C-A OPERATIONS PROCEDURES MANUAL

14.24 SMD EMS Process Assessment for Cryogenic System Maintenance and Operations

(AM-530-CSM)

Text Pages 2 through 8

Hand Processed Changes

HPC No.	Date	Page Nos.	Initials

Approved: ***Signature on File*** ______
Collider-Accelerator Department Chairman   Date

Approved: ***Signature on File*** ______
Superconducting Magnet Division Head   Date

M. Van Essendelft

BROOKHAVEN NATIONAL LABORATORY
PROCESS ASSESSMENT FORM

I. General Information

Process ID:	AM-530-CSM			
Process Name:	Cryogenic System Maintenance and Operations			
Process Flow Diagrams:	AM-530-CSM-01 through -02			
Process Description:	The process includes the maintenance and operations for the Cryogenic Systems managed by the Superconducting Magnet Division located in Buildings 902. The cryogenic system in Building 902 supplies supercritical helium for magnet testing. Cryogenic maintenance includes the routine replacement of oil and servicing of vacuum pumps; replacement of shaft seals in compressors; and, maintenance of the helium purifying systems (coalescers, mist eliminators, activated carbon). Section II and the above-referenced Process Flow Diagrams provide more detail on the Cryogenic System Maintenance procedures.			
Dept./Div.:	Superconducting Magnet Division			
Dept. Code:	AM			
Building(s):	902			
Room(s):	N/A			
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II. Detailed Process Descriptions and Waste Determination

Superconducting magnets are designed to bend and focus ion beams used in accelerator/collider projects at BNL and other laboratories. Superconducting Magnet Division designs, fabricates, tests and repairs superconducting magnets. The magnets are cooled to 4.6°K (and lower) using either liquid helium or supercritical helium gas. At cryogenic temperature, the magnets acquire superconducting properties, thereby greatly reducing the amount of electricity that must be supplied to generate the magnetic field.

Process Flow Diagrams AM-530-CSM-01 through -02, provided in Attachment 1, graphically depict the process inputs and outputs for Cryogenic Systems Maintenance and Operations. These diagrams were developed to support fabrication and assembly operations associated with the Relativistic Heavy Ion Collider (RHIC). With the RHIC program operational since 2000, the SMD supports the program in supplying upgrades and repairs as well as doing research and development for institutions around the globe. The processes and controls are still in use and continue to be applicable

The maintenance and operation of the Superconducting Magnet Division Cryogenic Systems has been organized into 3 major processing units, labeled 1.0 through 3.0. The system components are located in Building 902 and associated structures. Process Flow Diagrams AM-530-CSM-01 through -02, graphically depict the process inputs and outputs for the Cryogenic System Maintenance and Operations.

The cryogenic refrigeration systems in Building 902 supply supercritical helium for magnet testing for production and other cryogenic magnet research and development projects. The basic cryogenic system operates as follows: gaseous helium is compressed to high pressures (approximately 250 psig), it then passes through a purification system to remove any contaminants. After it is purified, it is refrigerated by first being precooled in a heat exchanger using liquid nitrogen; then temperature is lowered using expanders and heat exchangers to produce either liquid helium or supercritical helium gas. Once used, the warmed helium is supplied back to the compressors.

Cryogenic piping, storage reservoirs (dewars) and valve operating stations use vacuum insulation to minimize heat transfer into the system. Vacuum pumps are utilized to evacuate the enclosed space surrounding the cryogenic equipment and piping (vacuum-jacketed piping and valve boxes). Routine replacement is required of vacuum pump oil and o-rings, gaskets and seals. Vacuum pumps typically contain less than 5 gallons of oil.

Helium compressors use a heat transfer fluid (oil) for the following: lubrication of mechanical parts, removal of the heat of compression from the helium, and in screw-type compressors (used in the majority of helium compressors), to provide a shaft seal. The fluid used is UCON LB-170X, manufactured by of Union Carbide/Dow. It is synthetic oil (polyalkylene glycol) that biodegrades in 28 days. Screw-type compressors typically have a design leakage of oil from the shaft seal. The quantity of oil stored within the compressor varies depending on the size of the compressor and the cryogenic system. The helium compressors in Building 902 have dedicated oil reservoirs that vary in size from approximately 500 gallons to less than 100 gallons depending on the compressor size. In addition to maintaining a reserve volume of fluid, the reservoirs are used by the helium compressor systems to separate oil entrained in the helium during compression. Therefore, the quantity of oil within the compressors and reservoirs is much less than the maximum capacity of the reservoirs. Compressor oil is not changed as part of a routine maintenance schedule like vacuum pump oil. Levels are monitored daily to determine if an unexpected loss has occurred.

Compressors are cooled using heat transfer fluid to water and helium to water heat exchangers. The water is part of an open loop cooling tower system in Building 902. To control conductivity and water chemistry, fresh water is added to the tower and allowed to drain (blowdown). In the event of a fluid to water heat exchanger failure, the drain to the tower has been connected to the laboratory’s sanitary sewer system where the outflow can be diverted into lined holding tanks in the event that a heat exchanger leaks oil into the cooling water system. This allows an ability to minimize any release to the environment.

In addition to the compressors utilized for compressing helium for refrigeration, the cryogenic system includes helium compressors that are used to support magnet cooling test stations for pump and purge operations, for cooldown and warm-up. Utility air compressors are used to provide pneumatic controls for the cryogenic system. The compressed air supplied to the valve boxes is required to be dry and oil free. Oil mist and oil/water separators ('Eliminator') are used and the oil is skimmed from the water with pads to minimize liquid waste disposal. These compressors are smaller in size and do not hold large quantities of oil. Other cryogenic system equipment that contains oil includes the following: rotoflows used to adjust the speed on the turbine expanders; heat exchangers used to cool the oil from the compressors.

When helium gas flows through the screw compressors some oil becomes entrained in the helium and must be removed prior to the helium entering the refrigerators. From the compressor the helium passes through a series of coalescers (coarse filters), mist eliminators (fine filters) and molecular sieves (often referred to as charcoal beds, however these currently consist of coconut shells). Oil removed from the helium in the coalescers and mist eliminators is collected in a trap and returned to the compressor reservoirs as part of a closed loop system. Oil, if any, which is removed from the helium by the molecular sieve, is removed when the material is regenerated.

The primary chemicals used during cryogenic system maintenance are cleaners and degreasers. Ethyl alcohol is widely used to clean vacuum parts, as is LPS PreSolve and LPS Precision Cleaner. The vacuum pumps utilize either UCON 50 or UCON 70 oil and the compressors utilize either Plus 19 or HV 150 oil. Waste generated by the cryogenics system maintenance in Building 902 includes used oil and oily rags/debris. Building 902 personnel estimate approximately one drum of used oil is generated every 6 months. The used oil drum in the Building 902 cryogenics system area is locked so that only cryogenic system related used oil is placed in the drum.

A complete list of chemicals utilized by the Superconducting Magnet Division is tracked using the BNL Chemical Management System (CMS). Current lists of chemical assigned to the Division can be found using the BNL CMS web site. Not all of the chemicals listed in the CMS list or located in SMD Buildings are used on a regular basis. When projects are completed, the chemicals used for that particular project typically remain in storage cabinets at the building for possible use in the future.

In general, waste generated during cryogenic system maintenance is recycled if applicable, disposed of as regulated industrial waste, or discarded to the regular trash.

Regulatory Determination of Process Outputs

1.0 Vacuum Pumps and Compressors

The Building 902 complex contains 9 helium compressors and 5 vacuum pumps. The primary helium compressor (Mycom) is a two-stage system located in the pump room in Building 902. The auxiliary compressor system (Dunham and Bush) is a two-stage system (with 2 low pressure compressors and one high pressure compressor) located within a small enclosure outside the cryogenic system area of Building 902. Currently the Dunham and Bush compressor is out of service. Located in the pump room in Building 902, there are two (2) additional screw type compressors (Sullair) that are used as backup to maintain the cryogenic system during maintenance. There are also two (2) piston style (Gardner Denver) compressors that are used to move contaminated (dirty) helium gas into storage tanks. Three (3) smaller screw-type (Sullair) compressors are located in an adjoining room (along with the coalescers, mist eliminators and molecular sieves) and are used for pump and purging, warm-up and cooldown operations.

Vacuum pumps are serviced on a routine basis, which involves changing the oil and replacing o-rings, gaskets and seals as needed. Screw compressors are periodically serviced to replace leaking shaft seals. Spill diapers are placed around the equipment while the oil is drained and new oil is added. Only the vacuum pump oil is completely replaced. Oil is removed from the compressors only to facilitate replacement of the shaft seals. In Building 902, approximately one 55-gallon drum of used oil is generated every 6 months. Oil that has collected in drip pans beneath the screw compressors is also placed in the used oil drum. Oily paper rags and diapers used during maintenance activities are placed in an oily rag drum and transferred to the Hazardous Waste Management Facility (HWMF) for disposal as industrial waste. Non-oily rags and empty cleaner (LPS PreSolve) containers are discarded in the regular trash. Worn o-rings, gaskets and shaft seals that are oil-free are discarded in the regular trash. Oily, worn o-rings, gaskets and shaft seals are placed in the oily rag drum. Removed carbon seals are cleaned and then placed in the metal chip bin for off-site recycling along with any scrap metal from removed parts.

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action Required
1.1	Used oil	Non-hazardous solid waste as determined by process knowledge	Waste is drummed and sent to the WMF for disposal as industrial waste	None
1.2	Oily rags, diapers, o-rings, gaskets and shaft seals	Non-hazardous solid waste as determined by process knowledge	Waste is drummed and sent to the WMF for disposal as industrial waste	None
1.3	Non-oily rags, O-rings, gaskets, and shaft seals	Non-hazardous solid waste as determined by process knowledge	Waste is discarded in the regular trash	None

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action Required
1.4	Carbon seals and scrap metal	Non-hazardous solid waste as determined by process knowledge	Waste is placed in the segregated chip bins for off-site recycling	None
1.5	Empty LPS PreSolve containers	Non-hazardous solid waste as determined by process knowledge	Waste is segrgated and recycled	None
1.6	Cooling tower overflow blowdown	Non-hazardous liquid discharged determined by process knowledge	Waste is processed by BNL Sewage Treatment Plant for discarded in Peconic River	None

2.0 and 3.0 Coalescers, Mist Eliminators and Molecular Sieves

The cryogenic systems in Building 902 utilize coalescers (coarse filters), mist eliminators (fine filters) and/or molecular sieves (often referred to as charcoal beds, however these currently consist of coconut shells) to remove contaminants from helium. Coalescers, mist eliminators and/or molecular sieves are utilized to remove oil entrained in the helium from the screw compressors during compression. Purifiers comprising of molecular sieves jacketed in liquid nitrogen are utilized to remove impurities from helium gas received from off-site vendors and helium returned to Building 902 in dewars. Two in-line purifiers, each consisting of a mist eliminator and nitrogen-jacketed molecular sieve, are integral to the Building 902 cryogenics system.

The associated process flow diagram depicts the process units and all the possible inputs and outputs for each unit based on the above variations of purifying systems. The diagram does not represent one particular system but is a combination of all of the above. The purifying systems were combined for the purposes of this PAF as the wastes generated are based on the type of unit(s) in the purifying system.

Oil removed from the helium in the coalescers and mist eliminators is collected in traps and returned to the compressor reservoirs as part of a closed loop system. If the filter material with the coalescer or mist eliminator becomes saturated, it must be replaced. However, filters do not require replacement often. Oil, if any, which is removed from the helium by the molecular sieve, is removed when the material is regenerated. The molecular sieve is regenerated in place by heating the material so that water and other impurities adhered to the material will melt and collect in a trap at the bottom of the unit. The contaminated oily water is collected in a drum and transferred to the HWMF for disposal as industrial waste. The molecular sieves are not regenerated often.

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action Required
2.1	Saturated filters	Non-hazardous solid waste as determined by process knowledge	Waste is drummed and sent to the WMF for disposal as industrial waste	**None**
2.2	**Oily water**	Non-hazardous liquid as determined by process knowledge	Waste is drummed and sent to the WMF for disposal as industrial waste	None

III. Waste Minimization, Opportunity for Pollution Prevention

During the initial effort of evaluating SMD's processes for Pollution Prevention and Waste Minimization Opportunities, each waste, effluent, and emission was examined to determine if there were opportunities to reduce either the volume or toxicity of the waste stream. Consideration was given to substitute raw materials with less toxic or less hazardous materials, process changes, reuse or recycling of materials and/or wastes, and other initiatives. These actions were documented in this section of the original process evaluation. Further identification of Pollution Prevention and Waste Minimization Opportunities will be made during annual assessments of the SMD processes. If any Pollution Prevention and Waste Minimization Opportunities are identified, they will be forwarded to the Environmental Compliance Representative for action and implementation, as appropriate.

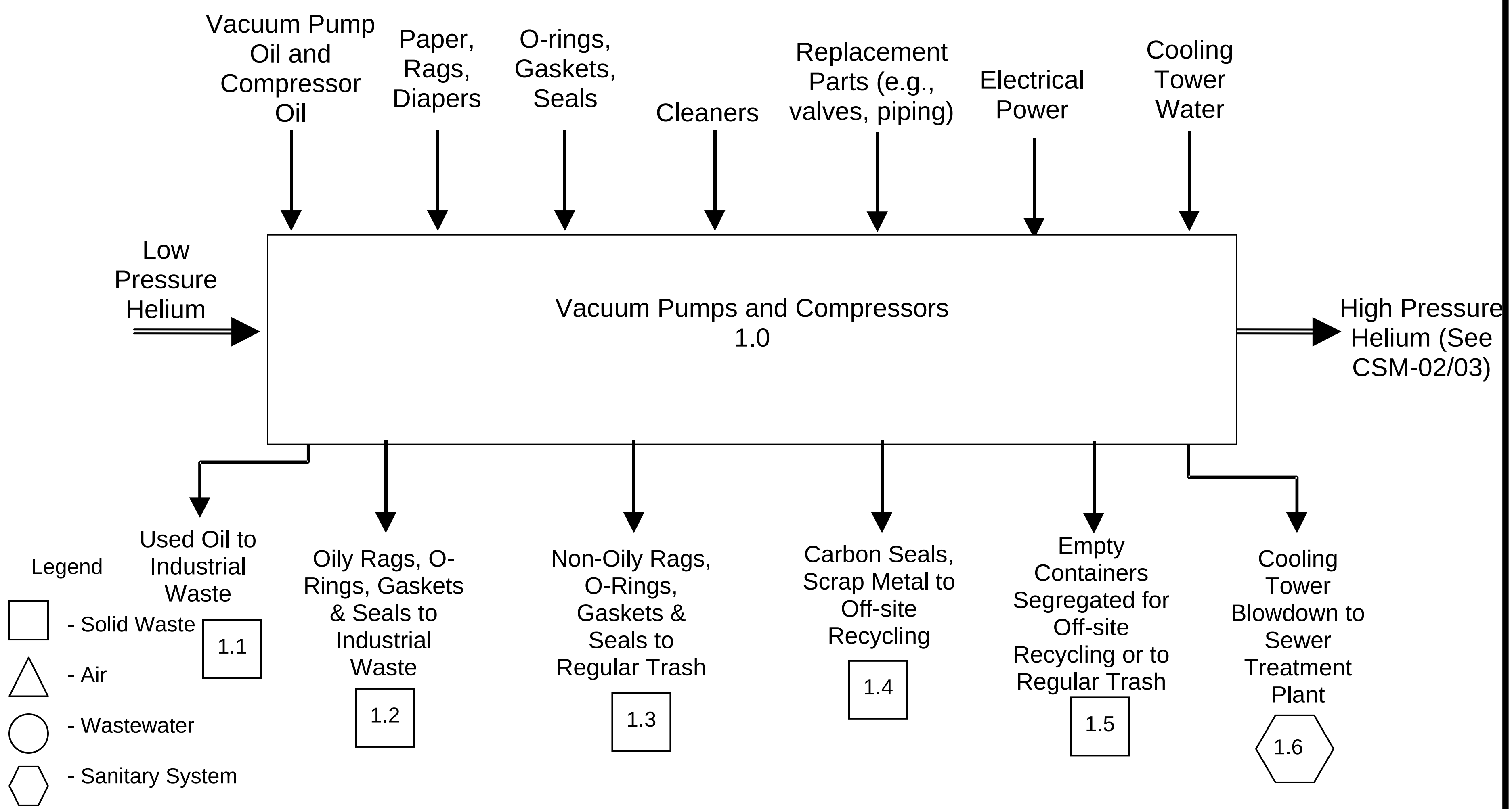
IV. Assessment Prevention and Control

During the initial effort of evaluating SMD's Assessment, Prevention, and Control (APC) Measures, operations, experiments and waste that have the potential for equipment malfunction, deterioration or operator error, and discharges or emissions that may cause or lead to releases of hazardous waste or pollutants to the environment or that potentially pose a threat to human health or the environment were described. A thorough assessment of these operations was made to determine: if engineering controls were needed to control hazards; where documented standard operating procedures needed to be developed; where routine, objective, self-inspections by department supervision and trained staff needed to be conducted and documented; and where any other vulnerability needed to be further evaluated. These actions were documented in this section of the original process evaluation. If new assessment, prevention, or control measures are identified during the annual assessment of the C-A process, they will be incorporated into the C-AD/SMD objectives and targets as applicable.

ATTACHMENT 1

PROCESS FLOW DIAGRAMS

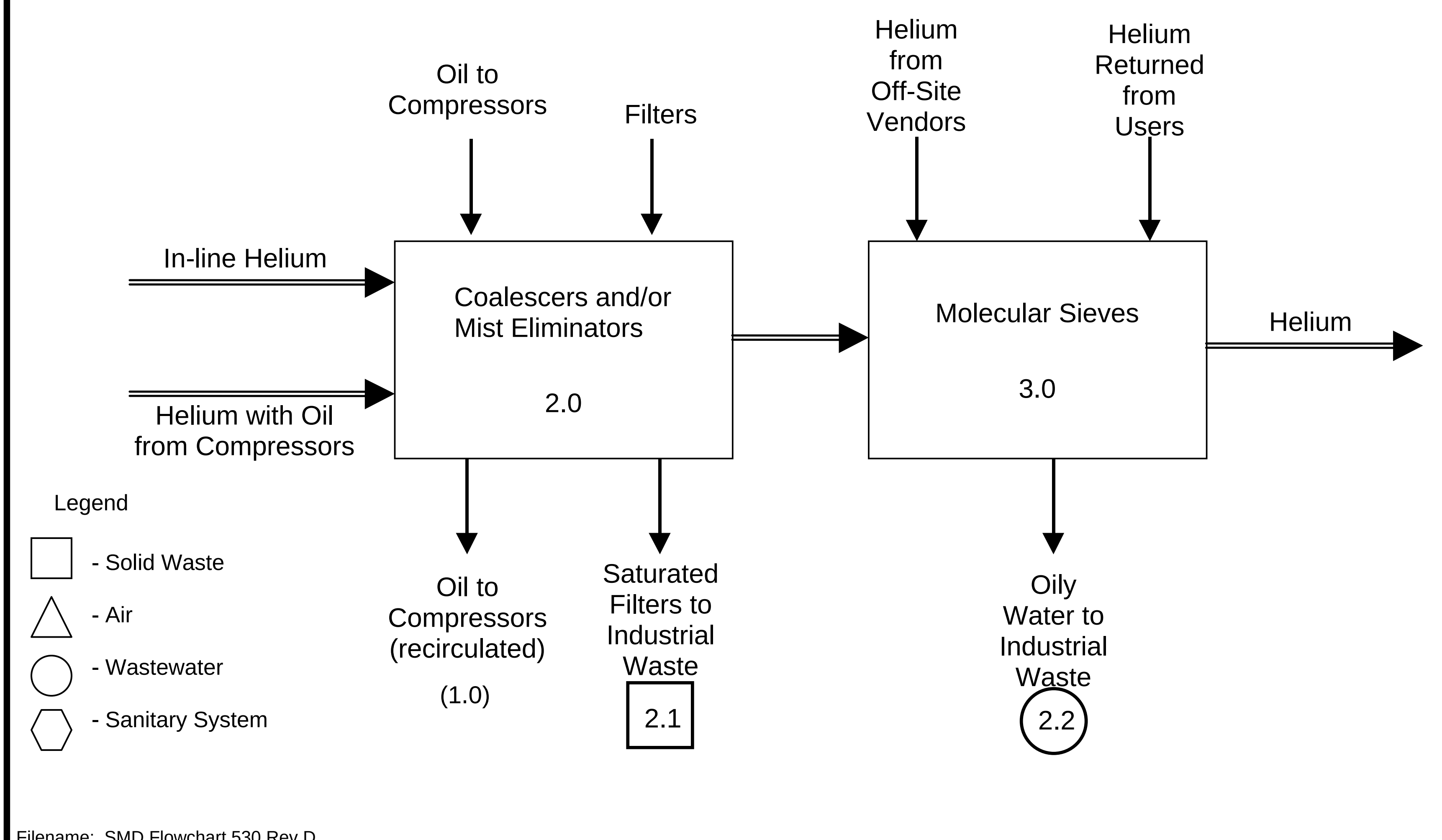
AM-530-CSM-01 through -02



Filename: SMD Flowchart 530 Rev D

BROOKHAVEN NATIONAL LABORATORY
PROCESS ASSESSMENT PROGRAM

Superconducting Magnet Division – Cryogenic System Maintenance
Process Flow Diagrams – Vacuum Pumps and Compressors



BROOKHAVEN NATIONAL LABORATORY
PROCESS ASSESSMENT PROGRAM

Superconducting Magnet Division – Cryogenic System Maintenance
Process Flow Diagram - Coalesers, Mist Eliminators and Molecular Sieves