# 3.0 SITE DESCRIPTION

The Westinghouse CFFF site is located in the central part of South Carolina in Richland County, some 8 mi southeast of the city limits of Columbia along SC Highway 48. The site coordinates are latitude 33° 52' 52" and longitude 80° 55' 24".

The CFFF is located on a semi-rural plot of approximately 1,151 acres. The main manufacturing building, waste treatment areas and holding ponds, parking lots, and other miscellaneous buildings occupy approximately 6% (68 acres) of the site area. About 1,083 acres of the site remain undeveloped. Included in the stated values above is the recently expanded Controlled Access Area (CAA). Since the 2009 DFP submission, the CAA has been expanded to include an additional 386,580 square feet of area (approximately 8 acres). The expansion includes a heavy duty asphalt road (26,793 sq. ft.), a traveler storage area (46,514 sq. ft.), and a trailer parking area (128,544 sq. ft.). The remaining area (184,729 sq. ft.) remains undeveloped.

The CFFF site is bounded by SC 48 (Bluff Road) to the north and by private property owners to the east, south, and west. The manufacturing facilities are located about 0.3 mi from the site boundary, at its nearest point. Farms, single-family dwellings, and light commercial activities are located chiefly along nearby highways. The region around the CFFF site is sparsely settled, and the land is characterized by timbered tracts and swampy areas, penetrated by unimproved roads. The "Controlled Area Boundary" is equivalent to the CFFF site's property boundary and encompasses the "Restricted Area". "Off-Site" areas are any beyond the site's property boundary.

The main manufacturing building for the CFFF is set back approximately 2,500 ft from the roadway. The main plant road, which connects the CFFF to Bluff Road, provides access for vehicle and truck traffic. A continuously staffed security guard station is located on the main plant road. Access to the site is controlled by a number of security measures, including fencing, security barriers, and natural barriers (e.g., land contours). The "Restricted Area" is defined in the license as the area within the fenced area including the main manufacturing building on the site. It is restricted in that individuals in this area must enter through security and outsiders must be escorted. The "Restricted Area" is a physically defined area, represented on three sides by a 7-ft high barrier chain link fence topped by three strands of barbed wire, and on the fourth side by the administration and main manufacturing building. The Controlled Area is controlled in that it is routinely monitored and patrolled and access to this area can be limited by the licensee for any reason.

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## 3.1 FACILITY DESCRIPTION

The main manufacturing building at the CFFF consists of an original building, plus several additions as described below. The main manufacturing building is a 550,000 $ft^2$ steel and concrete building with approximately 500,000 $ft^2$ devoted to manufacturing and 50,000 $ft^2$ to offices. The original building and subsequent additions were built to the Standard Building Code (published by the Southern Building Code Congress International, Inc.) of record at the time of construction.

Foundation construction is concrete slab on compacted fill approximately 4 ft above the surrounding grade. The plant floor is located at 142 ft (above MSL). The manufacturing area is laid out in 40-ft by 50-ft bays, while the office area is 30-ft by 30-ft bays. Construction is structural steel frame and trusses with a metal deck roof. The steel frame construction consists of wide flange columns with steel vertical trusses at the roof level between columns. In the additions, the roof is supported by open web bar joists. Along the periphery of the original building and of the additions, diagonal bracing is included. The roof is a built-up, Factory Mutual Class 1 roof. The roof elevation is 27 ft to 37 ft.

The building's exterior shell is prestressed concrete, single Tee wall panels in the manufacturing area and glass in the office area. The wall panels are generally 20 ft high (except in high bay areas where they are 30 ft high) and 5 ft wide, with the Tee web about 8 in. wide and 18 in. deep. The wall panels, which sit on concrete foundation walls, are attached to the building structural steel frame around its periphery and to adjacent panels. The panels are also attached at to the foundation wall by angles bolted to the wall and panel. Connecting the wall panels to the building structural steel and to the foundation walls stabilizes the panels and allows them to withstand suction forces during wind loading.

All exterior building walls are supported by concrete foundation walls on strip footings. The reinforced concrete foundation walls are 12 in. thick and extend down below the floor level 7 to 11 ft. The foundation walls are supported by 4.5 ft wide by 12 in. thick strip footings. In addition, there are piers (i.e., pilasters) and large spread footings at each column location along the exterior walls. Interior building columns are supported by caissons that extend between 9 and 11 ft beneath the floor. The floor slab is separated from the foundation by a ¼ in. pre-molded joint.

The original manufacturing building, designed in 1968, was designed to comply with the Standard Building Code, 1965 Edition, with only minor exceptions. The building was designed to meet Seismic Zone 1 criteria. The walls were designed to withstand 20-pound-force per square foot, equivalent to 90 mile per hour (mph) winds. The original building is a rectangular building plan extending between Column Lines A and H in the east-west direction (600 ft in fifteen 40-ft bays) and between Column Lines 1 and 16 in the north-south direction (350 ft in seven 50-ft

bays). This is a single-story building with story height of about 27 ft, except in the high bay region along the east side of the building where the story height is about 37 ft.

A building addition, designed in 1978, was designed to comply with the Standard Building Code, 1976 Edition. This addition added two bays on the west and north sides of the original building. Along the west side of the building, new bays extend from Column Line AA to CC, where Column Line AA is isolated from Column Line A of the original building. These bays extend from Column Line 102.8 to Column Line 18 for a total length of about 790 ft. along the north side of the building; new bays extend from Column Line 16A to 18, where Column Line 16A is isolated from Column Line 16 of the original building. These bays extend from Column Lines CC and E for a total length of about 300 ft.

A third building addition, designed in 1986, was designed to comply with the Standard Building Code, 1985 Edition. This southeast addition is connected to the original building along Column Line 1 between Column Lines E to H. This addition consists of seven 40-ft bays east of the original building between Column Lines 1 and 107 and four 50-ft bays extending between Column Lines E and I such that plan dimensions are about 280 ft in the north-south direction and 200 ft in the east-west direction. The building is about 27 ft high between Column Lines 1 and 104 and about 37 ft high between Column Lines 104 and 107. There are numerous internal levels within the southeast addition.

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## 3.2 SNM-1107 FACILITIES AND WORK AREAS

### 3.2.1 Facility Operations

Facilities at the CFFF include the main manufacturing building; the administration building; visitor's center and guard station; the waste treatment building; the advanced liquid waste treatment building; the emergency response building; the respirator building; the paint booth; the sanitary waste lagoon; four process waste lagoons; a tank farm; ammonia recovery stills; the $UF_6$ cylinder storage pad; staging and storage areas for wastes, equipment, and shipping containers; and parking lots. Figure 3.1 presents the site location map.

The CFFF is primarily engaged in the manufacture of fuel assemblies for commercial nuclear reactors. The manufacturing operations consist of receiving low-enriched (less than or equal to 5.0 wt.% $^{235}U$) uranium hexafluoride ($UF_6$) in cylinders; converting the $UF_6$ to produce uranium dioxide ($UO_2$) powder; and processing the $UO_2$ powder through pellet pressing and sintering, fuel rod loading and sealing, and fuel assembly fabrication. These operations are supported by absorber addition, laboratory, scrap recovery, and waste disposal systems. Most of the manufacturing operations are conducted in the main manufacturing building, which can be divided into two areas: the Chemical Area and the Mechanical Area. Uranium operations conducted in the Chemical Area include $UF_6$ conversion, powder blending, pellet manufacturing, fuel rod loading, and scrap processing. Uranium operations conducted in the Mechanical Area involve only encapsulated and sealed material, such as rod certification and storage, and final assembly. All manufacturing operations are governed by approved radiation and environmental protection, nuclear criticality safety, industrial safety and health, special nuclear material (SNM) safeguards, and quality assurance (QA) controls. A main site plan is shown in Figure 3.2.

Radioactive material authorization is granted under USNRC License No. SNM-1107 and the state of South Carolina License No. 094. Authorized activities at the CFFF include the following:

- Receipt, handling, and storage of SNM as $UF_6$, uranium nitrates, uranium oxides; and/or contained in pellets, fuel rods, fuel assemblies, samples, scrap, and wastes
- Receipt, handling, and storage of other licensed radioactive material
- Chemical conversion processing by the ADU and the IDR processes (IDR currently not in use), including $UF_6$ vaporization and hydrolysis, precipitation and centrifugation, drying, calcining, comminution, and blending

- Fuel fabrication, including powder preparation, die-lubricant mixing, neutron absorber (erbium oxide) mixing, pelleting, sintering, grinding, pellet coating with neutron absorber (zirconium diboride), fuel rod loading and inspection, and final fuel assembly
- QA and control inspection activities
- Analytical services laboratory operations, including wet-chemistry and spectrographic techniques
- Metallurgical laboratory operations, including sample preparation, polishing, testing, and examination
- Chemical process development operations, including laboratory-scale process research, prototype development, and equipment check-out
- Mechanical process development operations, including laboratory-scale research and development
- Health physics (HP) laboratory operations, including sample preparation and analysis, instrument repair and calibration, respirator fit-testing, and bioassay sample and sealed-source storage
- In-house and contracted, scrap recovery operations, including scrap batch processing, solvent extraction, coated-pellet recovery, scrap blending, and ammonia recovery
- $UF_6$ cylinder washing, hydrostatic testing and re-certification
- Equipment and facility maintenance activities
- Equipment and facility decontamination activities, including clothing
- Waste storage and disposal preparation operations, including HEPA filter testing, conversion liquid waste treatment, advanced waste-water treatment, lagoon storage, incineration, radioactive waste packaging for disposal, and calcium fluoride disposition
- Ancillary mechanical operations, including non-radioactive component fabrication and assembly
- Shipping container and overpack refurbishment

### 3.2.2 $UF_6$ Pad & Bay

Solid $UF_6$ in cylinders, typically Model 30B cylinders, is received from an enrichment facility supplier via truck transport. The cylinders are stored in racks on the $UF_6$ pad, located on the west side of the main manufacturing building within the CAA fenced area. When needed for conversion, individual cylinders are moved from the $UF_6$ pad to the $UF_6$ bay via forklift.

Two general systems have been used to convert $UF_6$ to $UO_2$ powder: ADU and IDR processes. These operations are supported by absorber addition, laboratory, scrap recovery, and waste disposal systems. [

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The vaporization process converts solid $UF_6$ to a gas for transport to the hydrolysis column. Vaporization is conducted in the $UF_6$ bay, which is located along the south wall of the main manufacturing building. Inside the $UF_6$ bay, cylinders are placed inside the vaporizers (steam chests), and then steam heated to an approximate temperature of 240 to 250 °F for vaporization.

The vaporizers may also be used for cylinder eduction to remove as much residual $UF_6$ heel from the cylinder as possible. Cylinder eduction is performed as needed to remove any residual $UF_6$ or heel, so that the cylinder meets weight and pressure requirements for off-site shipment. Nitrogen passing through an eductor creates a vacuum which draws residual $UF_6$ from the cylinder into the hydrolysis column. Empty cylinders, having passed various checks, are returned to the $UF_6$ pad for storage.

$UF_6$ gas from the vaporization process enters the hydrolysis column where it reacts with DI water and recirculated solution to form uranyl fluoride ($UO_2F_2$) solution. Hydrogen fluoride (HF) is produced as a byproduct. The $UO_2F_2$ solution generated in the hydrolysis process collects in the bottom reservoir section of the hydrolysis column. A portion of the solution is pumped through an automatic flow control valve to the precipitator, while the rest is recirculated into the hydrolysis column.

The fuel manufacturing process generates two broad categories of off-stream uranium-bearing solids referred to as "clean scrap" and "dirty scrap". The uranium that is collected as scrap throughout the manufacturing process is dissolved in nitric acid, producing an intermediate uranium product, uranyl nitrate (UN). The UN is eventually converted to a usable $UO_2$ powder using the same ADU conversion process as for $UF_6$.

UN is "spiked" with hydrofluoric (HF) acid to improve the processing characteristics of the solution and the fabricability of the resultant $UO_2$ product. An automated batch spiking station, located in the $UF_6$ Bay, blends HF and UN by weight. The spiked solution is pumped to the process surge tank on the ADU conversion line designated for UN processing. From there, it is fed directly into the precipitator, where it is precipitated with ammonium hydroxide to form ADU.

### 3.2.3 ADU Conversion

The CFFF uses an ADU conversion process to produce a ceramic grade uranium oxide powder. The multi-staged ADU conversion process is designed to convert $UF_6$ into $UO_2$ powder for blending and manufacture into pellets. All the operations of the ADU Conversion System take place in one of five ADU conversion lines, located within the Chemical Area of the main manufacturing building. The ADU conversion equipment has been designed to receive and process uranium in enrichments up to 5.0 wt.% $^{235}U$, through fuel assembly fabrication and shipping. The ADU conversion process includes the following operations: vaporization of solid $UF_6$, cylinder eduction, hydrolysis, precipitation of ADU, dewatering and drying of the precipitate, calcination, and powder milling.

### 3.2.4 Bulk Powder Blending

The ADU bulk powder blending operation blends $UO_2$, $U_3O_8$, and $UO_2/U_3O_8$ mixtures for the purpose of obtaining a homogeneous powder with uniform chemical and physical properties for pellet manufacturing. The blending operation is conducted in the bulk blending room, which is located in the Chemical Area. Nuclear criticality safety for the bulk blending operation relies on moderation control because the bulk container involved may contain up to 1,750 kilograms of uranium oxide powder. The bulk blending room is maintained as a moderation controlled (MODCON) area. Engineered controls and administrative controls exist to limit the amount of moderator entering the MODCON Area. Major equipment in the room consists of a dump hood station, a consolidation station, 2 remill stations, a tumble blender, a sampling hood, a bulk container cleaning station, a feeder valve assembly cleaning hood, and a cover plate cleaning/storage hood.

### 3.2.5 ADU Pelleting

The ADU pellet manufacturing operations involves fabricating uranium dioxide fuel pellets from ceramic grade uranium oxide powders. The pellet fabrication process consists of five basic operations - press feed preparation, pellet pressing, pellet sintering, pellet grinding and inspection, and scrap processing.

A powder batch for pellet pressing is prepared by mixing $UO_2$ powder with $U_3O_8$ recycle and green scrap recycle. Uranium oxide powders are delivered to the ADU pellet area as a blended product uranium oxide powder. $UO_2$ powder is delivered to the pellet line from the bulk blending area in an ADU bulk container with a powder feeder assembly attached. The bulk container is lifted by a crane into the bulk container enclosure (MODCON room) on the second level of the pressfeed preparation area and placed on top of the $UO_2$ vibratory feeder. $U_3O_8$ hard scrap and grinder sludge powder and green scrap powder/pellets in polypaks are lifted to the

second level of the pressfeed preparation area by the polypak elevator. The $U_3O_8$ is dumped from the polypak into the $U_3O_8$ recycle vibratory feeder hopper in the recycle hood.

$UO_2$ powder from the bulk container and $U_3O_8$ recycle material from the recycle feeder hopper are fed into the batch weighing hopper. When the batch is complete, it is transferred into the powder mixing blender and the mixing cycle is started. When mixing is completed, the mixed materials are emptied out of the blender into the powder lift pan. The powder lift pan containing the mixed material is raised by the powder lift elevator to the pre-compactor feed hopper. The mixed batch is dumped into the pre-compactor hopper and the empty pan returned to the powder mixing hood.

All of the ADU pellet lines are equipped with a similar pre-compaction/granulation/ pressing lubricant addition system. The mixed $UO_2$ powder and recycle materials are fed from the pre-compactor hopper by a vibratory feeder and drop by gravity into the pre-compactor. The compacted product drops by gravity into the granulator located in the roll mixing hood. The granulator consists of a series of rotating bars adjacent to a screen. The compacted product from the pre-compactor is forced through the granulator screen by the wiping action of the rotating bars. This produces granules. Granules drop by gravity from the granulator into collection polypak.

A pressing lubricant is added to the batch of granules in the polypak in the roll mixing hood. A lid is placed on the polypak and it is rolled to disperse the lubricant in the granules. When the roll mixing is completed, the polypak is opened and the granules are dumped into the pellet press feed hopper.

The pellet pressing operation consists of forming a green (unsintered) pellet with required physical dimensions and loading the green pellets into the molybdenum (moly) sintering boats for the sintering operation. The batches of pressfeed (the $UO_2$, recycle materials, and pressing lubricant produced by the pressfeed preparation operation) are dumped into the pellet press feed hopper for delivery to the pellet press dies. The green pellets are formed in the dies filled with pressfeed when the top and bottom punches apply pressure to the pressfeed. The green pellets are loaded into the moly sintering boats either with a vacuum head boat loader or manually.

Green pellets are heated in a controlled environment in the sintering furnace to dewax and sinter the pellets. Dewaxing removes the pore former and/or the die lubricant from the pellets. The sintering operation increases the density of the pellets by

sintering at a high temperature and reduces the O/U ratio of the uranium oxide by sintering in a reducing atmosphere normally 50% hydrogen and 50% nitrogen.

The sintering furnaces are electrically heated, pusher-type furnaces. The furnace consist of three sections, the preheat section for dewaxing the pellets, the high heat section for sintering the pellets, and the cooling section to cool the pellets and boats before they exit the furnace.

The pellet grinding operation consists of grinding the outside diameter of the sintered pellets to a specific size, loading the ground pellets on stainless steel trays, drying the pellets, and visually inspecting the pellets.

There are two basic types of scrap generated in the ADU pellet area, green scrap (unsintered material) and sintered scrap.

Clean green scrap is recycled back to the pellet press with the $UO_2$ during the powder mixing process. Contaminated green scrap is sintered, packaged in polypaks, and transferred to ADU conversion scrap processing area for further processing.

Sintered scrap is generated from three sources; contaminated sintered scrap, scrapped sintered pellets, and grinder sludge cleaned out of the grinder centrifuge. The contaminated sintered scrap is packaged in polypaks and transferred to ADU conversion scrap processing area for further processing. Both the hard scrap pellets and grinder sludge are oxidized to $U_3O_8$ in the pellet area for add back to the pellet press.

### 3.2.6 ADU Fuel Rod Manufacturing

The ADU fuel rod manufacturing includes the following functions:

- The assembly of fuel rod components
- The loading of fuel tubes with pellets
- The fabrication and inspection of fuel rods
- The scrapping and/or rework of fuel rods

Tubing is brought into the Chemical Area, placed at the loading station, and positioned for pellet loading. Pellet carts with enriched and/or blanket material are staged at the pellet loading station.

After pellet loading is completed, the loaded fuel rods are transferred to the fabrication portion of the fuel rod line. The end of the tube is cleaned to remove any pellet dust. A spring or other mechanical device is inserted in the fuel rod to prevent

the pellet stack from shifting. The fuel tube is closed by inserting a top end plug into the open end of the tube. The completed fuel rod is then transferred to the weld line.

At the weld line, the fuel rod receives a top girth weld before being transferred to the seal welder. At the seal weld station, the fuel rod is pressurized with helium and then seal welded. The fuel rods are then transferred to a collection area where they are loaded onto rod carriers before being sent to the QC inspection area in the Mechanical Area.

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### 3.2.9 Waste Processing

The CFFF generates both combustible and non-combustible forms of waste material. Scrap material of all types, created by departments throughout the Chemical Area in the normal course of operation, is sent to URRS for disposal. The

combustible wastes are incinerated on site and the ash and clinker residue is leached (chemically reacted with nitric acid) to remove uranium in the form of uranyl nitrate. The non-combustible wastes are prepared for burial or decontaminated for release from the plant or recycle.

Solid wastes are sorted into appropriate combustible and noncombustible fractions, and placed in specifically designated collection containers located throughout the work area. The wastes consist of paper, wood, plastics, metals, floor sweepings, and similar materials that are contaminated by, or contain, uranium. Following a determination that the wastes are properly sorted, the contents are transferred to a waste processing station.

Materials that are suited for thorough survey may be decontaminated for free-release, or re-use. Combustible wastes are packaged in compatible containers, assayed for grams $^{235}U$, and stored to await incineration. Noncombustible wastes, and selected combustible wastes, are packaged in compatible containers, compacted when appropriate, measured to verify the uranium content, and placed in storage to await shipment for further treatment, recovery, or disposal. Wastes designated for disposal are packaged in DOT approved 55-gal metal drums or in metal boxes. Materials packaged in metal boxes are pre-measured in standard containers prior to transfer to the boxes. Filled containers are stored in designated areas within the manufacturing or waste storage buildings; or, they may be stored outdoors, if protected from the elements.

The various process wastewater streams leaving the Chemical Area of the plant containing residual or trace uranium are treated for uranium recovery and/or disposal. Liquid process wastes are treated, prior to discharge to the Congaree River. Waste treatment, for the removal of uranium, ammonia, and fluorides, consists of filtration, flocculation, lime addition, distillation, and precipitation (in a series of holding lagoons). Compliance with licensed limits is verified by passing the waste streams through on-line monitoring systems, or by manual sampling and analysis on a batch-basis. The treatment systems have sufficient holdup capacity to assure the limits are continuously met.

The wastewater treatment system includes the following process operations:

- Waterglass liquid waste effluent treatment
- Warm caustic waterglass cake dissolution
- Aqueous waste and miscellaneous acidic waste disposal
- Blender dryer operation

Site sanitary sewage is treated in an extended aeration package plant prior to discharge, either directly or through a polishing lagoon. The discharged effluent is chlorinated, and mixed with treated liquid process waste, at the facility lift station. The combined waste is then passed through a final aerator, followed by pH adjustment as required and subsequently pumped to the river via a 4-in. pipeline.

Storm water from the site enters a system of storm drains and drainage ditches and ultimately flows to the Congaree River.

All radioactive material transfers from the plant controlled areas are surveyed to determine the appropriate disposition. Environmental Safety & Health (ES&H) oversees the survey and containerization of all material transfers to the Low-Level Waste Storage Building. For unrestricted, free release of an item (including transfer of item to a "clean" area of the plant), comprehensive surveys must be performed by ES&H for both smearable and fixed alpha contamination and beta-gamma radiation. For restricted off-site release of an item (i.e., for testing, repair, rework, etc,), these surveys would be determined on a case-by-case basis, and generally would require item surveillance throughout transport and off-site handling by an approved Westinghouse employee. Contaminated items designated for temporary storage and further processing are surveyed to specified limits and containerized to prevent dispersion of radioactive materials.

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### 3.2.11 Laboratories

Laboratories provide various services to support production operations and health and safety functions.

The Analytical Services Laboratory (Chem Lab) is responsible for providing support for the CFFF. This includes routine analytical chemistry analysis for process control, product QA, waste treatment and disposal, radiological and environmental control, and SNM accountability. The Chem Lab analyzes several uranium compounds, including ADU, $UO_2$ powder, $UF_6$, $U_3O_8$, uranyl nitrate, and $UO_2$ pellets. There are numerous function specific laboratory rooms within the facility. Specifically, the Chem Lab performs the following analyses:

- gravimetric, titrametric, pH, and ion specific electrodes wet chemistry techniques;
- surface area (BET), bulk density, porosity and particle size, and density or specific gravity;
- mass spectrometry;
- atomic absorption, emission spectroscopy, and laser and x-ray fluorescence;
- gas analysis (LECO); and
- ultraviolet visible spectrophotometry.

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The HP Laboratory is used by HP Operations to provide radiation and environmental measurement and protection services for the chemical manufacturing lines. Typical activities include monitoring in-plant airborne radioactivity concentrations, monitoring radioactivity levels in effluents discharge to the environment, and analyzing uranyl nitrate for $^{235}U$ concentration.

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The Metallurgical Laboratory (Met Lab) performs porosity measurement, and microstructure and grain size analysis on representative pellet samples. The analyses are performed to provide data for ongoing quality studies, and to support research and development efforts. Met Lab analyses are not used for production release. Pellet samples are prepared for metallurgic evaluation in a multi-step process; cutting and mounting, rough grinding, polishing, ultrasonic cleaning, and etching. Approximately half of each pellet is removed from the sample during preparation

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### 3.2.12 Incinerator

Low-level radioactive combustible scrap at the Columbia plant is incinerated to permit the recovery of uranium and to minimize the volume of waste disposed of at a licensed LLRW disposal facility. This incineration process consists of primary and secondary combustion chambers; off-gas scrubbing and filtration system; and an ash transfer milling and leaching system.

The URRS incinerator is a controlled air, gas-fired unit with two chambers. The lower ignition chamber operates at a somewhat lower temperature than the upper combustion chamber. System controls for ignition chamber draft (negative pressure), temperature of lower/upper chambers, and exhaust filter house HEPA filter pressure drop are provided to ensure safe and efficient operation. Typical incinerator solid feed materials include uranium contaminated paper, shoe covers, gloves, mops, plastic bags, tape, and fiberboard containers. There is a semi-automatic ash removal system at the rear of the ignition chamber.

The incinerator off-gas is treated by scrubbing and filtration. Exhaust gases are drawn from the upper combustion chamber and enter a quench tower where they are cooled by a spray of recirculating scrubber solution. The gases are drawn from the quench tower through a venturi scrubber and then a packed scrubber where scrubber solution falls through the column packing material, counter-current to the gas flow. The scrubber solution is treated with sodium hydroxide to maintain a slightly acidic pH, pumped through a bank of cartridge filters, and cooled using a heat exchanger. Excess scrubber solution is automatically or manually transferred to liquid waste treatment. Off-gases from the packed scrubber pass through the three demister housings to reduce the moisture in the gas stream. The condensed liquid is returned to the scrubber system for reuse.

### 3.2.13 Dissolvers

The uranium that is collected as scrap throughout the CFFF manufacturing process is dissolved in nitric acid, producing an intermediate product, uranyl nitrate (UN). The scrap solids are dissolved in one of three safe geometry dissolver systems, which are installed adjacent to the Solvent Extraction area. Two of the dissolver systems are primarily for "clean scrap" and the third is for "dirty scrap". The key components of each system are horizontally mounted contactors in which the solids are mixed with a heated nitric acid ($HNO_3$) / water mixture for dissolution. The contactors and all associated intermediate vessels are of safe geometry size.

The "clean scrap" dissolvers feature a single contactor for each system. Feed material for these dissolvers is clean scrap $U_3O_8$ or crystalline UNH that dissolves completely, with almost no residue, forming UN solution clean enough for immediate use in ADU conversion. Solution produced at the dissolvers is collected in safe geometry intermediate storage vessels, analyzed for $^{235}U$ and free $HNO_3$ contents, then pumped to UN bulk storage tanks. Pump outs are also continuously monitored by gamma monitors.

The "dirty scrap" dissolver features a set of three interconnected contactors. The three contactors are arranged to provide for uranium dissolution and also for separation and water washing of insoluble residues, which are a substantial part of "dirty scrap" feed materials. Incinerator ash is the primary solid feed material for this dissolver. UN solution from this dissolver contains high levels of impurities and it must be purified via solvent extraction before it can be returned to the ADU conversion process. The impure UN solution is pumped directly from intermediate safe geometry dissolver vessels to other safe geometry process vessels in the Solvent Extraction area. Residues are dried in ovens in the Fluoride Stripping area and either recycled through the dissolver for further uranium recovery, or put into drums for burial disposal.

### 3.2.14 Solvent Extraction

The objective of Solvent Extraction is to separate uranium from contaminants, recover it as clean uranyl nitrate solution and deliver it to storage tanks so that it may be converted back to usable product $UO_2$. Contaminated uranyl nitrate solution is delivered to the solvent extraction area through piping for the conversion scrap area, the C4 dissolver area, or the UN storage tank area.

The Solvent Extraction System comprises two sets of glass extraction columns, a primary set to recover the majority of the uranium and a secondary set to scavenge the last of the uranium from the raffinate prior to its discharge as a free-release waste stream. Each set of columns features an extraction column, where a solvent mixture containing tributyl phosphate (TBP) extracts uranium from a high-acid content uranium-bearing feed; and a stripping column, where the uranium is removed from the solvent with clean water forming a purified uranyl nitrate solution. All the columns are pulsed with large diaphragm pumps to facilitate movement of the solvent through perforated plates that are installed in the columns to provide a mechanism for breaking the solvent into small droplets as it passes through each column.

The primary and secondary systems both have steam-heated product concentrators to increase the uranium solution strength of the product coming off the stripping

columns in order to satisfy subsequent processing requirements for the product nitrate solution. Additional ancillary equipment, vessels, and pumps are utilized to contain and supply the solvents, water, and acid components necessary for the process. The entire system features automatic flow controls for liquid and steam requirements and a central control computer to control the process parameters.

### 3.2.15 Decon Room

The Decon/Cutting Room is used for the decontamination, cutting and dismantling of equipment. Occasionally, materials decontaminated in the Decon/Cutting Room are released for transfer to the outside, on-site storage areas (i.e. Low-Level Waste Storage Building, trailers, pads). Large metal pieces are cut into sizes small enough for subsequent decontamination and disposal. Two electric driven saws are used for assorted sheet metal, pipe, and HEPA filter dismantling. Two different torches are used to cut other, very large metal pieces; a plasma torch is used to cut stainless steel; a natural gas/oxygen torch is used to cut other scrap metals. Torch burning is also used to remove paint and corrosion from these non-flammable materials. All areas of an item that would be inaccessible to survey for contamination are cut out.

A Torit Downflo Filter System is provided for room/work station ventilation. Material collected from the Torit system is dispositioned as contaminated scrap, and brought to Scrap Reprocessing for oxidizing.

# Figures

## Figure 3-1: CFFF Site Location Map

**Figure 3-2: CFFF Main Site – Site Plan**

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## 3.3 CURRENT RADIOLOGICAL CONDITIONS

For the purpose of preparing the CFFF DFP, it is assumed that the radiological conditions anticipated at the time of decommissioning will be much the same as those currently found at the facility.

Radiological conditions within the process areas of CFFF are well contained within process equipment, fume hoods, ovens, and glove boxes. The radiological conditions are routinely monitored and controlled at all levels to prevent contamination and excessive exposure due to radioactive materials in unwanted areas. Approved contamination surveys and smear measurements are performed to assure that maximum acceptable limits are not exceeded. The current criteria applied to contamination surveys are:

- Average contamination is based on areas not greater than 10 $m^2$.
- Decontamination is required within three working shifts whenever the average contamination exceeds the limits.
- Decontamination is required immediately whenever the average contamination exceeds five times the limit.
- Decontamination is required immediately whenever the average contamination is found in clean areas.
- Verification surveys are performed to assure decontamination activities have been effective (i.e., below the established limits).

Maximum acceptable limits and minimum survey frequencies for floor and other readily accessible surfaces are specified in Table 4.

**Table 4: Contamination Survey Limits and Frequencies**

| Area Description | Alpha Activity on Smear (dpm/100 $cm^2$) | Minimum Frequency |
|---|---|---|
| Eating Tables / Vending Areas | 50 | Weekly |
| Change Rooms / Break Rooms | 200 | Weekly |
| Clean Areas | 200 | Monthly |
| Intermediate Areas | 200 | Bi-weekly |
| Contamination Controlled Area (CCA) | 5000 | Bi-weekly |

Facility personnel are required to clean up any inadvertent spills as they occur. Nonetheless, contamination from leaks and spills has migrated to inaccessible areas i.e.

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concrete expansion joints, floor to wall junctions, and piping penetrations which lead beneath the concrete floors. Overhead areas are also susceptible to loose contamination and are not routinely surveyed or decontaminated and are considered areas of concern.

Prior to transfer of any items from a CCA at the facility, a documented survey instrument measurement shall conclude that the following limits are not exceeded: average uranium-alpha contamination of 220-dpm/100 $cm^2$; maximum uranium-alpha contamination of 2200-dpm/100 $cm^2$; average beta-gamma emitter contamination of 660-dpm/100 $cm^2$; maximum beta-gamma emitter contamination of 6600-dpm/100 $cm^2$.

Determining the radiological conditions is necessary in order to both derive release criteria as well as to calculate how much the remedial actions will cost to reduce the residual radioactivity at the site to meet the release criteria. The type of surveys required to derive release criteria includes radioanalysis of samples to determine which radionuclides are present and the relative ratios of those nuclides. Direct surveys, loose contamination surveys, radiation surveys, concrete core samples and soil samples are some of the surveys required to understand how much remediation is required to remove residual contamination below the accepted release criteria.

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