic locations to mitigate the consequences of exposures.

- Area fluoride and radiation detection systems and alarms are strategically located to support worker evacuations during a hazardous chemical release.

### 6.3.3 Chemical Process Safety Management Measures

Management measures, including those for chemical process IROFS, are discussed in LA, Revision B Chapter 11 and are implemented to assure the reliability and availability of chemical process related IROFS.

The safety management measures provide the overriding management oversight and assurance that the CPS Program is maintained and functions properly. The IIFP Facility applies management measures in a graded approach based on unmitigated risks as described in the ISA Summary. Based upon criteria defined in approved written procedures, the relative importance of IROFS is determined and the appropriate types and numbers of management measures are assigned to assure the IROFS are functional when needed.

#### 6.3.3.1 Procedures to Ensure Reliable Operation of Engineered Controls

The IIFP Facility maintains approved written procedures to ensure reliable operation of engineered controls (such as inspection and testing procedures and frequencies, calibration programs, functional tests, corrective and preventive maintenance programs and criteria for acceptable test results). Additionally, programs and procedures address construction and configuration controls to ensure CM during design and construction.

#### 6.3.3.2 Procedures to Ensure Proper Implementation of Administrative Controls

The IIFP Facility maintains approved written procedures to ensure administrative controls are correctly implemented (such as employee training and qualification in procedures, refresher training, safe work practices, development of procedures and training program evaluation).

## 6.4 REQUIREMENTS FOR NEW FACILITIES

The IIFP Facility is a new chemical process facility. Revision B of the LA, Chapter 3 “Integrated Safety Analysis” and Revision B of the ISA Summary describe the methodology for satisfying the principles of the facility Base Design Criteria (BDC) in 10 CFR 70.64 (CFR, 2009c). The ISA Summary describes how the chemical safety BDC is applied in establishing the design principles, features and control systems of the new process.

The IIFP Facility is designed with the defense-in-depth approach for protecting against chemical accidents. In accordance with 10 CFR 70.64(a)(5) (2009c) and NUREG-1601, Section 2-4 (NRC, 1997a), the design provides for adequate protection against chemical risks produced from licensed material, facility conditions that affect the safety of licensed material and hazardous chemicals produced from licensed material. For chemical process safety, the facility design considered the following:

- Preference for the selection of engineered controls over administrative controls to increase overall system reliability
- Preference for prevention over mitigation and operator intervention
- Operational design features that enhance safety by adding extra measures and reducing challenges to IROFS

There are a number of operational design features that are not IROFS and no credit is taken for these features in the risk-based ISA. However, as extra measures in addition to IROFS, these features do help ensure chemical process safety. These features include robust and chemical compatible equipment, piping, connections and valves that confine hazardous chemicals. For example: 1) purge and evacuation (P&E) systems and equipment are installed in the $DUF_4$ and FEP Process Buildings to provide for purging equipment and piping with dry nitrogen and evacuating the residual hazardous chemicals prior to opening the equipment or piping for maintenance, 2) physical barriers include fire walls as determined by the Fire Hazards Analysis described in LA, Revision B Chapter 7 “Fire Safety,” 3) vented hoods are appropriately provided in the decontamination and maintenance areas, 4) isolation and check valves are used in piping containing hazardous chemicals and 5) temperature and pressure controls, sensors with alarm points and control valves are appropriately included that provide data and operational controls for assisting in the safe operation of the processes.

The IIFP Facility is not proposing any facility-specific or process-specific relaxations or additions to the Basic Design Criteria of 10 CFR 70.64 (2009c).

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