CSE LICENSE ANNEX

LLRW PROCESSING SYSTEM

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SAFE GEOMETRY DISSOLVER SYSTEM

REVISION RECORD

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LLRW PROCESSING

Process Summary

The Columbia plant 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 Uranium Recycling and Recovery Services (URRS) for disposal. Every reasonable effort is made to avoid waste burial; the ever-rising cost of volume and uranium surcharges for burial shipments is the economic driving force for much of the on-site decontamination and volume reduction processes. 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. "Free Release" is the desired disposition. Metallic material that cannot be sufficiently decontaminated for "free release" might be deemed sufficiently clean for "metal melt" disposition. This material is placed into a container for shipping to a waste processor for smelting into ingots to be used as shielding blocks for the U.S. nuclear industry. Various processors also provide the service of further decontamination or compacting our waste prior to burial.

All radioactive material transfers from the plant controlled areas are surveyed to determine the appropriate disposition. Regulatory Engineering & Operations (REO) oversees the survey and containerization of all material transfers to the Low-Level Waste Storage Building, other contaminated material storage areas outside the plant, and off the plant site. For unrestricted, release of an item (including transfer of item to a "clean" area of the plant), comprehensive surveys must be performed by REO 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.

Of the various instruments available for measuring contamination, the Canberra Computer Based Gamma Scanning Systems (for determining ^{235}U content in containers of medium to low density waste and process scrap), the "Pac-4G Gas Proportional Alpha Instrument" (for determining alpha radiation count rate as counts per minute, cpm) and the "E-120 Geiger Instrument" (for determining ^{235}U concentration as g/10 liters) are typically used by REO for establishing the disposition of LLRW. Qualified URRS personnel also use the Pac-4G to decide internal material staging and metal melt disposition.

The LLRW processing system includes the following process stages; a brief description of each stage is provided.

1. Trash Collection
2. Assay Operations
3. Rotary Shear Shredder
4. Incineration
5. Ash Handling
6. Compaction
7. Decon/Cutting Room
8. Liquid Honing
9. Ultrasonic Cleaning
10. Parts Washer
11. Grit Blaster (proposed)

Trash Collection:

The segregation of collected trash requires the cooperation of all departments that generate trash throughout the chemical area in that all bagged trash be devoid of metal, wet rags or mopheads, wet filter media (cloths, cartridges, bags) or oil. Each trash collection point consists of containers for combustible trash, with a limited number of locations having a separate container for non-combustible trash. All wet materials, such as filter cloths, cartridges, mop heads, and wet rags are first placed in wet storage containers located in the Scrap Recovery area then washed in the Washing Machine. The washed materials are eventually brought to URRS and placed in one of the two 55-gallon drums designated for staging wet materials; URRS-source wet materials are directly disposed of in the other drum.

All gross contamination must be removed before placing any material in any scrap container. Large plastic items such as hardhats, polypaks and Lexan sheets are placed on a cart and delivered to URRS personnel; these items will be shredded for incineration. Special procedures apply to the disposal of ADU and IFBA fuel rod scrap (i.e. tubes, components, zircaloy lathe turnings), UF_6 pigtails and moly scrap, with emphasis on removing gross uranium contamination (i.e. pellet fragments, powder or other questionable material) and preparations for subsequent handling and decontamination.

All bags of collected combustible trash are first processed through a metal detector. Exceptions are honing grit, met lab combustibles, and sludges with minute particles; these should not be passed through the metal detector, but may be added to the drum if the drum is to be consumed in the incinerator prior to inventory (i.e. inventory is more than a month off or the drum is going directly to the incinerator). Rejected trash is resorted. Combustible scrap is then staged for weighing (mass control), assay (measure total ^{235}U content) and incineration.

There are four scales available for use to ensure the mass limit requirements for assay and incineration of combustible trash are met. The drums may be filled with bags of trash that have been successfully scanned through the metal detector. The drum fill weight (net) is limited to 66 pounds. If the scale weight limit light (red) comes on (66 lbs), the operator will remove the last bag added to the drum. Filling the drum past the "weight limit" point risks reaching the "high weight" alarm (90 lbs) which requires issuing a "Redbook Incident Report" or a "Data Pak Report" (119 lbs).

Non-combustible scrap includes both metallic and non-metallic materials. All metallic, non-combustible scrap is sorted for either hand cleaning or size reduction (Decon/Cutting Room) and/or staged to be cleaned for free release, metal melt or recycle use. These assorted metallics include vessels, structures, tools, equipment, piping, and hardware. Non-metallic, non-combustible scrap is sorted for volume reduction (shredding or compaction). This category of scrap includes materials such as insulation, furnace brick, lexan, plexiglass and light gauge metal items (i.e. aluminum foil and wire) not suitable for metal melt disposition. This scrap category material is weighed to ensure the assay station loading weight limit of 500 pounds is not exceeded, assayed for g ^{235}U content, and then staged for dumping into a container for shipment to a waste processor for further volume reduction and eventual burial at Barnwell. Insulation, the largest volume of this scrap category, is generally not compacted or shredded in-house. Owners of the scrap generated are responsible for the segregation of scrap and removal of gross contamination.

Metallic scrap is staged for decontamination as necessary. Decontamination is accomplished using one or more of several operations: (1) hand cleaning, (2) torch removal of surface oxidation and scale, (3) liquid honing treatment, (4) ultrasonic cleaning, and (5) automated parts washing. Other honing processes have been proposed.

Scrap that is a combination of non-combustible and combustible materials (i.e. HEPA, pre-filters and AC bags) is staged according to ^{235}U content; ≤ 5 g ^{235}U and >5 g ^{235}U. All of these materials may be dismantled and segregated inside the Decon/Cutting Room. These same materials may also be brought into the Decon/Cutting Room solely to prepare material for dismantling and then delivered through a wall opening into a "Dismantling and Separation Hood." Combustible and non-combustible materials are placed in appropriate containers for further processing. There is also a totally self-contained "Sorting Hood," located outside the Decon/Cutting Room, planned for like service, but not presently in operation. Filter dismantling is required to separate any aluminum foil or wire spring from filter media and to collect loose uranium residue.

Assay Operations:

The Canberra Computer Based Gamma Scanning Systems are designed to determine the amount of specific radioactive nuclides present in containers of medium to low density waste and process scrap using an attenuation corrected gamma-ray measurement technique developed at the Los Alamos Scientific Laboratory. Two systems are used in this endeavor: System #2, a Segmented Gamma Scanner (SGS) for non-combustible waste, and System #3, a Q^2 Passive Gamma Measurement System for combustible trash and incinerator ash.

The Segmented Gamma Scanner (SGS) is a Germanium detector, passive gamma measurement system used to measure total ^{235}U content in 55 gallon drums. Non-combustible waste destined for burial, metal melt or decontamination are assayed for accountability. Wet cartridge filters, mop heads or rags, washed or judged to be lightly contaminated, are routinely assayed to determine the need for further washing and incineration. Molybdenum scrap in 1-gallon paint cans and dried press cake in polypaks may also be assayed. The limits for items measured in the SGS - Assay #2 are: Drums - 42.0 g ^{235}U, and wet material (Cuno) - 104.0 g ^{235}U. All assay results are verified below the posted limits; otherwise, they are repackaged and assayed. The criticality control limit for any 55 gallon drum is 104 g ^{235}U. The assay result for each drum is entered into a computerized material traceability system and recorded on the drum label; this is critical for managing drum shipments to GTS Duratek for processing or to Barnwell for direct burial, both of which have a site limit of 325 g ^{235}U. Any drum counted for the purpose of spacing must be measured on Assay #2 (SGS) and assigned a gram ^{235}U value prior to shipment or inventory.

The Q^2 Waste Assay Passive Gamma Measurement System is a NaI passive gamma measurement system used to measure total ^{235}U content in large polypaks containing incinerator ash (milled ash, 1/8"-screen unpulverized ash, pulverized ash, or Torit fines) and combustible trash in 52 or 55 gallon drums destined to be burned. Incinerator ash materials are assayed only if not processed within 72 hours. HEPA filters (24" x 24" x 12" size) may also be assayed, but only if having a scanned survey value of $\leq$1.0 g ^{235}U/10 liters and only for criticality control; not to be used for inventory or shipment. Filters having a survey or assay value of >1.0 g ^{235}U/10 liters are to be dismantled and sorted prior to incineration. The limits for items measured in the Q^2 - Assay #3 are: drums of trash - 17.0 g ^{235}U, and Ash - 91.0 g ^{235}U.

If the assay system is down, drum filling may continue, accumulating weighed drums of trash according to appropriate spacing requirements. Also, assayed drums may be combined to a more condensed storage if appropriate assay/weight guidelines are satisfied.

Rotary Shear Shredder:

The rotary shear shredder is used for two basic operations: (1) non-combustible scrap volume reduction prior to shipping to a waste processor and eventual burial, and (2) shredding combustibles such as filter boards and assorted large plastic pieces (i.e. polypaks, hard hats, Lexan sheets) prior to incineration.

Non-combustible, non-metallics designated for volume reduction are verified free of visible contamination, or decontaminated as necessary. Decontamination is generally not a consideration (i.e. refractory brick), but can be accomplished by hand cleaning the material (i.e. large plastic pieces) in the URRS Decon/Cutting Room or Sorting Hood. Once the material is judged to be clean, it is staged for either shredding or compaction in 55 gallon drums.

To prepare absolute (ABS) filters (HEPA and intermediate filters) for incineration, the filters are changed and surveyed for disposition. Dirty filters are segregated into two categories; those containing ≤ 5 g ^{235}U/10 liters, and those greater. Filters that are ≤ 5 g ^{235}U/10 liters may be staged in a close-pack array; filters reading >5 g ^{235}U/10 liters should be staged with a 12 inch minimum spacing between bagged filters. These filters are not shredded, but sent to the URRS Decon/Cutting Room for disassembly. Any filter bundle not marked as to survey count are assumed >5 g ^{235}U/10 liters and are not shredded. IFBA-source filters are stored in the IFBA area until ready for disposal in URRS.

The shredding operation proceeds as follows: Operators place a drum onto the feed elevator which lifts the drum and dumps its contents into the shredder feed hopper. The material is shredded, falling into one of two receiver drums. Following the shredding operation, the material in the receiver drums may be compacted. For non-combustibles, the full receiver drums are weighed and assayed to determine g ^{235}U content, and then staged for dumping into a compaction box for shipment to GTS Duratek and eventual burial. For filters, the two full receiver drums are weighed and assayed to determine g ^{235}U content, and staged for incineration.

Incineration:

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 licensed burial grounds. 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 off-gas filtration and ash leaching systems are described and analyzed in other Safety Evaluations.

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.

Paper bags filled with contaminated combustible wastes are delivered to the incinerator area where they are monitored for metal, assayed for ^{235}U content, and weighed (mass control). The amount of waste and associated ^{235}U charged to the incinerator are limited for criticality safety purposes. A limit of 100 g ^{235}U may be charged to the incinerator at one time, and a total of 1,386 g ^{235}U may be charged to the incinerator during a "burn" campaign. The incinerator operator must ensure the feed drum is controlled and used only for transporting feed materials from the staging area in the UF_6 bay to the incinerator. Nothing is to be added to the drum until it is moved back to the UF_6 bay. When uranium-bearing, non-hazardous, liquid waste (i.e. oil, ethylene glycol) is to be burned, small amounts of it are manually added to the bagged waste just prior to the waste being loaded into the incinerator feed system. Likewise, materials such as conpor resin, zirc-contaminated shavings or fines, floor sludge, sanitary sludge and kerosene may be charged to the incinerator in limited quantities and with appropriate handling.

After placing the trash inside the incinerator charging bay, trash loading to the incinerator is started with remote controls to sequence the closing of the outer door, opening the inner door and pushing the trash into the incinerator. The lower chamber burner and ash pile are readily observed from the viewport on the lower chamber door. The incinerator operator will manually stir the ash pile inside the lower chamber to ensure volume reduction and a complete trash burn. Additional trash charging is made, making sure that the material charged for a particular "burn" does not exceed the mass control limits.

An operator rakes the ash from the lower chamber into the ash cleanout chute, where a ram pushes it toward a cooling chamber. After allowing the ash to cool, the operator rakes the ash into an elevator skip bucket which delivers it up to a ventilated hood where metal is sorted out. This is the beginning of the Ash Handling process.

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 (covered under another Safety Evaluation) pass through a condenser and a "knock-out" tank to reduce the moisture in the gas stream. The condensed liquid is returned to the scrubber system for reuse.

Ash Handling:

As indicated, incinerator ash is cooled and conveyed to a ventilated hood where tramp metal is sorted out. This is the beginning of the Ash Handling process. The ash is then milled for size reduction. This milling is typically done in two stages. Primary milling involves use of a Fitzmill comminuting (hammermill) machine. The secondary milling, if needed, is done using a Mikro-Pulverizer. The milling system ventilation is provided by a Torit Downflo Cartridge Filter System.

The cooled ash drops from the elevator skip bucket into a chute. The chute extends into a ventilated hood and has a discharge trap door. With the Fitzmill running, the operator opens the trap door, allowing the ash to flow onto a sorting screen. A vibrator with foot pedal control is mounted on the elevator discharge chute to promote ash flow. The operator inspects the ash for tramp metal using a magnet and visual inspection. The metal is removed, put in a polypak and staged for disposal. Material passing through the sorting screen drops into the mill feed throat, through the rotor chamber and discharges into a polypak. The milling action is achieved by the impact of high-speed hammers, and the forcing of the ash onto a mill throat breaker plate and through a perforated screen.

Ash is fed to the Fitzmill until the "polypak full" alarm is activated; the mill will shut off automatically. Milling will continue until the ash chute is empty.

The milled ash is staged for either acid leaching (dissolution) or pulverizing using the Mikro-Pulverizer.

The operator puts a polypak with milled ash to be pulverized into the Pulverizer hood. Using gloveports, the operator removes the lid from the polypak and manually empties the solids onto the impact surface of a vibratory feeder. The feeder moves the solids along a screen. The "oversize" solids travel the length of the screen and fall into another polypak. Solids passing through the screen are vibrated into the pulverizer inlet chute above the pulverizer feed screw. A level of solids is maintained above the feed screw to prevent blowback into the hood by sequencing the operation of the pulverizer feed screw and vibratory feeder. The feed screw pushes the solids into the pulverizer chamber. A retaining screen at the bottom of this chamber controls the particle size of the product. Air also enters the pulverizing chamber through 2 ports located on either side of the chamber. Solids passing through the retaining screen fall through a discharge chute, sliding gate valve and associated ductwork, and are collected in the fines polypak. When the fines polypak is full, the feed screw motor stops but the pulverizer motor continues to operate. After the full polypak is removed and replaced with an empty polypak, the filling cycle is repeated.

The pulverized ash is staged for acid leaching (dissolution). The "oversize" material is staged for remilling through the Fitzmill.

The air entering the pulverizing chamber of the Pulverizer is vented from the discharge chute through 2 ports on either side of the conical hopper, which is connected to a filtration system (Torit Downflo Cartridge Filter System). The Torit system also provides ventilation for Fitzmill and Mikro-Pulverizer hoods and enclosures. Torit fines are collected in a polypak. This material is staged for processing through the acid leaching process (dissolution).

Compaction:

A low pressure compactor is used to compact designated scrap for volume reduction. The compactor is generally used for compacting light gauge metals (i.e. wire, aluminum from filters) that are unacceptable for "metal melt" disposition, but not for combustible materials, trash, or absolute filters. The compactor may also be used to compact drums that are to be dispositioned for metal melt.

The drum of scrap is positioned into the compactor. Compaction is limited to only slightly contaminated LLRW. Metal bars or pieces that might penetrate the drum are not to be compacted. The compactor ram is activated when the compactor door is closed. Material compaction is continued until the drum is full with compacted scrap, but not to exceed a 500-pound gross weight limit for the Assay Station. The drum of compacted scrap is staged for weighing and then assayed to confirm contents does not exceed 104 g ^{235}U (criticality control limit), and then readied for shipment for eventual burial. Generally, this category of material will have a very low assay result (<10 g ^{235}U) and a weight of <250 pounds.

Decon/Cutting 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. Also, all areas of an item that would be inaccessible to survey for contamination is 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.

Liquid Honing:

Non-combustible scrap classified as large, heavy metal pieces is segregated for decontamination using liquid honing. Paint and corrosion should be removed prior to liquid honing; this is done in the Decon/Cutting Room. Very large pieces to be cleaned are cut up in the Cutting Room before being sent to the honing booth for decontamination. Parts cleaned in the Liquid Honing Booth are generally expected to be disposed of as either "free release" or "metal melt."

The URRS liquid honing process removes surface contamination along with surface finishes, including portions of base metals being decontaminated. The system consists of an enclosed walk-in work chamber which contains one operator station with rubber glove ports, safety glass sight window, and control console. Small parts to be cleaned are staged on the booth grating at the glove port station.

The booth has a door which allows for the entrance of large parts on a trolley along with an operator for interior cleaning.

The Honing process uses a closed loop system to circulate an abrasive media slurry of inert alumina and water. The media slurry is pumped through a mixing chamber to the process decontamination guns. After removal of surface debris and contamination, the slurry mixture is returned to the sump for recirculation and reuse. A gamma monitor is installed externally on each of the two sump chambers to assure criticality safety. A passive overflow precludes overfilling the sump.

The surface finish obtained on the parts and aggressiveness of the cleaning action are infinitely variable by the operator across the equipment operating range. The lubricating action of the water buffers the action of the abrasive media and also prevents the surface debris removed from becoming airborne.

The station sump is initially filled with water, with over-flow water draining to a settling tank (weir box). A prescribed amount of honing media is added to the sump. Water is added to sump until weir box is full. The weir box is maintained near-full during operation to ensure sufficient water for rinsing parts, trolley and grating. An air-operated pump is used to circulate the rinse water. An abrasive "blast" pump is used to circulate water and media for parts honing. For "walk-in" cleaning operation, a "dead-man gun" is used, with safety-trigger control of flow of media and blast air. For small parts washing from the outside operator station, a "blast gun" with separate air regulator is used.

A cyclone separator is supplied, mounted inside the enclosure, to separate used abrasive media and debris from the water. This operation is performed when the basic charge of abrasive media has broken down and it is noted that the cleaning effectiveness has been reduced and more time is required to complete a cleaning operation and/or when the contamination increases to an activity level approaching $3x10^{-5}$ μCi/cc. Cycloning the solids out of the sump will usually decrease the contamination level significantly and the water in the equipment may be retained and mixed with a new charge of abrasive media. The solids are spun-out and discharged through the bottom of the cyclone separator into a bucket placed on the grating.

The spent grit is disposed of as combustible trash. Eventually the water will also have to be replaced as determined by contamination level. The Honing Booth water is pumped from the weir box, through a cartridge filter, to one of the two Parts Washer Check Tanks, sampled, and pumped to the contaminated sump if $<3x10^{-5}$ μCi/cc; if not, the water is filtered using the Parts Washer filter press until below this release limit.

Ultrasonic Cleaning:

The URRS ultrasonic cleaning system is designed to remove surface contamination on small parts and metallic waste that would otherwise be discarded for burial, but may be cleaned sufficiently well for free release or metal melt. The system uses ultrasonic power to remove surface contamination. The addition of nitric acid or other cleaning agents or "decon chemicals" to the bath water facilitates the cleaning. Nitric acid will also etch surface finishes and remove portions of base metals being decontaminated.

The Ultrasonic Cleaner (UT) converts electrical energy at an ultrasonic frequency into mechanical sound energy for cleaning through magnetostrictive transducers metallically fused to the bottom of the cleaning chamber. The electrical energy is supplied by the generator station. The energy from the transducers is coupled into the cleaner solution through the diaphragm of the sonic chamber to produce intense cavitation in the solution. Cavitation is the creating of hollow particle vacuole bubbles in the cleaning solution. It is the imploding action occurring when the cavitation bubbles collapse against the surfaces of the item being cleaned that produces the scrubbing action. The ultrasonic action also generates substantial heat energy, resulting in an increase in bath temperature. The increasing of bath temperature enhances cavitation cleaning effectiveness.

The UT system essentially consists of two basin sinks and a filter press, through which the water and cleaning agent from either tank is circulated as needed. Each tank has a high level overflow, and any tank overflow is drained to the floor which has a 4" high curb. Each tank is also equipped with a gamma monitor for activating an emergency (high-high activity at 5 g ^{235}U/liter) dump valve drain, and a low-level probe interlocked to stop both ultrasonic transducers of the affected tank and the system pump. A high gamma alarm sounds a horn and engages a panel light at 1 g ^{235}U/liter.

The basins are filled to a prescribed level with city water. Nitric acid or decon chemical is added to the wash tank per engineer's instructions. A ventilation system is provided to service all system hoods designed to capture water vapor and chemical fumes emitting from work areas.

Putting parts in the tank should not result in liquid overflow; but if there is excess liquid in the tank, it is pumped to the fluoride stripping system feed tank for uranium recovery. If the water in either tank is dirty or discolored, it is recirculated through a filter press until it is clear and void of particles. If the water cannot be cleaned, it is pumped to the fluoride stripping system feed tank for uranium recovery, and fresh city water and cleaning agent are added. If the fluoride stripping system feed tank cannot receive solution, or if the liquid discharge is small, the solution may be transferred into a pail or other favorable geometry container and delivered to Scrap Reprocessing.

Metal parts to be cleaned are placed in one of several perforated cleaning baskets and lowered into the wash tank using an overhead hoist. After a specified washing time, the parts are raised from the tank and rinsed with water. The basket is momentarily placed on the drain table, then lowered into the rinse tank. The rinse tank water is pumped from the tank, through a filter press, and returned to the rinse tank until visibly clean. Again, the basket is raised to permit rinsing of the parts. The basket is placed on the final drain table. The parts may be air-dried in the basket, or removed to dry on the sorting table.

Scrap Zircaloy tubing is commonly cleaned using the Ultrasonic Cleaner. To facilitate cleaning of the tubing, the tubes are first split using a machine called a Tube Crusher. The 3/8" tubes have a cut length of about 3 feet. These are fed, one at a time, into the crusher feed fixture that directs the tube through a set of dual rollers that split the tube. The two tube halves exit a discharge fixture, falling into a receptacle (i.e. drum). After UT cleaning, the split zirc tubes are surveyed by REO personnel for free release for sale to a processor for the steel industry. The free released zirc may also be shipped to Western Zirconium for needed add-back material to their smelting process.

Parts Washer:

The parts washing system is designed to clean parts for either "free-release," "metal melt" or uranium reduction. Presently, the primary use of the Parts Washer is for cleaning weld slag to achieve "metal melt" disposition. The washing machine can accept washing trays for parts of various sizes. A sink is provided to remove gross contamination before taking parts to the washer. A washing tray full of parts to be cleaned is manually loaded to the washer. The last tray of washed parts is removed manually from the rinsing section of the machine. City water is used for parts cleaning, with two heaters in series used to heat the water.

The washer and rinse sink discharges drain to an open reservoir tank (stand-pipe). This tank is also used to collect drained liquid from the system filter press; the liquid is poured into the tank with a strainer basket in place. No other liquids are to added to this tank. An air-operated pump is used to send this wash and/or rinse tank water to either of two Check Tanks. The tank contents is circulated through a filter press before sampling for activity. The solution is released for discharge to the contaminated sump if the activity is $<3\times10^{-5}$ µCi/cc; filtering is continued as needed. The Check Tanks are also used to stage contaminated solution from the Liquid Honing Booth weir box for filtering and sampling prior to discharge to the contaminated sump.

Grit Blaster:

The system described here is not yet operational. The intended purpose of the Grit Blaster is to serve as another liquid honing process for cleaning small metal items to "metal melt" release limits. The specific system proposed may be used for cleaning moly boats for repair rather than being cleaned in the larger liquid honing booth previously described. The Grit Blaster may also be used to clean other small parts for like utility or free-release.

As with the honing booth, the Grit Blaster ejects a mixture of abrasive particles and water in a circulated system from a special gun at high velocity and is directed against the object to be treated.

Procedures and Drawings

Key procedures and drawings for these LLRW Processing Systems are identified in the tables below:

Trash Collection:

PROCEDURE NO.	TITLE
COP-831001	Handling, Processing, & Disposing LLRS
COP-831007	Sorting Hood Operation
COP-831016	Metal Detector Operation
COP-836033	Combustible Trash Collection Scale System
COP-841000	Low-Level Radioactive Scrap Handling
COP-843002	Control of Non-Favorable Geometry (NFG) Containers in the Chemical Area
ROP-01-004	Pac 4-G Operation
ROP-01-009	Geiger Counter Model E-120

DRAWING NO.	TITLE
500F03AR01-1	Equipment Arrgmt. Bay 1-2 & BB-CC
500F03AR01-2	Equipment Arrgmt. Bay 1-2 & AA-BB
500F03AR20-2	Equipment Arrgmt. Bay 1-101 & AA-BB

Assay Operations:

PROCEDURE NO.	TITLE
COP-830251	Standard and Replicate Checks for SGS/Q^2
COP-831001	Handling, Processing, & Disposing LLRS
COP-831012	Operation of Canberra Segmented Gamma Scanner (SGS)
COP-835510	Operation of Canberra Q^2 System
COP-843002	Control of Non-Favorable Geometry (NFG) Containers in the Chemical Area

DRAWING NO.	TITLE
500F03AR01-2	Equipment Arrgmt. Bay 1-2 & AA-BB

Rotary Shear Shredder:

PROCEDURE NO.	TITLE
COP-814610	Pigtail Disposal
COP-815003	Cleaning Absolute Filters and Prefilters
COP-831001	Handling, Processing & Disposing LLRS
COP-831013	Shredder Operating Procedure
COP-841000	Low-Level Radioactive Scrap Handling
COP-843002	Control of Nonfavorable Geometry (NFG) Containers in the Chemical Area
MCP-108110	Changing In-Plant Absolute (HEPA), Intermediate and Pre-Filters
ROP-05-008	Surveying Filtration Devices for ^{235}U

DRAWING NO.	TITLE
500F03AR01-1	Equipment Arrgmt. Bay 1-2 & BB-CC
500F03AR01-2	Equipment Arrgmt. Bay 1-2 & AA-BB

Incineration:

PROCEDURE NO.	TITLE
COP-830210	Incinerator Operation
COP-831001	Handling, Processing & Disposing LLRS
COP-836033	Combustible Trash Collection Scale System
COP-841000	Low-Level Radioactive Scrap Handling
COP-843002	Control of Nonfavorable Geometry (NFG) Containers in the Chemical Area

DRAWING NO.	TITLE
304F01EQ01	Incinerator Area Contactor Tube and Quench Pot Details
304F01EQ02	Incinerator Absorber and Water Weir Details
304F01EQ06	Incinerator Refractory Layout
304F01EQ12	Incinerator Lower Chamber Air Tube and Hearth Modifications
304F01HV02	Incinerator Upper Chamber to Quench Column Cross Over
304F01PI01-1,2	Incinerator Burner Controls & Instrumentation List
304F01PI02-1-4	Incinerator Off-Gas
304F01PI03	Incinerator Valve & Instrument List
304F01PI04	Incinerator Door Vent P&ID
304F06EQ02-1	Incinerator Ash Handling System
304F06EQ02-3	Incinerator Cooling Chamber Detail
304F06EQ02-4	Incinerator Skip Bucket Frame
304F06EQ02-5	Skip Bucket Details
304F06EQ02-6	Incinerator Skip Bucket and Hopper Details
500F03AR02-3,4	Equipment Arrangement Bay 2-3 & A-BB
S10-0470-D	Metaullics Systems Co. L.P. Drawing, Model 10-168 Impervite Heat Exchanger
S-111-C-18B	Metaullics Systems Co. L.P. Drawing, "Alternate Vertical & Horizontal Movable Supports, Series "BC" Heat Exchangers"

Ash Recovery:

PROCEDURE NO.	TITLE
COP-830210	Incinerator Operation
COP-830219	Torit Downflo Cartridge Filter - Startup, Operation, & Shutdown
COP-830220	Mikro Pulverizer - Startup, Operation, and Shutdown
COP-836032	Fitzmill Startup, Operation, and Shutdown

DRAWING NO.	TITLE
304F01EQ15	Incinerator Fitzmill Model V-DAS06-SSB
304F06EQ02, 2, 3, 9, 12	Ash Handling System
304F09EQ01, 1-6	Ash Handling Hood
304F09EQ02	Pulverizer Sound Enclosure
500F03AR02-2,3	Equipment Arrgmt. Bay 2-3 & A-BB
21914-D	MikroPul Drawing, "2 Mikro Pulverizer"
D-214133	FMC Syntron, Link-Belk & Aseeco Products Drawing, "General Arrangement SFH-22 Feeder with Spec. 12"Wx62" LG. Trough"

Compactor:

PROCEDURE NO.	TITLE
COP-831001	Handling, Processing, & Disposing LLRS
COP-831006	LLRS Low Pressure Compactor
COP-843002	Control of Non-Favorable Geometry (NFG) Containers in the Chemical Area

DRAWING NO.	TITLE
500F03AR01-1	Equipment Arrgmt. Bay 1-2 & BB-CC

Decon/Cutting Room:

PROCEDURE NO.	TITLE
COP-831007	Sorting Hood Operation
COP-836020	Operation of Plasma Torch
COP-836021	Operation of Natural Gas/Oxygen Cutting Torch
COP-836022	Cutting Room Ventilation Downflo Cartridge Filter House

DRAWING NO.	TITLE
500F03AR20-1	Equipment Arrgmt. Bay 1-101 & BB-CC
500F03AR20-2	Equipment Arrgmt. Bay 1-101 & AA-BB

Liquid Honing:

PROCEDURE NO.	TITLE
COP-831001	Handling, Processing & Disposing LLRS
COP-831014	Liquid Honing
COP-841000	Low-Level Radioactive Scrap Handling

DRAWING NO.	TITLE
372F02PI03	Liquid Honing & Aux. Equipment P&ID
500F03AR19-1	Equipment Arrgmt. Bay 101-102 & BB-CC

Ultrasonic Cleaning:

PROCEDURE NO.	TITLE
COP-831001	Handling, Processing & Disposing LLRS
COP-836029	Tube Crushing Station
COP-836030	Ultrasonic Cleaning Station for Metallic Parts Free Release or Reuse
COP-841000	Low-Level Radioactive Scrap Handling
COP-843002	Control of Non-Favorable Geometry (NFG) Containers in the Chemical Area
RA-402	Material Transfer to LLRW Storage
ROP-02-004	Abandonment or Disposition of Material or Equipment

DRAWING NO.	TITLE
372F02EQ04	Ultrasonic Cleaning - Wash Hood
372F02EQ05	Ultrasonic Cleaning - Rinse Hood
372F02EQ07	Perferated Cleaning Basket
372F02EQ08	Ultrasonic Cleaning Wash Tank T-984
372F02EQ09	Ultrasonic Cleaning Wash Rinse T-985
372F02PI01	Ultrasonic Cleaning P&ID
372F02PP02	Ultrasonic Cleaning Piping Plan
372F02EQ10	Ultrasonic Cleaning Drainboard & Table
372F02HV02-1,2	Ultrasonic Cleaning Ventilation Elevation
500F03AR19-1	Equipment Arrgmt. Bay 102-103 & BB-CC
500F03AR19-2	Equipment Arrgmt. Bay 101-102 & BB-CC

Parts Washer:

PROCEDURE NO.	TITLE
COP-831015	Operation of Parts Washer
COP-843002	Control of Movable NFG Containers in the Chemical Area

DRAWING NO.	TITLE
372F02PI04	Parts Washer P&ID

Grit Blaster:

This system is not yet operational.

The following Vapor-Blast Manufacturing Co. drawings were reviewed for the CSE.

DRAWING NO.	TITLE
C49-35	Floor Plan & Utilities Connection Dwg
D55-290	General Assembly of Spec. 3030 VELH Machine
C87-1583	Air Slurry & Hydro-Cyclonic Rinse Piping
C87-1584	Fresh Water Rinse & Drain Piping Diagram
A82-253	Exhaust Collection Tank for 5" Fan
D125-94	2" Dia. Tumbling Barrel Sub-Assembly

Environmental Protection and Radiation Safety Controls

To be provided in a future Integrated Safety Assessment

Nuclear Criticality Safety (NCS) Controls and Fault Trees

Trash Collection

Control Parameters and Safety Limits:

Control Parameters
dry combustible trash
- mass

wet combustible trash
- mass

Safety Limits
- See Table 1 (Dry)
- See Table 2 (Wet)

Bounding Assumptions: (From Table in SNM-1107)

- Heterogeneous UO2 plastic - moderated (Dry)
- Homogeneous H2O - water moderated (wet)
- Partial water-equivalent reflection all around
- 5.0 wt% enrichment

Controls

Safety Significant Controls

Administrative controls with computer or alarm assist (AC)
Administrative controls with computer or alarm assist (AC) typically consist of operator actions that are prompted or assisted by computer output. The requirements for functional verification are determined by this evaluation.

Control ID	Control Function/ Failure Condition/ Action	Procedure Number	Funct. Verif. Required	Initiating Event (IE) No.
AC-DRY-1-01	Prevent mass limit from being exceeded/ Trash collection scale fails and operators do not detect/ Operator conduct regular checks	COP-836033	yes	DRY-5,6

AC-DRY-1-02	Prevent mass limit from being exceeded/ Trash collection scale light comes on at HI level/ Operator stops filling drum	COP-836033	yes	DRY-7
AC-DRY-1-03	Prevent mass limit from being exceeded/ Trash collection scale alarm sounds at HI HI level/ Operator notifies Team Manager, fills out Redbook report	COP-836033	yes	DRY-8

<u>Administrative controls</u>

Safety Significant administrative controls are required operator actions that usually occur without prompting from a computer/control panel alarm or indication. These controls may require documentation via Control Form or some other record. Functional verification is not normally required.

Control ID	Control Function/ Failure Condition/ Action	Procedure Number	Funct. Verif. Required	Initiating Event (IE) No.
A-DRY-1-01	-Prevent mass limit from being exceeded/ Gross uranium or pellets in trash/ Area operators ensure no gross uranium or pellets in trash	COP-84100	No	DRY-1
A-DRY-1-02	Prevent mass limit from being exceeded/ Gross uranium or pellets in trash/ URRS operators ensure no gross uranium or pellets in trash	COP-831003		DRY-3
A-WET-1-01	Prevent excessive mass in URRS drum/ Wet trash reaches drum without caked-on material removed/ Operators remove caked-on material	COP-841000		WET-1
A-WET-1-02	Prevent excessive mass in URRS drum/ Wet trash reaches URRS drum without being washed/ Area operators wash wet trash before taking to URRS	COP-841000		WET-2

Margin of Safety

The nuclear criticality margin of safety for the trash collection process is evaluated to be very strong. Calculations performed indicate that $k_{eff} \leq 0.95$ for all normal operating conditions and expected process upsets. Further, for any credible process upset, or series of credible process upsets which result in a contingency, k_{eff} is less than 0.98.

The parameter that directly affects neutron multiplication for wet and dry combustible trash is mass. Criticality safety limits (CSLs) and Bounding Assumptions (BA) have been established. A criticality would be possible with combustible trash given the following conditions:

- combustible trash contains excessive amounts of uranium which is not detected by an operator, and it is placed in a drum such that the safety limit is exceeded.

Noncombustible trash does not pose a criticality concern.

Table 1: Nuclear Criticality Safety Limits for k_{eff} 0.90, 0.95, and 0.98 for the Dry Combustible Trash System

PARAMETER	NORMAL OPERATING CONDITIONS	BOUNDING ASSUMPTION	CRITICALITY SAFETY LIMIT ≤ 0.90	CRITICALITY SAFETY LIMIT ≤ 0.95	CRITICALITY LIMIT ≤ 0.98
^{235}U MASS	29.9 kg Total Mass (66 lb.)	Unrestricted UO2	not calculated	40.8 kg Total Mass (90 lb.)	53.9 kg Total Mass (119 lb.)
MODERATOR/ CONCENTRATION	dry trash - paper and plastic moderation	Optimum Moderation	Optimum Moderation	Optimum Moderation	Optimum Moderation
GEOMETRY	NFG (55 gallon drum)	NFG (55 gallon drum)	NFG (55 gallon drum)	NFG (55 gallon drum)	NFG (55 gallon drum)
SPACING	N/A	N/A	N/A	N/A	N/A
DENSITY	Homogeneous UO2•H2O	Homogeneous UO2•H2O	Homogeneous UO2•H2O	Homogeneous UO2•H2O	Homogeneous UO2•H2O
ABSORBERS	None				
ENRICHMENT	≤ 5.0 wt%				
REFLECTION	Full Water reflection Assumed in Calc	Partial	Partial	Partial	Partial

Table 2: Nuclear Criticality Safety Limits for k_{eff} 0.90, 0.95, and 0.98 for the Wet non-URRS Combustible Trash System

PARAMETER	NORMAL OPERATING CONDITIONS	BOUNDING ASSUMPTION	CRITICALITY SAFETY LIMIT ≤ 0.90	CRITICALITY SAFETY LIMIT ≤ 0.95	CRITICALITY LIMIT ≤ 0.98
^{235}U MASS	<91 kg (200 lb.) Total Mass	Unrestricted UO2	91 kg U 238 lb. Total Weight	105 kg U 271 lb. Total Weight	120 kg U 304 lb. Total Weight*
MODERATOR/ CONCENTRATION	wet trash	Optimum Moderation	Optimum Moderation	Optimum Moderation	Optimum Moderation
GEOMETRY	NFG (55 gallon drum)	NFG (55 gallon drum)	NFG (55 gallon drum)	NFG (55 gallon drum)	NFG (55 gallon drum)
SPACING	N/A	N/A	N/A	N/A	N/A
DENSITY	Homogeneous UO2•H2O	Homogeneous UO2•H2O	Homogeneous UO2•H2O	Homogeneous UO2•H2O	Homogeneous UO2•H2O
ABSORBERS	None				
ENRICHMENT	≤ 5.0 wt%				
REFLECTION	Partial around concrete below	Partial around concrete below			

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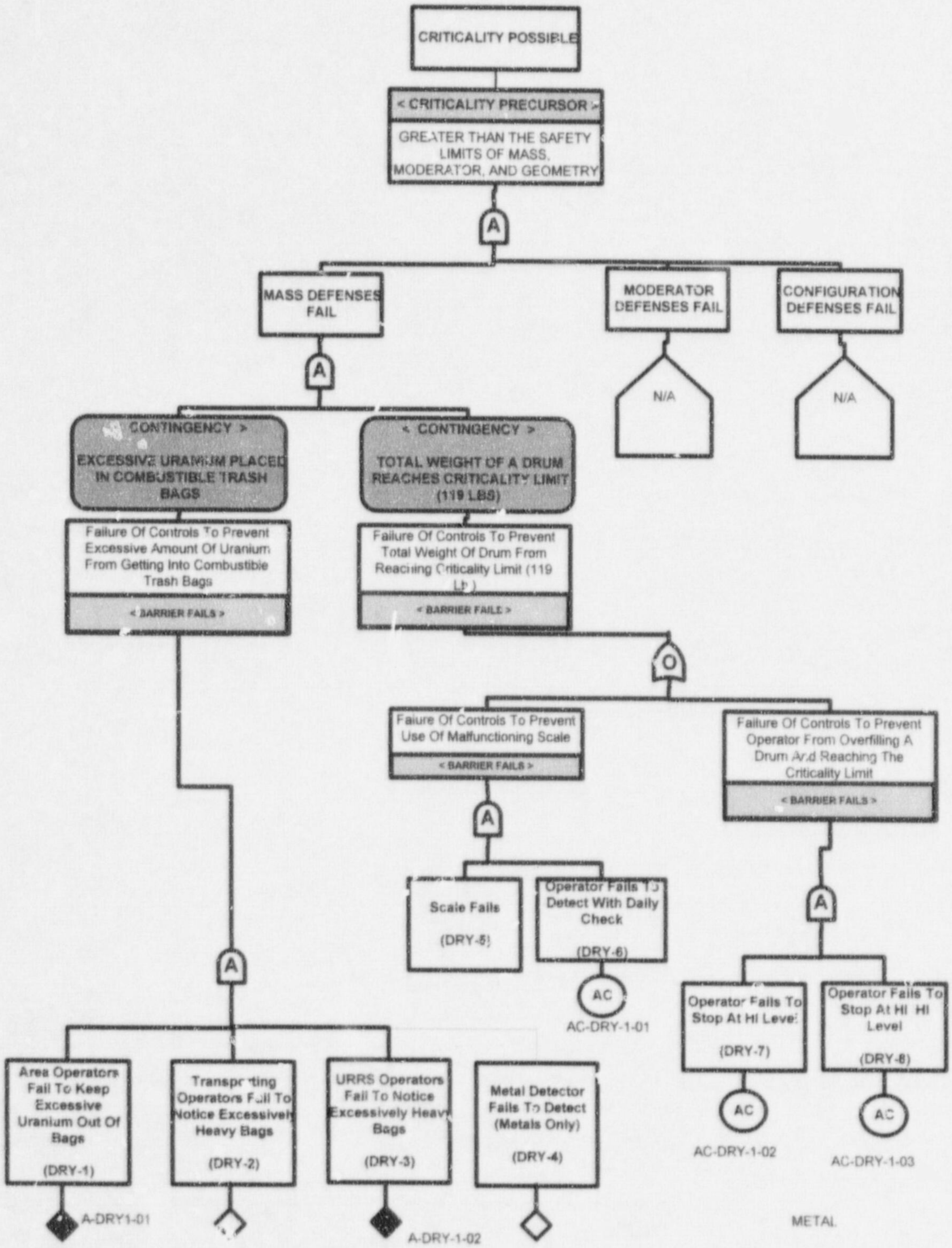
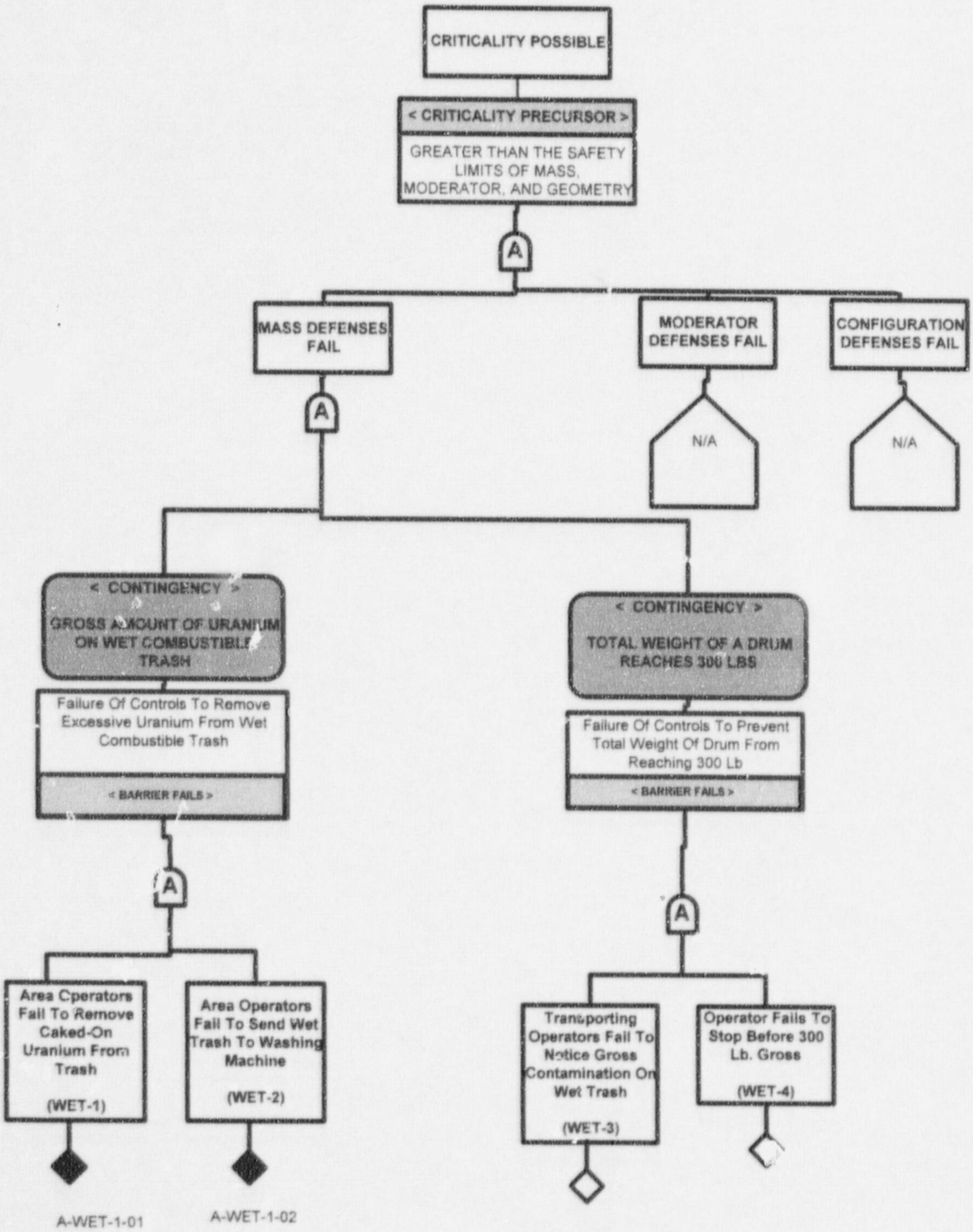
*Tare weight of drum is 40 lb

DRY COMBUSTIBLE TRASH



NON-URRS GENERATED WET COMBUSTIBLE TRASH



Assay System

Criticality in the assay systems is not a concern. The two assay systems are used for determining the ^{235}U content of LLRW prior to further processing. Proper assay is crucial to ensuring an acceptable margin of safety for the downstream LLRW processes. This section describes the two assay systems, their application, and measurement cortrol

Rotary Shear Shredder

Control Parameters and Safety Limits:

Control Parameters
- mass

Safety Limits
- See Tab!.

Bounding Assumptions: (From Table in SNM-1107)
- Homogeneous UO2
- Optimum H2O moderation
- Partial water-equivalent reflection all around
- 5.0 wt% enrichment

Controls

Safety Significant Controls

Administrative controls

Safety Significant administrative controls are required operator actions that usually occur without prompting from a computer/control panel alarm or indication. These controls may require documentation via Control Form or some other record. Functional verification is not normally required.

Control ID	Control Function/ Failure Condition Action	Procedure Number	Funct. Verif. Required	Initiating Event (IE) No.
A-SHD 1	Maintenance Properly Surveys and Sorts Filters	MCP-108110	none	SHD 1-3
A-SHD 2	Operators shred only HEPA filters marked "<5"	COP-831001	none	SHD 4

Margin of Safety
The nuclear criticality margin of safety for the shredding system is evaluated to be very strong. This evaluation has determined that a criticality due to accumulation of fissile material while shredding non-combustibles is not credible. Therefore, criticality is credible, though unlikely, only while shredding ABS filters.

Note that the current practice is not to shred any HEPA filters at all, but to disassemble them in a ventilated hood in order to separate the non-combustible aluminum foil from the combustible material. The combustible material is then loaded into drums (see Section 5.3.1), assayed, and incinerated. Powder that comes loose during disassembly is collected in a polypak. The aluminum is treated as non-combustible.

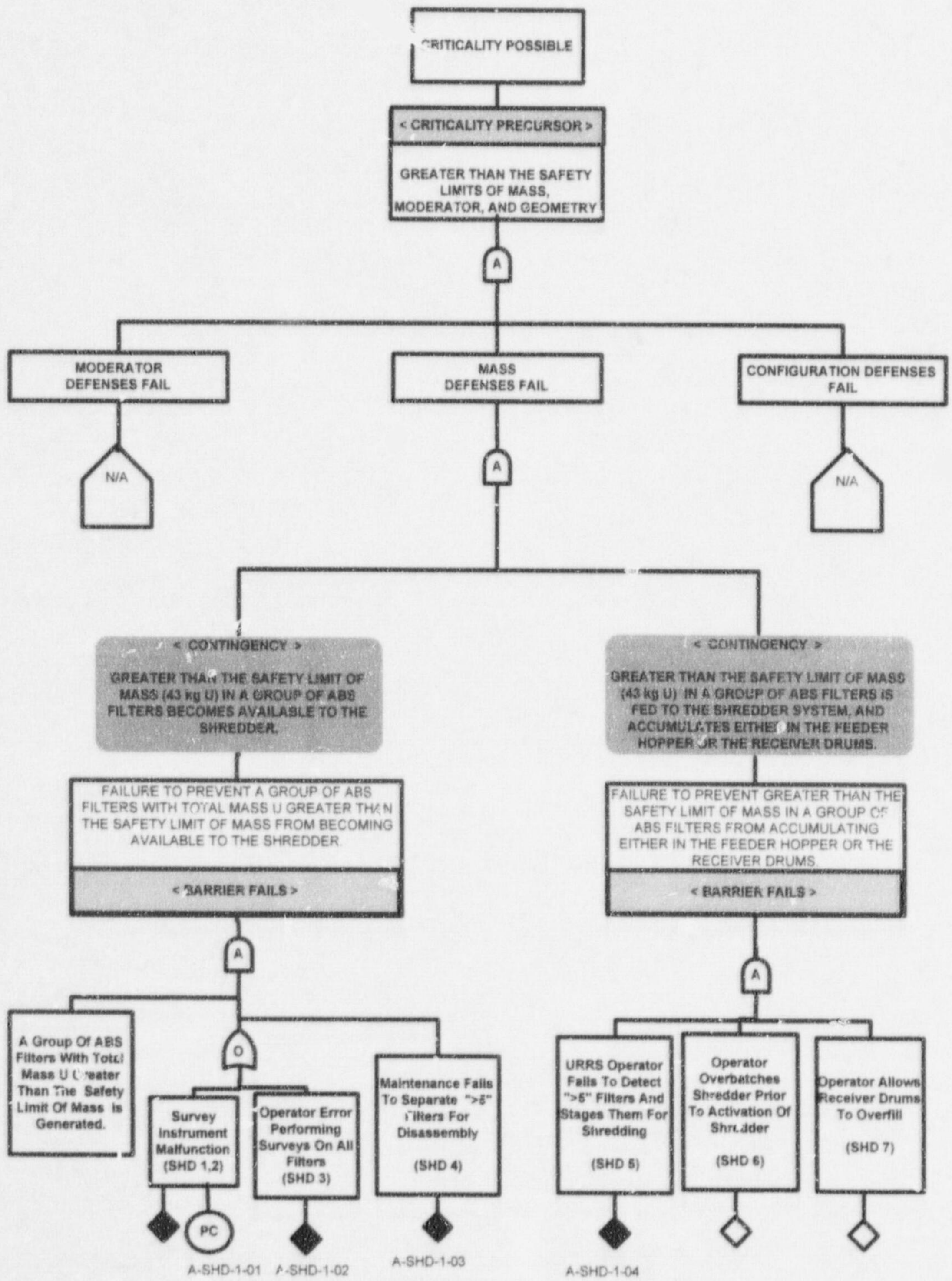
The parameters that directly affect neutron multiplication for the shredding system, assuming 5.0 wt% ^{235}U enrichment, is mass. Double contingency protection consists of preventing ABS filters with excessive SNM from getting to the shredder, and then preventing accumulation in the shredder system, most likely in the receiver drums. Criticality safety limits (CSLs) and Bounding Assumptions (BA) are established for mass. A criticality would be possible in the shredder system given the following combinations of credible process upsets:

- Sufficient material at optimum density gets into the shredder and sufficient moderator is introduced such that the powder is at optimum moderation, and the mixture forms a spherical configuration either in the feed hopper, the shredder, or one of the receiver drums.

Table 3: Nuclear Criticality Safety Limits for k_{eff} 0.90, 0.95, and 0.98 for the Shredder

PARAMETER	NORMAL OPERATING CONDITIONS	BOUNDING ASSUMPTION	CRITICALITY SAFETY LIMIT ≤ 0.90	CRITICALITY SAFETY LIMIT ≤ 0.95	CRITICALITY LIMIT ≤ 0.98
^{235}U MASS	≤ 0.5 g ^{235}U/Liter or ≤ 1.13 kg U/HEPA	Unrestricted UO2	23.7 kg U	31.7 kg U	43.0 kg U
MODERATOR/ CONCENTRATION	dry trash	Optimum Moderation	Optimum Moderation	Optimum Moderation	Optimum Moderation
GEOMETRY	NFG	Spherical	Spherical	Spherical	Spherical
SPACING	N/A	N/A	Isolated	Isolated	Isolated
DENSITY	Homogeneous UO2•H2O	Homogeneous UO2•H2O	Homogeneous UO2•H2O	Homogeneous UO2•H2O	Homogeneous UO2•H2O
ABSORBERS	None				
ENRICHMENT	≤ 5.0 wt%				
REFLECTION	Partial	Partial	Partial	Partial	Partial

ROTARY SHEAR SHREDDER



Incinerator

Control Parameters and Safety Limits:

Control Parameters

- mass

Safety Limits

- See Table 4

Bounding Assumptions: (From Table in SNM-1107)

- Homogeneous UO2
- Optimum H2O moderation
- Partial Reflection
- 5.0 wt% enrichment

Controls

Administrative controls with computer or alarm assist (AC)

Administrative controls with computer or alarm assist (AC) typically consist of operator actions that are prompted or assisted by computer output. The requirements for functional verification are determined by this evaluation.

Control ID	Control Function/ Failure Condition Action	Procedure Number	Funct. Verif. Required	Initiating Event (IE) No.
	See Trash Collection Controls (Sect 5.3.1)			IE# INC 1
AC-ASY-X-01	-Prevent unqualified operator from using Assay System - unqualified operator uses System -assay system will not allow operator to proceed	COP-831012 COP-835510		IE# ASY 1
AC-ASY-X-02	-ensure accurate measurements -out of range instruments may give inaccurate measurements -operators perform required Daily or Weekly calibration checks or standards and replicates checks	COP-831012 COP-835510 COP-830251 FNMC		IE# INC 4
AC-ASY-X-03	-ensure accurate measurements -uncalibrated instruments may give inaccurate measurements -Operators perform required calibrations	COP-831012 COP-835510 COP-830251 FNMC		IE# ASY 5

Administrative controls

Safety Significant administrative controls are required operator actions that usually occur without prompting from a computer/control panel alarm or indication. These controls may require documentation via Control Form or some other record. Functional verification is not normally required.

Control ID	Control Function/ Failure Condition/ Action	Procedure Number	Funct. Verif. Required	Initiating Event (IE) No.
	See Trash Collection Controls (Sect 5.3.1)			IE# INC 1
A-ASY-X-01	-ensure accurate measurement -Incorrect curve selected 10 times consecutively -Proper Calibration Curve Selected	COP-831012 COP-835510		IE# ASY 1
A-ASY-X-02	-ensure accurate measurement -Failure to calibrate -Measurement Control Program Ensures Proper Calibration	FNMC		IE# ASY 4,5
A-ASY-X-03	-ensure accurate measurement - Calibration standards not maintained -Calibration Standards Properly Fabricated and Maintained	FNMC		IE# ASY 3
A-INC-1-01	-record correct assay value from drum -operator records incorrect value -Operator Records correct gram ^{235}U data for each drum	COP-830210	no	IE# INC 3
A-INC-1-02	-ensure low uranium concentration in incinerator -increase in uranium concentration in incinerator -Operator Limits Each Charge to 100 grams ^{235}U	COP-830210	no	IE# INC 3
A-INC-1-03	-keep incinerator grams ^{235}U below safety limit - grams ^{235}U exceeds safety limit - Operator Terminates Burn at 1386 grams ^{235}U	COP-830210	no	IE# INC 3
A-INC-1-04	-ensure low uranium mass in incinerator -operator allows ash to accumulate from one burn to another -Operator Removes Ash Following Burn	COP-830210	no	IE# INC 4

Margin of Safety

The nuclear criticality margin of safety for the incinerator system is evaluated to be very strong. Calculations indicate that $k_{eff} \leq 0.95$ for all normal operating conditions. Further, for any credible process upset, $k_{eff} < 0.98$.

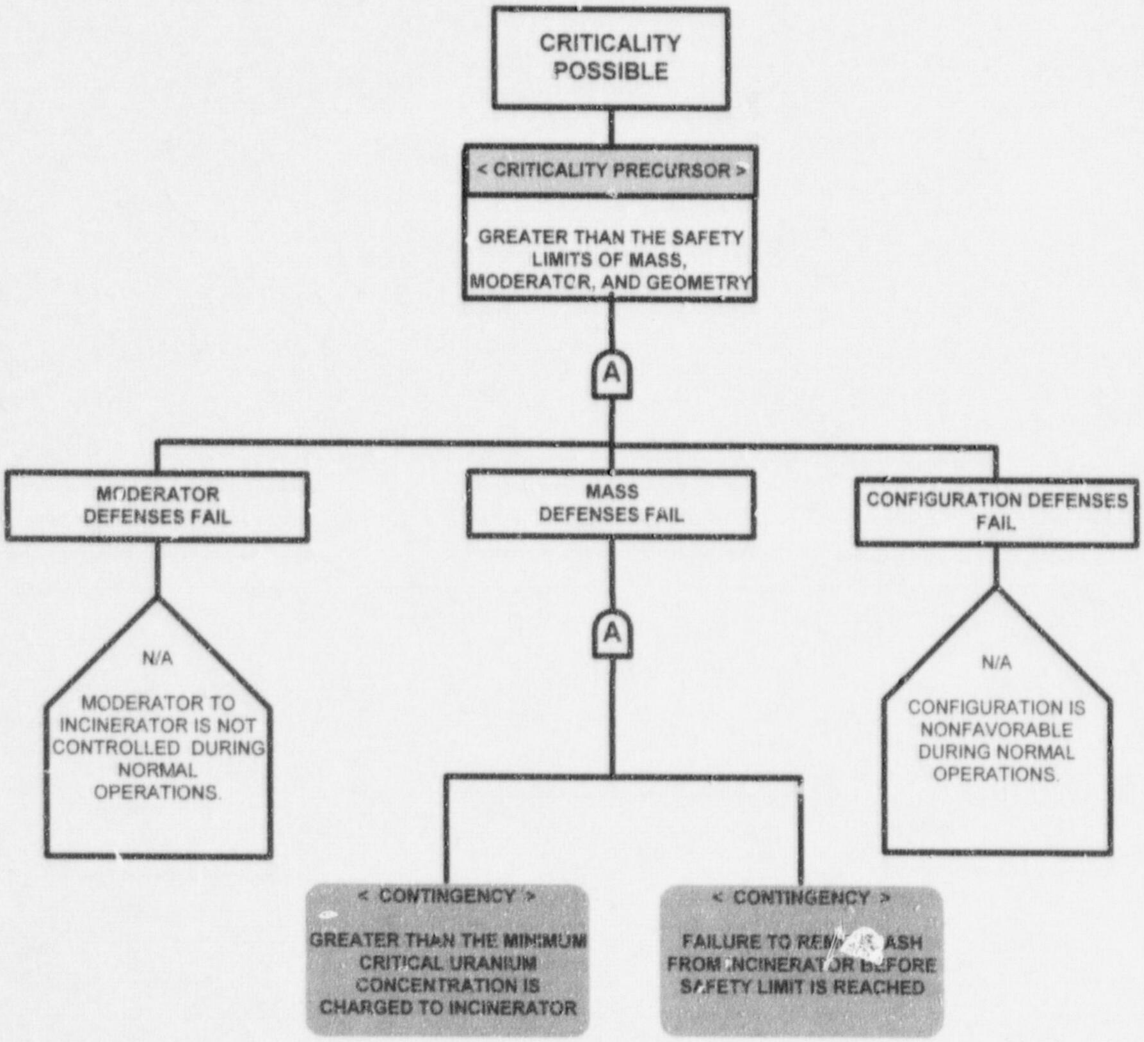
The parameter that directly affects neutron multiplication for the incinerator system, assuming 5.0 wt% ^{235}U enrichment, is mass. Nuclear criticality safety consists of preventing high uranium concentration (or density) material from becoming available to the incinerator, and preventing an accumulation of uranium in the incinerator that exceeds the safety limit for mass. The former is accomplished by keeping the wt% U in the combustible trash extremely low, and the latter by limiting the total uranium mass in the incinerator (unburned material and ash) to less than the safety limit.. Criticality safety limits (CSLs) and Bounding Assumptions (BA) on the combustible trash are established for mass.

Table 4: Nuclear Criticality Safety Limits for k_{eff} 0.91, 0.95, and 0.98 for the Incinerator

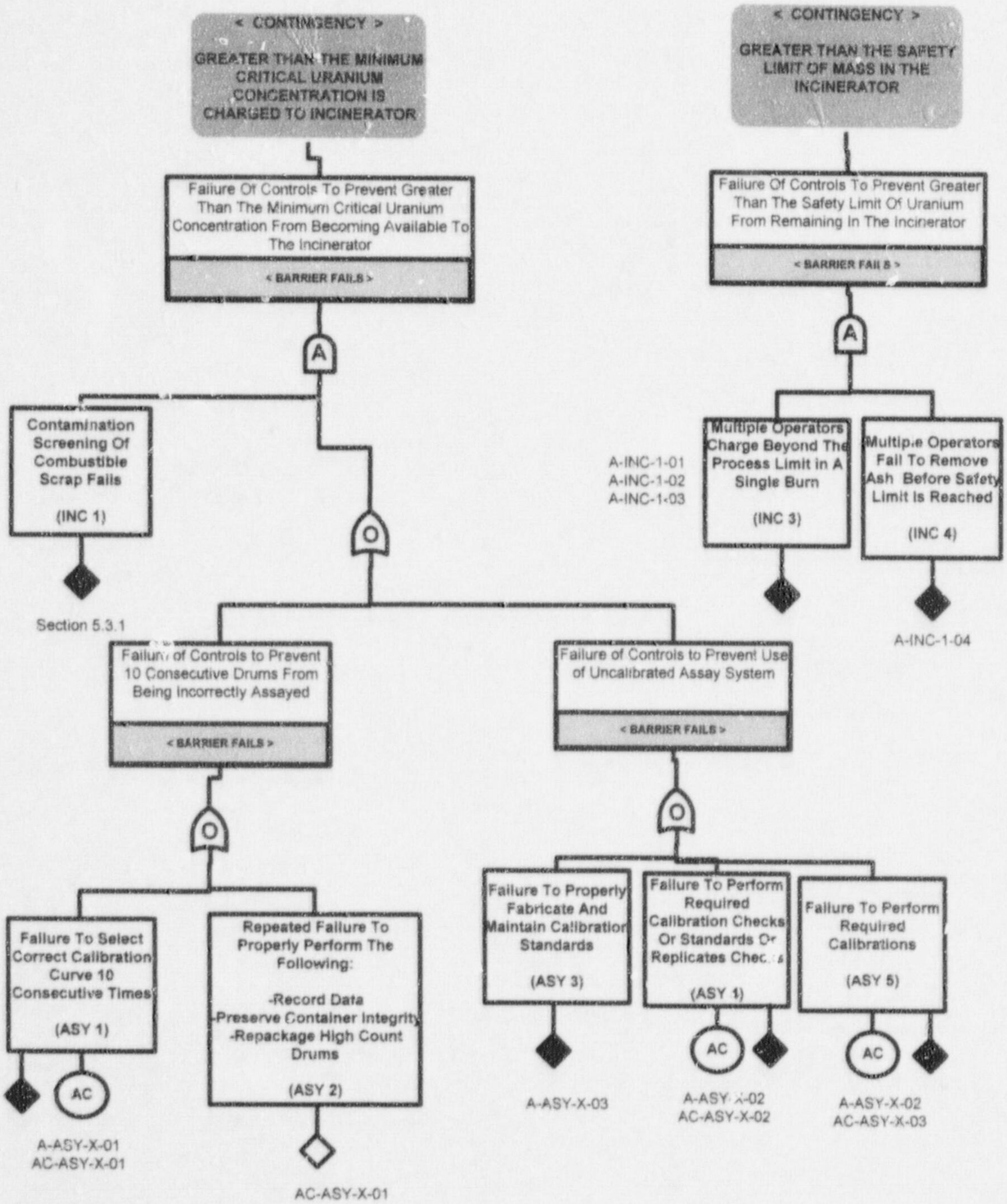
PARAMETER	NORMAL OPERATING CONDITIONS	BOUNDING ASSUMPTION	CRITICALITY SAFETY LIMIT ≤ 0.91	CRITICALITY SAFETY LIMIT ≤ 0.95	CRITICALITY LIMIT ≤ 0.98
^{235}U MASS	< 1386 g ^{235}U	Unrestricted UO2	1,386 g ^{235}U* (27.7 kg U)	1,851 g ^{235}U* (37 kg U)	2,203 g ^{235}U* (44 kg U)
MODERATOR/ CONCENTRATION	Optimum	Optimum			
GEOMETRY	NFG	Hemisphere			
SPACING	N/A				
DENSITY	Homogeneous UO2•H2O	Homogeneous UO2•H2O (H/X=500)			
ABSORBERS	None				
ENRICHMENT	≤ 5.0 wt%				
REFLECTION	Partial around, Concrete Below	Partial around, Concrete Below			

*CRI-96-026

INCINERATION



INCINERATION



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Ash handling

Control Parameters and Safety Limits:

Control Parameters
- mass
- geometry

Safety Limits
- < 21.6 wt% U

Bounding Assumptions: (From Table in SNM-1107)
- Homogeneous UO2
- Optimum H2O moderation
- Partial Reflection
- 5.0 wt% enrichment
- No neutron absorbers in system

Margin of Safety

The nuclear criticality margin of safety for the ash handling system is evaluated to be very strong. In fact, criticality is not credible. The parameters that directly affect neutron multiplication for the calciner product hood, assuming 5.0 wt% ^{235}U enrichment, are mass (uranium concentration) and geometry.

Previous analysis determined that the minimum $H/^{235}U$ ratio necessary for criticality of an infinite amount of saturated UO_2 powder is 1800, which corresponds to 21.8 wt% U. The ash produced in the LLRW incineration process averages 10 wt% U, and does not exceed 15 wt% U. The extremely low uranium concentration is due to the layers of controls placed on combustible trash in the trash collection assay, and incineration processes. and the inherent process characteristics of the incineration process.

Compactor

The compaction unit is used for volume reduction of noncombustible material that was previously determined to be free of gross contamination in the originating area, and verified to be free-of-gross contamination by the URRS operator before being placed into the compactor. Hence, criticality is not credible.

Decon/Cutting Room

The decon/cutting room is used for decontamination, dismantling, and cutting of equipment. All gross contamination must be removed from equipment before being taken into the room. As such, criticality is not credible.

Liquid Honing

Control Parameters and Safety Limits:

Control Parameters
- Concentration
- Mass

Safety Limits
- See Table 5

Bounding Assumptions: (From Table in SNM-1107)
- Homogeneous UO2
- Optimum H2O moderation
- Full water-equivalent reflection all around
- 5.0 wt% enrichment

Controls
Safety Significant Controls

Administrative controls with computer or alarm assist (AC)
Administrative controls with computer or alarm assist (AC) typically consist of operator actions that are prompted or assisted by computer output. The requirements for functional verification are determined by this evaluation.

Control ID	Control Function/ Failure Condition/ Action	Procedure Number	Functional Verification Required	Initiating Event (IE) Number
AC-HON-01	- Prevent High Uranium Concentration/ - RT-998A and 998B alarm at 20 gU/liter/ - Operators stop process and contact team manager	COP-831014	Yes	IE# HON 6,7

Administrative controls

Safety Significant administrative controls are required operator actions that usually occur without prompting from a computer/control panel alarm or indication. These controls may require documentation via Control Form or some other record. Functional verification is not normally required.

Control ID	Control Function/ Failure Condition/ Action	Procedure Number	Functional Verification Required	Initiating Event (IE) Number
A-HON-01	-Prevent grossly contaminated components from getting into Honing/ -Generating Area Does Not Properly Sorts Noncombustible Trash/ - Remove gross contamination	COP-841000	No	IE# HON 1
A-HON-02	-Prevent grossly contaminated components from getting into Honing / -URRS does not sort Noncombustible Trash/ - Return items with gross contamination to sending area	COP-831001	No	IE# HON 2
A-HON-03	-Prevent grossly contaminated components from getting into Honing/ -Honing Operator does not check for contamination/ - Removes gross contamination	COP-831014	No	IE# HON 3

Margin of Safety

The nuclear criticality margin of safety for the liquid honing system is evaluated to be very strong. The liquid honing system is an extremely low risk system with respect to nuclear criticality safety. Criticality is so unlikely so as to be not credible.

The parameters that directly affect neutron multiplication for the liquid honing system, assuming 5.0 wt% ^{235}U enrichment, are mass and concentration. Double contingency protection consists of preventing an accumulation of fissile material in alumina-water slurry. Criticality safety limits (CSLs) and Bounding Assumptions (BA) are established for mass and concentration.

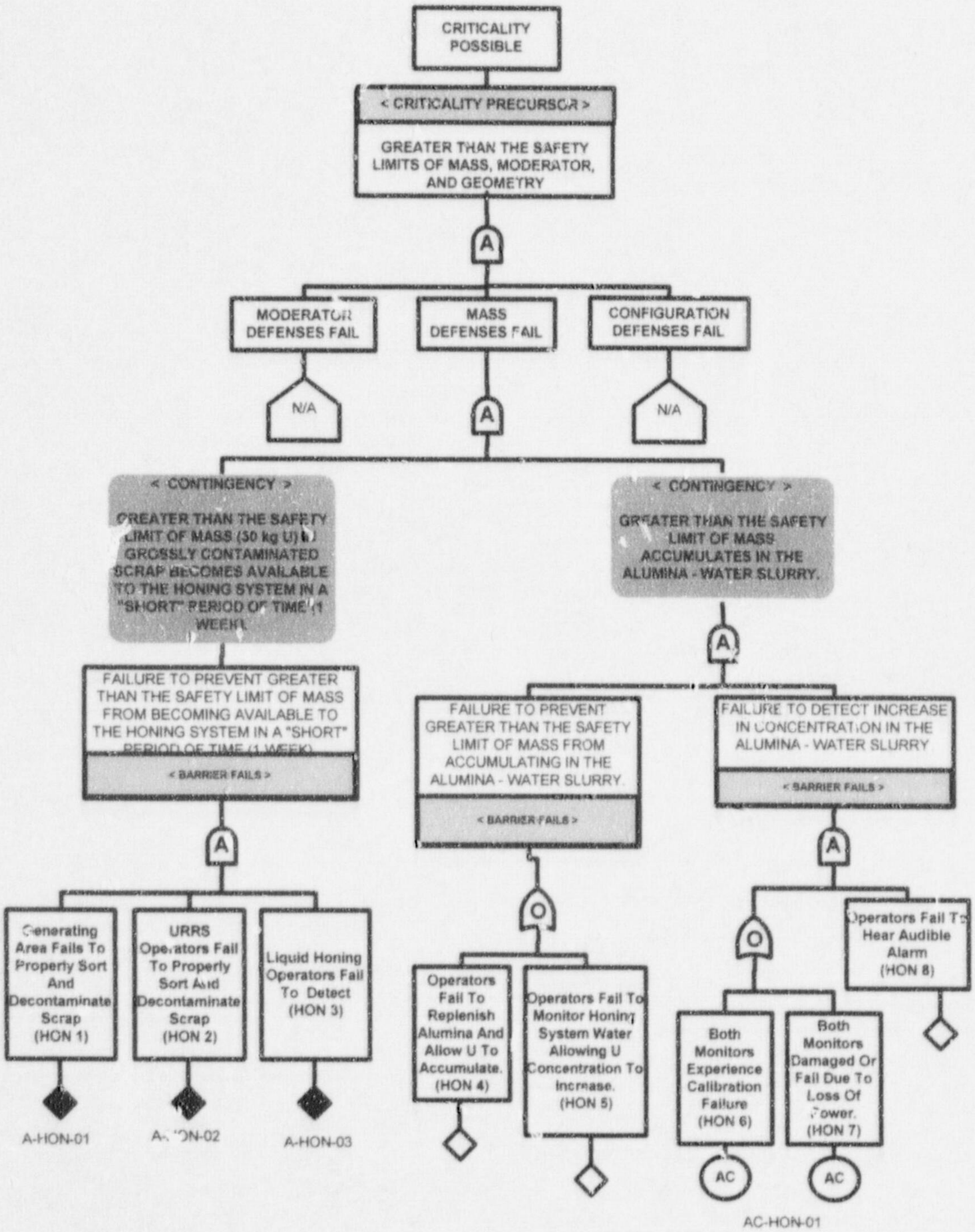
A criticality would be possible in the liquid honing system given the following combinations of credible process upsets:

- Sufficient material accumulates in the alumina-water slurry such that the mixture forms a critical configuration.

Table 5: Nuclear Criticality Safety Limits for k_{eff} 0.90, 0.95, and 0.98 for the Liquid Honing Booth

PARAMETER	NORMAL OPERATING CONDITIONS	BOUNDING ASSUMPTION	CRITICALITY SAFETY LIMIT ≤ 0.90	CRITICALITY SAFETY LIMIT ≤ 0.95	CRITICALITY LIMIT ≤ 0.98
^{235}U MASS	≤ $3x10^{-5}$ μCi/ℓ	Unrestricted UO2	18.5 kg U	24.7 kg U	30.0 kg U
MODERATOR/ CONCENTRATION	Fully Moderated	Optimum Moderation			
GEOMETRY	NFG	Spherical			
SPACING	N/A	N/A			
DENSITY	Homogeneous UO2•H2O	Homogeneous UO2•H2O			
ABSORBERS	None				
ENRICHMENT	≤ 5.0 wt%				
REFLECTION	Full	Full			

LIQUID HONING



Ultrasonic Cleaner

Given the bounding assumptions, as stated in the License. and the nature of the operation surrounding the ultrasonic cleaner, a criticality in the system is not credible. Calculations show that more than 150 kg uranium plus water must get into a basin in order for a criticality to be possible, either to form a critical uranyl nitrate concentration or an oxide mixture.

Parts Washer

The parts washer process is an extremely low risk system with respect to criticality. criticality is considered not credible.

Grit Blaster

The Grit Blaster is in design and procurement phase.

Chemical Safety and Fire Safety Controls

To be provided in a future Integrated Safety Assessment.