PROCESS INFORMATION

The chemical agent demilitarization process involves the destruction of chemical agents and related munitions by neutralization and supercritical water oxidation (SCWO) systems. The Munitions Storage Building (MSB) will provide storage for munitions prior to processing at the Munitions Demilitarization Building (MDB). The demilitarization process involves disassembly of the chemical-agent-filled munitions, draining of chemical agent from munitions, and the use of Neutralization/SCWO systems to destroy the chemical agent. Processing will be conducted in two main buildings and will consist of the following core systems:

- MDB.
  - Munitions Unpacking and Handling, consisting of the
    - Unpack Area (UPA)
    - Projectile Reconfiguration Room (PRR)
  - Projectile/Mortar Disassembly (PMD) System
  - Dunnage Shredding and Handling (DSH) System
  - Energetics Rotary Hydrolysis System
  - Energetics Neutralization System (ENS)
  - Projectile Agent Removal (PAR) System
  - Projectile Rotary Hydrolysis System
  - Projectile Agent Hydrolysis (PAH) System
- SCWO Building.
  - Agent Hydrolysate SCWO (AHS) System

- Energetics/Dunnage Hydrolysate SCWO (EHS) System
- Brine Recovery System (BRS).

Additional descriptions of the chemical demilitarization process are provided in **Section D-8**, Miscellaneous Treatment Units.

Munitions Demilitarization Building (MDB):

Munitions Unpacking and Handling

The palletized munitions will be transported via Modified Ammunition Van (MAV) from the MSB to the loading/unloading area of the MDB and moved into the UPA for inventory/inspection prior to moving them into the PMD Explosion Containment Room (ECR). The Explosion Containment Room Vestibule (ECV) will surround and separate the ECR from the UPA, and also will serve as an airlock to the PMD ECR.

The UPA will be sized to provide a minimum of 4 hours of munitions staging capability, a space for empty pallet staging, an area for two floor weigh scales, and a waste collection area. The materials movement in the UPA will be performed by a combination of material handling equipment; i.e., a 5-ton overhead crane, forklifts, and manual/motorized pallet trolleys.

Munitions that will require reconfiguration will be transferred to the PRR. After the munitions have been reconfigured, they will be wheeled from the PRR to the UPA where they will be placed in one of two projectile mortar conveyor lines to be fed to the PMD System.

Projectile/Mortar Disassembly

The PMD System will use two automatic, hydraulically powered machines, one in each of the two ECRs, to process all calibers of projectile munitions in order to remove their energetic components. Fuzes and whole bursters will be removed from the projectiles and will be sent to the ERH System. Downloaded projectiles containing agent will be sent to the PAR System. Burster caps and fuzes from the 4.2-inch mortars will be fed manually to the Heated Discharge Conveyor (HDC) (ERH-HDC-100 A/B) at the end of the PAR System where they will be decontaminated to meet the 5X level.[1] At this time, they will not need further treatment before being transported offsite as clean scrap metal.

If components cannot be removed mechanically by the PMD, they will be passed back into the ECV, where they will be transferred to the munitions reject table. These munitions will be collected and will be processed manually at the Toxic Maintenance Area (TMA).

Dunnage Shredding and Handling

Dunnage and other non-process waste will be pretreated by shredding and grinding in the DSH System until all solid material is reduced to less than 1 millimeter (mm) in size. Powdered solids will be mixed with energetics hydrolysate and other liquid wastes to form a heavy slurry, which then will be oxidized in the EHS. All dunnage and non-process wastes will be assumed to be potentially agent-contaminated.

Wood dunnage will be size-reduced in a dedicated low-speed shredder, size reducing screw conveyor, hammer mill, and micronizer to achieve a fine wood flour suitable for slurry. Metal from pallets and boxes will be magnetically separated on the conveyor between the hammer mill and micronizer and will be collected in a container. Periodically, this metal will be transferred to the front end of the PAR HDC.

Metal parts from demilitarization protective ensembles (DPEs) (air hose inlet fitting, exhaust air flap valve rivet, rubber boots steel toes) will be removed promptly after the DPE suit is doffed, following suit decontamination. These metals will be transferred to the PAR HDC (PAR-HDC-100 A/B).

Plastics and DPE suits will be processed in a two-stage granulator/micronizer size-reduction system. Material will be shredded in a dedicated granulator and then cryo-cooled and micronized to achieve adequate size reduction.

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[1] The U.S. Army established different levels (1X, 3X, 5X) for chemical agent contamination. The different levels specify the conditions necessary to achieve that level (e.g., temperature and residence time). In this section, 5X requires items contaminated with chemical agent to be decontaminated at a temperature of at least 1,000°F for a residence time of 15 minutes.

Spent activated carbon from plant heating, ventilation, and air conditioning (HVAC) filters will be treated by mixing with water and processing through a grinder.

Wood, plastic, and carbon solids will be stored in bins or tanks before being transferred to one of two Hydropulpers (DSH-HYD-100 A/B). Fluids entering the Hydropulper will be supplied from the EHS Off-Spec Effluent Tanks (DSH-TNK-103) and Spent Decon Holding Tanks (030-TANK-105/106/107). Other fluids added to the Hydropulpers may include spent hydraulic oil and waste lubricating oil. Additional water or dilute solution of sodium hydroxide (NaOH) may be added as needed to adjust water content, neutralize any residual agent, or to adjust the slurry to meet the requirements of the EHS Reactor (EHS-SWO-100 A/B). Other additives also will be used to ensure that the solids remain in suspension and that the slurry can be pumped and processed reliably in the EHS system.

Operators will be able to control the mix of materials in the Hydropulper and adjust the properties, such as pH, as needed. When a batch of slurry is ready for use as feed to the EHS System, the Hydropulper will be isolated from the input material flows. Positive displacement pumps will be used to continuously circulate the slurry to the suction point of the EHS feed pumps and back to the Hydropulper. Flow in both the supply and return lines will be maintained at a velocity sufficient to ensure that the slurry remains well mixed at all times, regardless of the operation of the EHS Feed Pumps. While one Hydropulper is feeding the slurry recirculation loop, the other Hydropulper will be used to prepare the next batch.

A Spent Carbon Glove Box (DSH-GLV-101) will be constructed in accordance with the American Glovebox Society (AGS) Guideline for Gloveboxes, 2nd Edition, AGS-G001-1998. This glovebox will be used for vacuuming spent granulated activated carbon from 55-gallon drums and transferring its contents to the Spent Carbon Storage Bin (DSH-HOP-104).

Spent carbon will be metered via a screw conveyor, from the spent carbon storage bin to the Spent Carbon Suspension Feed Tank (DSH-TNK-101). To ensure a homogeneous carbon/water suspension, the pre-charge mixture will be agitated by the Spent Carbon Suspension Feed Tank mixer before being fed to the Spent Carbon Grinder (DSH-GRN-101). After being processed through the grinder, the effluent will be fed to the Spent Carbon Slurry Tank (DSH-TNK-102), from where it will be fed to the Hydropulpers. The grinder also will be able to feed slurry back to the Spent Carbon Suspension Feed Tank.

The Pallet Low-Speed Shredder (DSH-SHR-100) will receive pallets and munition boxes from the UPA via the Pallet Feed Conveyor (DSH-CNV-100). The shredder will break the wood material into pieces generally less than 5 inches in size. From the shredder, the wood material will fall into the Wood Surge Hopper/Screw Feeder (DSH-CNV-101). The screw feeder will deposit the wood onto the Wood Hammer Mill Feed Conveyor (DSH-CNV-102), which will feed the material to the Wood Hammer Mill (DSH-HAM-100). The hammer mill will reduce the wood material to pieces less than 0.5 x 0.5 by 3 inches in size. From the hammer mill, the wood particles will fall onto the Wood Micronizer Feed Conveyor (DSH-CNV-103), which will feed the material to the Micronizer Inlet Rotary Valve (DSH-RTV-100). Metal (nails and hinges) will be removed by a magnetic separator. The metal will be deposited into a Tramp Metal Container (DSH-TMC-100). The Micronizer Inlet Rotary Valve will feed the wood to the Wood Micronizer (DSH-MZR-100), which will reduce the wood to pieces less than 1 mm in size. From the micronizer, the wood will be fed to the Wood Micronizer Cyclone Product Discharge (DSH-RTV-101), and from there to the Wood Flour Storage Hopper (DSH-HOP-100). From the Wood Flour Storage Hopper the wood will be fed to the Wood Flour Storage Tank (DSH-TNK-100), and then to the Hydropulpers.

The DSH wood material process system is fully enclosed from the time the wooden pallets and munition boxes are fed to the Pallet Low-Speed Shredder. Each step in the line (the shredder, hammer mill, micronizer, and micronizer cyclone discharge) will be vented to the Wood Micronizer Bag Filter (DSH-BHF-100). When the bag filters are cleaned, the wood particles will be fed into the Wood Flour Storage Hopper (DSH-HOP-100) via the Cyclone Rotary Valve (DSH-RTV-103). After being cleaned in the bag filter, the air will be fed to the MDB HVAC system.

The Plastic/Rubber Granulator (DSH-GRN-100) will receive plastic/rubber DPE material via the Plastic/Rubber Granulator Feed Conveyor (DSH-CNV-106). After passing through the granulator, the material will fall into the Granulated Plastic/Rubber Cyclone/Surge Hopper (DSH-HOP-101). From the hopper, material will fall into the Plastic/Rubber Cryocooler/Screw Conveyor (DSH-CYO-100), which will feed the material to the Plastic/Rubber Hammer Mill (DSH-HAM-101). After passing through the hammer mill, the material will fall into the Hammer Mill Surge Hopper (DSH-HOP-102). From this hopper a Cryo Hammer Mill Screw Conveyor (DSH-CNV-107) will feed the material to the Plastic Fines Storage Bin (DSH-HOP-103). From this Hammer Mill Surge Hopper, the material will be fed to the Hydropulpers.

A Plastic/Rubber Glovebox (DSH-GLV-100) will be constructed in accordance with the AGS Guideline for Gloveboxes, 2nd Edition, AGS-G001-1998, to be used for removing plastic/rubber DPEs from 55-gallon drums and placing the contents onto the plastic/rubber processing line.

Energetics Rotary Hydrolysis

The Energetics Rotary Hydrolysis System will consist of two Energetics Rotary Hydrolysers (ERHs) (ERH-HDZ-100 A/B) and associated equipment. Each ERH has a full train of associated equipment. Both ERH trains are parallel and will not be cross-connected. The system will process propellant from the UPA and energetics in bursters and fuzes from the PMD. The energetics and propellants will be dissolved and hydrolyzed (decomposed to organic and inorganic salts and soluble organic compounds and various gases) in the ERH and will be discharged to the Energetics Hydrolysate Neutralization Reactor. The Energetics Neutralization Reactor System will be considered a separate miscellaneous treatment system from the Energetics Rotary Hydrolysis System. The residual metal will be discharged through an HDC (ERH-HDC-100 A/B).

The ERH will consist of a large rotary drum with a single internal spiral flight, as well as lifting flights. Water and NaOH will be introduced at the inlet end of the ERH with metal parts and energetics material from the PMD. The drum rotation will cause the spiral flight to push the solid material along the length of the drum. Multiple energetics can be fed to each ERH flight, with a maximum total explosive loading in the ERH of about 11 pounds trinitrotoluene (TNT) equivalent. The rotation of the drum will ensure agitation and mixing of the hydrolyzing solution with the energetics and metal parts. The drum will be steam heated on the outside surface to maintain the hydrolyser and its content at 100° to 110°C. The elevated temperature will melt the energetic material and wax binder and will enhance the hydrolysis reaction kinetics. A shell with thermal insulation will enclose the drum, which will reduce the heat losses to the room. The drum will rotate slowly, and each batch will move through the vessel so that its residence time in the hydrolyser is sufficient (2 hours) to ensure complete hydrolysis. At the discharge end, the metal parts remaining after hydrolysis will be lifted out of the solution by the spiral flights in the conical discharge section of the drum, and will be discharged through a chute directly into an HDC. Perforations in the conical discharge section of the drum will allow the liquid hydrolysate to separate from the metal parts and will drain into a sump. The ERH drum and liquid discharge region will be configured to maintain a minimum of 12 inches of liquid depth within the ERH drum.

Energetics Neutralization System

The hydrolyzed energetics will be pumped to one of the four Energetics Hydrolysate Neutralization Reactors (ERH-RTR-100 A/B/C/D) where acid will be added to neutralize the hydrolysate and to precipitate the aluminum hydroxide formed as a result of the reaction of aluminum components with NaOH. During the 155mm and 4.2-inch munitions campaigns, aluminum hydroxide should not be present, because all aluminum parts will be diverted at the PMD to an HDC. The hydrolyzed energetics will be transferred to the Aluminum Filtration System via the Hydrolysate Feed Pump (ERH-PMP-100 A/B/C/D). Offgases from the hydrolyser and from the Energetics Hydrolysate Neutralization Reactors (ERH-RTR-100 A/B/C/D) will be fed to the pollution abatement system consisting of a scrubber (ERH-SCR-100 A/B), condenser (ERH-CDR-100 A/B), and carbon absorbers (ERH-FIL-101 A/B) before it will be exhausted to the plant ventilation system. Condensate from the scrubber will be returned to the ERH.

Projectile Agent Removal System

The PAR System utilizes cryofracture, followed by chemical agent hydrolysis in a Projectile Rotary Hydrolyser (PRH) that consists of a Munition Load Robot (PAR-MLR-100 A/B), Cryobath Conveyor (PAR-CYO-100 A/B), Munition Unload Robot (PAR-MLR-101 A/B), Cryopress with tilting table (PAR-CYP-101 A/B), and PRH (PAR-HDZ-100 A/B). Cryofracture is a process developed by the Army in which the munitions are embrittled by cooling to approximately -320°F in liquid nitrogen and then fractured to access the cavity of the projectiles, exposing solidified or gelled agent and agent heels.

The PAR System will consist of two identical process lines operating in parallel, one line for each of the two munitions processing lines. The PAR System will be located in three rooms. Munitions will be loaded into the system in the Cryobath Loading Room (CLR). The Cryobath will be located in the Cryobath Room (CBR), and the munitions will be unloaded from the system in the Cryobath Unloading Room (CUR). The area categories for all three rooms will be A.

Munitions will be fed into the PAR System from the PMD Machine via the Downloaded Munition Transfer Conveyor (PAR-CNV-100 A/B). A Munition Load Robot in the CLR will place munitions onto the Cryobath Conveyor. After traversing the Cryobath in the CBR, a Munition Unload Robot in the CUR will remove the munitions from the Cryobath Conveyor and feed them to the Cryopress with tilting table. After the munitions are fractured in the Cryopress, the munitions will be discharged to the Projectile Rotary Hydrolysis System via the Press Discharge Chute (PAR-MCH-100 A/B). The Projectile Rotary Hydrolysis System will be considered a separate miscellaneous treatment system from the PAR. The PAR Projectile Rotary Hydrolysis System will be discussed under "The PAR Projectile Rotary Hydrolysis System."

The Hydraulic Cryofracture Press shall be capable of 500 tons maximum pressing load in downward direction, die space of 60 inches left-to-right by 36 inches front-to-back, a daylight of 40 inches top-to bottom, 24 inches pressing stroke, 50 inches per minute (in/min) pressing speed at maximum load, 200 in/min stripping speed at up to 60 tons load, 400 in/min fast approach, 400 in/min fast return, and bed dimensions of 48 inches by 36 inches.

The structural frame for the Hydraulic Cryofracture Press shall be a unitized, or one-piece, type frame construction. The material of construction for the press components, e.g., frame, base, slide, and crown, shall be carbon steel. The press shall be free standing with no lateral motion constraints provided except through the foundation anchor bolts. The frame and its support foundation shall be designed to satisfy seismic zone 2A structural requirements in accordance with federal specification TM-5-809-10. Because of the unique instantaneous release of the press load at each fracture, the foundation and anchor bolts shall be designed to withstand the full elastic strain energy of the frame structure acting upward on the foundation and anchor system. The overall construction shall avoid interior cavities that can become contaminated by chemical agent. Cavities that may be essential for structural integrity shall be closed and seal welded to prevent becoming contaminated, or they shall be amenable to decontamination on a frequent basis. All welding shall be performed in accordance with requirements of American Welding Society D1.1. The press slide shall be guided by adjustable gibs, with replaceable wear surfaces. The slide/ram shall be sealed.

The Hydraulic Cryofracture Press shall be capable of performing an operating cycle within 30 seconds. An operating cycle begins with the press slide in its full up position and consists of (1) fast approach for 16 inches, (2) pressing stroke for 8 inches, and (3) fast return for 24 inches. An operating cycle may occur at a maximum rate of 60 cycles per hour. The total number of operating cycles under load for the life of the unit is one million cycles.

Ventilation air will be ducted through the press, discharge chute, and into the PRH to minimize the spread of agent contamination. Hot water will be used to flush the press tooling and discharge chute.

Projectile Rotary Hydrolysis System

The PRHs, part of the Projectile Rotary Hydrolysis System, (PAR-HDZ-100 A/B) will receive cryofractured projectiles and mortars from the two cryofracture systems. The two PRHs are larger but similar in function and construction to the two ERHs. Each PRH will be externally steam heated to maintain the metal parts and hydrolyzing mixture at approximately 194°F (90°C). The drum of the PRH will be fitted with an internal spiral flight and lifting flights to be able to transport and mix the fragments axially along the drum from feed to discharge. A shell with thermal insulation will enclose the drum to reduce the heat losses to the room.

Hot water will be introduced at the discharge end and will flow countercurrent to the solids flow stream. The liquid level in the PRH must be higher than the height of the spiral flight to allow the liquid to flow towards the feed end. The hot water will melt the frozen agent and/or agent heels, and will be discharged through perforations in the drum at the inlet end bulkhead of the PRH, separating the mixture from metal fragments. At the discharge end, the spiral flight in the conical discharge section of the drum will lift the metal fragments out of the mixture, where the metal will be discharged through a chute directly into the HDC (PAR-HDC-100 A/B).

The metal fragments will be heated on the HDC by radiant electrical heaters from approximately 190°F to 1,000°F, and will be held to at least 1,000°F for 15 minutes to achieve a decontamination level of 5X. Miscellaneous metal wastes, aluminum burster well cups, and fuzes from 4.2-inch mortars will be introduced into the HDC at the PRH discharge interface chute. Metals leaving the HDC will pass through a double flap valve arrangement, which will prevent air from entering the HDC.

Nitrogen gas will be used as a cover gas in the HDC and will be extracted through the PRH to the PRH inlet end, along with room air that will be drawn through the Cryopress. This effluent will pass through a scrubber, condenser, and carbon filters before releasing to the plant's HVAC system. The condenser will operate at a temperature lower than the freezing temperature of chemical agent (58°F) to ensure that emissions will be negligible.

The Projectile Rotary Hydrolysis System will consist of two PRHs operated in parallel (one per munition processing line). The Projectile Rotary Hydrolysis System will be located in the PRH Room. The area category of the PRH Room will be A.

The Projectile Rotary Hydrolysis System will receive cryofractured munitions from the Press Discharge Chute (PAR-MCH-100 A/B) of the Cryopress with tilting table. After traversing the PRH, the munitions will be discharged via the HDC to a Tramp Metal Container.

Other metal parts (metal parts from the DSH System, aluminum from the PMD Machine, and aluminum hydroxide from the Filter Press) also will be delivered to the HDC (bypassing the hydrolyser) for placement in the Tramp Metal Container. These metal parts will be transported offsite for further treatment and/or disposal.

Projectile Agent Hydrolysis System

Chemical agent drained from the munitions in the PRHs will be fed to the Agent Neutralization Reactors (PAH-RTR-100 A/B/C/D) via the Neutralized Agent Transfer Pump (PAH-PMP-101 A/B/C/D/E/F/G/H). Offgases from the hydrolysers and the Agent Neutralization Reactors (PAH-RTR-100 A/B/C/D) will be fed to the pollution abatement system.

Chemical agent will be extracted from the projectiles by cryofracture and by washing the fragments with a countercurrent flow of hot water in the PRHs. The quantity of water used in the PRH and for washing the Cryopress (which drains to the PRH) will be set to produce a mixture of 15 percent agent in water. The agent mixture will be extracted from the inlet end of the PRHs and will be pumped to one of the four Agent Neutralization Reactors where the hydrolysis reaction is completed.

When an agent neutralization reactor batch is filled, the reactor will be isolated and the flow from the PRHs will be diverted to the next reactor. The agent mixture then will be heated, agitated, and recirculated for up to two hours, a period long enough to ensure complete reaction of the agent to primarily thiodiglycol and hydrochloric acid. The reactor will be sampled to confirm complete destruction of the agent and then it will be neutralized by the addition of NaOH.

The contents of the first reactor will be hydrolyzed, tested, then neutralized and pumped to the Hydrolysate Tank (PAH-TNK-101) within a time period less than the time to fill the remaining three agent hydrolysis reactors. The batch time schedule is summarized below:

Step	Activity	Duration, hr:min	Elapsed time
1	Charge (fill) reactor	2:00	2:00
2	Stabilize temperature at 194°F	0:30	2:30
3	Reaction at 194°F	1:15	3:45
4	Hold for lab confirmation	1:15	5:00
5	Adjust pH (neutralize)	0:15	5:15
6	Transfer hydrolysate to storage	0:45	6:00

Gas evolved during the hydrolysis of agent will be drawn off the PAH System reactors through a vent gas scrubbing system where caustic soda solution will be sprayed through a packed column to contact the vent gases and neutralize any agent vapors. Scrubbed gases leaving the scrubber will pass through the vent condenser where they will be cooled below the freezing point of the chemical agent (58°F). Condensate and spent caustic solution will be returned to the agent reactors. The non-condensables will be reheated and passed through the two carbon filters before going to the plant HVAC carbon filters.

Following neutralization, the hydrolysate contains about 10 percent dissolved solids from agent. The Hydrolysate Tank will be sized to hold an inventory of fluid large enough to enable the AHS System to operate through a period of about 24 hours, without new hydrolysate generation. Hydrolysate will be agitated continuously and will be pumped through a line that connects to the suction of the AHS System feed pumps, and will be returned to the Hydrolysate Tank. This will keep the hydrolysate in the line well mixed at all times, regardless of any stoppage of the AHS System feed pump.

Supercritical Water Oxidation (SCWO) Building

AHS System

The two AHS Reactors (AHS-SWO-100 A/B) will receive agent hydrolysate from the Hydrolysate Tank via the hydrolysate supply pump. The AHS Reactors will oxidize agent hydrolysate under supercritical conditions of approximately 1,140°F and approximately

3,400 pounds per square inch gauge (psig), under which organics are completely converted to water, carbon dioxide, and inorganic salts.

The approximately 15 percent agent/water hydrolysed and neutralized with NaOH will be supplied from the Hydrolysate Tank as pH-adjusted feed to the AHS Reactors.

The feed end (top) of the AHS Reactor is connected to supplies of high-pressure process water, auxiliary fuel (70 percent isopropyl alcohol), high-pressure air, high-pressure hydrolysate, and high-pressure nitrogen. Process water, hydrolysate, fuel, and air will be combined and will enter via a single, concentric nozzle assembly. Nitrogen will be pumped into the space between the liner and the reactor vessel.

During system startup, an electric preheater in the process water line will be used to raise the reactor temperature. To bring the reactor to full operating conditions, auxiliary fuel and air will be used to heat the reactor to the desired operating temperature of approximately 1,140°F (approximately 650°C). Once the reactor is at operating temperature, the heater will be turned off. Hydrolysate flow then will be initiated and auxiliary fuel flow will be reduced. Excess air flow will be used to ensure complete oxidation of all hydrocarbon material.

To minimize startup and thermal transients, the AHS Reactors will be operated on a semi-continuous cycle. Once started, hydrolysate will be oxidized continuously for up to 22 hours. The AHS Reactor then will be cooled down and will be flushed at high pressure to clear any buildup of salts that are insoluble at supercritical conditions. The AHS Reactor will be cooled and depressurized for weekly maintenance every six flush cycles.

The AHS Reactor will be designed to keep the process fluid at supercritical conditions for sufficient time to permit organics to be mineralized before entering the quench zone at the base of the reactor, where quench water is injected directly to lower the temperature and to dissolve the salts formed in the AHS Reactor. The fluid discharged from the AHS Reactor will pass through a cooler and will enter a phase separation vessel. The Solids/Liquid/Gas Separator (AHS-SPR-100 A/B) will perform two functions. First, it will separate the gas and liquid effluent streams at high pressure to provide a gas stream for reliable pressure control. Second, it will provide a quiescent environment for settling potentially large, erosive solids present within the liquid stream. The solids will be handled accordingly prior to offsite disposal. Gases and liquids then will flow to separate pressure reduction stations before entering a low-pressure phase separation vessel. Smaller particles in the liquid stream will be separated in the hydrocyclone in an AHS Low Pressure Gas/Liquid Separator (AHS-SPR-102 A/B). Non-combustible gases, mostly carbon dioxide and nitrogen, are monitored and filtered before they will be released to the environment via the plant HVAC system. Liquids will be monitored and will be transferred to the BRS. If liquids failed to meet the release specifications, they will be returned to an AHS Off-Spec Effluent Tank (PAH-TNK-100) for reprocessing.

Due to the highly corrosive action of chlorine and sulfur in the agent hydrolysate at supercritical conditions, the AHS Reactor will be provided with a removable titanium liner assembly. High-pressure nitrogen will be introduced between the insulated liner and the reactor shell, which serves to prevent reaction products from contacting the shell, and will keep shell temperature low. It is anticipated that the wear liner will have to be replaced about once every two weeks during the 155mm campaign. During the other munition campaigns, less frequent replacement will be required, and for the EHS System, long replacement intervals will be required.

After being processed in the AHS Reactor, the effluent will be fed to the BRS.

Energetics/Dunnage Hydrolysate SCWO (EHS) System

The two EHS Reactors (EHS-SWO-100 A/B) will receive energetic/dunnage hydrolysate slurry from the Hydropulper (DSH-HYD-100 A/B) [via the Hydropulper/Emulsifier Transfer Pump (DSH-PMP-100 A/B)]. After being processed in the EHS Reactor, the effluent will be fed to the BRS.

The EHS system is similar in design and capacity to the AHS System. During the 4.2-inch mortar campaign, the piping will be aligned to connect one EHS Reactor to the Energetics Hydrolysate Tank (ERH-TNK-100), and three EHS Reactors to the Hydropulper.

The EHS has a much lower salt content in its effluent brine discharged to the BRS than the agent hydrolysate effluent from the AHS System. Consequently, it is possible to use the EHS effluent directly as quench water for the EHS, which will reduce the load on the BRS by about 25 percent, and reduces the cost of the BRS accordingly.

Brine Recovery System (BRS)

The BRS consists of a regenerative heat exchanger, a Brine Concentrator, a Crystallizer, and two Solid Separation Units. The BRS will be designed to process EHS System and AHS System effluents. The EHS and AHS effluents will be approximately 2 to 4 weight percent (wt.%) salt solution comprising primarily of sodium sulfate (Na_2SO_4), sodium chloride (NaCl), and sodium monophosphate (NaH_2PO_4). The water that will be recovered from this unit will be used in the plant, mainly in the AHS and EHS Reactor Systems and the Hydropulpers. The solid contents will be fairly low and will be designed to be less than 10 to 15 parts per million (ppm).

The Brine Concentrator will recover 80 percent of the water in the brine. The concentrated brine from this unit will be fed to a Crystallizer for further water recovery.

Acidity of the feed will be adjusted to a pH of 9 by a caustic addition system to protect the equipment under high temperature and corrosive conditions. The feed then will be heated by the regenerative heat exchanger, in which condensate leaving the unit flows countercurrent to the brine feed and heats the feed. The heated brine then will be introduced into the concentrator, which is a vapor compression evaporator. It will consist of an atmospheric flash tank containing heating coils and a compressor for the steam coming overhead. The heat to this unit will be supplied through mechanical recompression of the steam.

A high alloy falling film condenser will be located at the top of the evaporator to provide heat transfer surface for exchange of heat between the evaporator recycle and the compressed steam. The steam coming out of the evaporator sump will be compressed by a blower compressor and will be returned to the top of the column into the overhead condenser. The compressed steam will exchange heat with slurry recycle to supply heat for vaporization and consequently, will condense to form the recovered water from the unit. An antifoam skid will be provided for the Brine Concentrator package to subdue foaming in the evaporator.

During startup and cleaning, there will be no internal steam available from the evaporator and the compressor cannot be a source of energy to heat the recycle stream from the recycle pump. An external source of low pressure steam will be provided during the startup period until the unit comes on line.

The concentrated brine from the Brine Concentrator will be fed to the Evaporator/Crystallizer for further water recovery and separation of the solids.

The principle of design and operation of this unit will be similar to the Brine Concentrator, except that the exchange of heat between the compressed steam and the slurry will take place in a forced circulation heat exchanger and crystallization will take place inside the flash column. The slurry recycle rate also will be much higher in order to prevent vaporization in the exchanger. Recovered water from this unit will join the condensate from the Brine Concentrator and will be sent to the SCWO Water Storage Tanks for process use. A slurry side stream from the bottom of the Flash Tank will be fed to a solid separation unit. The evaporator column will be connected to the Brine Tank for boilout and dumping storage requirement. The evaporator column will be provided to hold the contents of the evaporator and an equal volume of dilution water during the cleaning cycle. The concentrator and crystallizer units will share one brine tank. The brine tank utilization will not be more than 10 percent of the time for each unit.

The solids dewatering unit will be either a plate and frame filter press or an automatic pressure filter similar to an Oberlin pressure filter. The solids dewatering unit will be capable of dewatering an average rate of approximately 1,600 pounds per hour (lbs/hr) (primarily Na_2SO_4 and Na_2HPO_4, or NaCl) including bound water of hydration. The filter cake will be suitable for offsite landfill disposal. The solid separation unit being considered for this process at this stage is a pressure filter. Two filter units, each with 50 percent capacity, are being considered for this purpose.

The BRS will be designed to treat EHS and AHS effluents based on a series of assumptions and design criteria set out below. The design capacity with necessary allowances for unit boilout will be 60 gallons per minute.

The average peak SCWO effluent rates available for these cases will vary from 15,414 lbs/hr in the case of processing 105mm projectiles up to 31,351 lbs/hr in the case of processing 155mm projectiles. The case with maximum effluent will be selected as the basis for the design of the brine recovery package. A 30 percent turndown ratio capability will be provided in the design of the unit in order to accommodate the lower rates as applicable for the 105mm campaign.

Brine from SCWO systems contains 2 to 4 percent salt. In the design case, it will be concentrated to about 15 to 20 percent salinity in the Brine Concentrator and will be concentrated further in the Evaporator/Crystallizer to a total solid content of about 58 percent. The slurry from this unit will be fed to a pressure filter that will produce solid cakes suitable to pass paint filter test for landfill disposal.

The quality of recovered water from this unit will contain 10 to 15 ppm weight total solid, suitable for use in the SCWO systems and other units in the plant.

Ventilation Systems

Each building at the PCAPP will have an HVAC system. Personnel buildings will have standard rooftop or central HVAC units. The design of each HVAC system servicing a process building or room will depend on the hazard category of the building or room. Hazard categories are based on the anticipated type and degree of agent contamination. Hazard categories are defined as follows:

Category A: Areas that have a high probability of contamination, either liquid or vapor agent, negative pressure relative to atmosphere.

Category A/B: Areas with a high probability of agent vapor contamination and under certain process operating conditions assumed to be contaminated with liquid agent, negative pressure relative to atmosphere.

Category B: Areas with a high probability of agent vapor contamination resulting from routine operations, negative pressure relative to atmosphere.

Category C: Areas with a low probability of agent vapor contamination, negative pressure relative to atmosphere.

Category D: Areas that are unlikely to ever have agent contamination, atmospheric pressure.

Category E: Areas kept free from any chance of agent contamination barring a major event, air supply to the building or room is filtered through activated carbon to protect workers in the event of an accidental release of chemical agent, positive pressure relative to atmosphere.

Buildings with areas defined as hazard categories A through C will have ventilation systems for air supply and exhaust. In addition to controlling room temperature, room pressure and air flow, these HVAC systems will confine contaminants to specific areas and minimize a contamination spread due to agent leak. These ventilation systems will:

- Collect, treat, and monitor ventilation from the work area that may contain chemical agent vapors prior to being exhausted to the ambient air

- Provide mixing of air that is essential for monitoring work areas with chemical agent detection devices

- Provide a negative pressure within the work areas to eliminate escape of chemical agent vapors.

Carbon adsorption has been the historical method of choice for treating air-contaminated chemical agent vapors. Carbon has a high capacity to adsorb and retain the chemical agent vapors.

MDB Ventilation Systems

The MDB will have areas ranging from hazard Category A to E. Category A through C areas of the MDB will be kept under negative pressure in such a way that the areas of the highest potential contamination will be at a greater negative pressure that the lower contamination level area. Thus, the air always will flow from cleaner areas (hazard Category C) to the more contaminated areas (hazard Category A). Finally, the air will be collected from the more contaminated areas and passed through a ventilation filter system before being exhausted to the atmosphere. The ERH, PAH, and PRH vent gas system will discharge to rooms that are filtered through the MDB ventilation filtration system. This exhaust stack will be a source of significant emissions.

The walls, floors, and ceilings of the MDB will be sealed to prevent migration of vapor or liquid agent. Contamination spread through doorways will be prevented by the use of airlocks. Category A through C areas will have special coatings applied to building surfaces for protection from agent and subsequent decontamination solution. Area layout will conform to the human factors engineering requirement for personnel in DPE.

MDB hazard Category A through C areas will have air supply and exhaust HVAC systems. Air supply will be taken directly from the outside through an air-tempering hot water coil. The air then will be passed through two particulate filters. Next the air will be heated by a hot water coil or cooled by chilled water to the temperature desired for discharge to the individual rooms via the building duct work system. The CLR will have an individual HVAC unit for air supply equipped with a desiccant for dehumidification.

The exhaust HVAC system will have eleven filtration trains in parallel, nine in operation at any given time, one assumed to be undergoing maintenance, and one spare on standby. Exhaust air will be ducted from the MDB through a manifold, then to the exhaust filter trains. The first bank of each filter train will remove any gross particulates. The second bank will be a HEPA filter. An activated carbon filter bed will be third. The second through sixth activated carbon banks will be backup to avoid agent breakthrough in the event the first carbon bank becomes saturated. The final bank will be a HEPA filter to collect any fine particles that erode from the carbon filters.

Prefilters and HEPA filters will be changed when the pressure drop across the filter element exceeds 10 inches of water column. Automatic Continuous Air Monitoring System (ACAMS) will sample for agent between the first and second banks of carbon filters in each train. When the ACAMS alarm, the carbon filters will be changed. Redundant analyzers will be provided at the second, third, fourth, and fifth banks of carbon filters, as well as at the common exhaust discharge stack to warn of agent breakthrough in the event that a filter unit mounted analyzer fails. The MDB Ventilation Stack will be designed to handle a nominal 143,460 actual cubic feet per minute at 5 inches of water column pressure drop across each filtration train.

Category D areas will be provided with independent standard industrial HVAC systems.

Category E area HVAC systems will provide positive pressure to the room or building they service. The air supply will be filtered with activated carbon.

SCWO Building Ventilation Systems

The SCWO ventilation air supply and exhaust systems will be similar to the systems provided for the MDB.

The Reactor Room A/B/C/D, the Laboratory Room, the Wet Chemical Room, the AHS and EHS Emergency Dump Tanks, the two AHS Low Pressure Gas/Liquid Separators, and the two EHS Low Pressure, Gas/Liquid Separators will vent past the SCWO HVAC Ventilation Filtration System prior to discharge through the SCWO Building stack to the atmosphere. The SCWO HVAC Ventilation Filtration System will be comprised of eight filter trains, with six on line at any given time, one assumed down for maintenance, one on standby as a spare. Each filter train will have a particulate prefilter, a HEPA filter, 6 banks of carbon filters and a HEPA filter.

Laboratory Building Ventilation Systems

The Laboratory Building (LAB) ventilation air supply and exhaust systems will be similar to the systems provided for the MDB. The MDB process area will be routinely exposed to chemical agents during operations. The carbon filter system for LAB exhausts will undergo only intermittent exposure to low concentrations of chemical agents. The LAB will be an insignificant source of air emissions.

Personnel and Maintenance Building Ventilation Systems

The Personnel and Maintenance Building will be equipped with particulate and carbon filtration of air supply and exhaust. This filtration will be in place for personnel protection in the event of an agent leak. This building will not be a source of air emissions.

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