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C-A OPERATIONS PROCEDURES MANUAL

14.9 C-A EMS Process Assessment for RHIC Cooling Water Systems  
(RHIC-523&528-CWS)

Text Pages 2 through 23

Hand Processed Changes

<u>HPC No.</u>	<u>Date</u>	<u>Page Nos.</u>	<u>Initials</u>
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Approved: \_\_\_\_\_ *Signature on File* \_\_\_\_\_  
Collider-Accelerator Department Chairman Date

M. Van Essendelft

**BROOKHAVEN NATIONAL LABORATORY  
PROCESS ASSESSMENT FORM**

**I. General Information**

Process ID:	RC-523+528-CWS			
Process Name:	RHIC Cooling Water Systems			
Process Flow Diagrams:	RCWS-Maintenance, RCWS -1000P, RCWS -1002, RCWS -1004, RCWS -1005P, RCWS – 1005E, RCWS -1006, RCWS -1008, RCWS -1010, and RCWS -1012			
Process Description:	<p>The RHIC Cooling Systems provide cooling for equipment used at the Relativistic Heavy Ion Collider (RHIC). There are eight cooling systems at different locations around the ring. These systems include:</p> <ul style="list-style-type: none"> <li>▪ 1000P – RHIC Injection Cooling Systems</li> <li>▪ 1002 – BRAHMS Cooling System</li> <li>▪ 1004 – RF Cavities and RF Power Amplifiers Cooling Systems</li> <li>▪ 1005E - Helium Recovery Cooling System</li> <li>▪ 1005P – Helium Compressor Cooling Tower</li> <li>▪ 1006 – STAR Experiment Cooling Systems</li> <li>▪ 1008C – PHENIX Experiment Cooling Systems</li> <li>▪ 1010 – PHOBOS Experiment Cooling System</li> <li>▪ 1012 – Spin Polarimeter Cooling System (future)</li> <li>▪ 1012 – Jet Target Cooling System</li> </ul> <p>Each of these systems is described in detail in the flow diagrams referenced above.</p>			
Dept/Div:	Collide-Accelerator Department			
Dept Code:	AD			
Buildings:	1000P, 1002, 1004, 1005E, 1005P, 1006, 1008C, 1010, and 1012			
Room(s):	Mechanical Rooms			
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Initial Release Date:	12/21/98			

## **II. Detailed Process Descriptions and Waste Determination**

The Relativistic Heavy Ion Collider (RHIC) Cooling Systems are located throughout the RHIC Complex. Attachment 1, Table II-1 provides information on operational status, future planned expansions and discharge locations.

Each system is typically comprised of a closed loop (or loops) primary cooling system(s), heat exchanger(s), and an open loop heat secondary system (cooling tower or chiller). Process flow diagrams RCWS-Maintenance, RCWS -1000P, RCWS -1002, RCWS -1004, RCWS -1005P, RCWS -1006, RCWS -1008, RCWS -1010, and RCWS -1012 show the process inputs and outputs for each of the eight RHIC Cooling Systems. Part of RCWS- 1012 is a future system. Attachment 1, Table II-2 lists the chemicals used and discharge flow ranges. Process Flow Diagram RCWS-Maintenance is for RHIC Support Equipment Maintenance. The following subsections provide specific descriptions for each system.

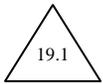
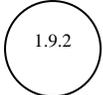
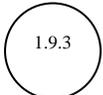
### **1.0 RHIC Injection Cooling System (Building 1000P)**

The RHIC Injection Cooling System is located south of the Collider, adjacent and east of the W-Line near the 6 o'clock position, in Building 1000P. This system includes two process systems, a closed loop water cooling-system for the RHIC injection magnets (including some AGS magnets in the U-line and g-2) and a cooling tower system (see Process Flow Diagram RSWS-1000P). The magnet cooling system is a deionized closed loop. The water in the cooling system loop becomes activated, having an average concentration of about 8000 pCi/liter of tritium. The piping system is single-walled, since SCDHS Article 12 requirements do not require double-walled piping for systems containing materials below the EPA drinking water standard (20,000 pCi/liter tritium). The magnet heat is transferred by heat exchanger to the cooling tower water system. The cooling tower system transfers the heat to the atmosphere. Blowdown occurs from the cooling tower system automatically via on-line conductivity measurement and is discharged to the storm water drainage system at Outfall 002 (SPDES Permit No. NY 0005835). Outfall 002 includes three recharge basins located in the center of the RHIC ring.

Wastes generated include used filter bags and spent resins from the deionization of the magnet system water, cooling tower blowdown, and cooling tower cleaning. The magnet cooling water is deionized. The deionization process includes an initial bag filter, a mixed resin (cation and anion) cartridge deionizer, an oxygen scavenger, and a final bag filter. Spent deionizer resin is disposed by WMD as low-level radioactive wastes (LLW). Used filter bags from this same system are disposed as solid waste. These wastes have the potential to be radioactive because this cooling system starts at AGS magnets in the U-line and g-2 and the first few magnets have the potential to be activated. The filter bags and contents are analyzed for radioactivity to determine the proper disposal path. The BNL potable makeup water to the magnet cooling system also includes deionization. Used filter bags wastes from this process are disposed as trash. The C-A Water Systems Group purchases regenerated resins and replaces spent resin in building 974. The spent resin is drummed, sampled and disposed of through the Environmental and Waste Management Services Division according to the analysis results.

Wastes generated in the cooling tower system include cooling tower blowdown and cleaning waters. These wastes are both discharged to groundwater via recharge basins located in the center of the RHIC ring (Outfall 002HN, SPDES Permit No. NY 0005835).

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action
<div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">1.1</div> <div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">1.3</div>	Make-up water used filter bags. (potable water)	Non-hazardous solids waste to trash/process knowledge.	Used filter bags are dried, bagged and placed in a dumpster.	None
<div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">1.2</div>	Make-up water spent deionizer resins. (potable water)	Non-hazardous solid waste to disposal /process knowledge.	Spent resin is removed and sent to WMD and subsequently transported off-site as LLW for disposal.	None
<div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">1.4</div> <div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">1.7</div>	Cooling water loop used filter bags.	Non-hazardous solid waste to trash/process knowledge.	Used filter bags are dried, bagged and placed in dumpster.	Analyze for radioactivity
<div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">1.5</div>	Magnet cooling system oxygen scavenger resins.	Non-hazardous solid waste to disposal /process knowledge. <sup>1</sup>	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	None
<div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">1.6</div>	Cooling water loop spent dionizer resins.	Low-level radioactive waste (LLW)/process knowledge.	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	None

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action
	Water vapor.	Deminimis release of clean water to the atmosphere/process knowledge.	Released to the atmosphere.	None
	Cooling tower blowdown.	Permitted discharge to groundwater (Outfall 002HN)/SPDES Permit # NY 0005835.	Blowdown water is transported to recharge basin.	None
	Cooling tower cleaning waters.	Permitted discharge to groundwater (Outfall 002HN)/SPDES Permit # NY 0005835.	Cleaning waters are transported to recharge basins.	None

## 2.0 BRAHMS Cooling System (Building 1002)

### **SYSTEM NOT OPERATIONAL – Magnets & Power Supplies Drained and Tower Shut Down**

The BRAHMS cooling system is located inside of the RHIC ring at the 2 o'clock position, in Building 1002. This cooling water system contains no radionuclides. The system includes two process systems, a closed loop magnet cooling water system and a cooling tower system (see Process Flow Diagram RCWS-1002). The magnet cooling system is designed as a deionized closed loop. The cooling system water flows through a heat exchanger and transfers excess heat to the cooling tower system. The cooling tower system transfers the heat to the atmosphere. An Aqua-Flow ozone system, located outdoors, is used to treat the cooling tower water. Blowdown from the cooling tower system occurs automatically via conductivity measurement. This blowdown is discharged to the storm water drainage system at Outfall 002A (SPDES Permit No. NY 0005835) via a path that passes through the 4 o'clock position in the ring. Outfall 002 includes three recharge basins located in the center of the RHIC ring.

Wastes generated include used filter bags and spent resins from the deionization of the closed loop cooling system water, cooling tower blowdown, and cooling tower cleaning wastes. The closed loop cooling system water is deionized. The deionization process includes a mixed resin (cation and anion)

cartridge deionizer and a bag filter. Wastes from this process, with the exception of spent resins, will be disposed as trash. The C-A Water Systems Group purchases regenerated resins and replaces spent resin in building 974. The spent resin is drummed, sampled and disposed of through the Environmental and Waste Management Services Division according to the analysis results. Resin cartridges are screened as the beam intensity of the Collider increases to confirm they have not become contaminated with radioactivity. Wastes generated in the cooling tower system include cooling tower blowdown and cleaning waters. These wastes are both be discharged to the storm water drainage system at Outfall 002A (SPDES Permit No. NY 0005835) via a path that passes through the 4 o'clock position in the ring. Outfall 002 includes three recharge basins located in the center of the RHIC ring.

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action
2.1	Make-up water spent deionizer resins. (potable water)	Non-hazardous solid waste to regeneration/disposal contractor/process knowledge.	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	None
2.2	Make-up water used filter bags. (potable water)	Non-hazardous solid waste to trash/process knowledge.	Used filter bags are dried, bagged and placed in a dumpster.	None
2.3	Cooling water loop spent deionizer resins.	Non-hazardous solid waste to regeneration/disposal contractor/process knowledge. <sup>1</sup>	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	See footnote and Section IV.
2.4	Cooling water loop used filter bags.	Non-hazardous solid waste to trash/process knowledge. <sup>1</sup>	Used filter bags are dried, bagged and placed in a dumpster.	See footnote and Section IV.

	Water vapor.	Deminimis release of water treatment chemicals to the atmosphere/process knowledge.	Released to the atmosphere.	None
	Cooling tower blowdown.	Permitted discharge to groundwater (Outfall 002A)/SPDES Permit # NY 0005835..	Blowdown water is transported to recharge basin.	None
	Cooling tower cleaning waters.	Permitted discharge to groundwater (Outfall 002A)/SPDES Permit # NY 0005835.	Blowdown water is transported to recharge basin.	None

<sup>1</sup> The spent resins will be tested as the beam intensity of the Collider increases to confirm waste determination. Test should include radiological analysis (gamma scan and gross beta). Spent filters will be checked with a meter to test for radioactivity.

### 3.0 RF Cooling System (Building 1004)

The RF Cooling systems are located inside of the RHIC ring at the 4 o'clock position, in Building 1004. This cooling water system contains no radionuclides. The cooling system includes three process systems; a chemically treated (Drewgard 4109) closed loop cooling water system for the RF cavities, a deionized water closed loop cooling system for the RF Power Amplifiers, and a cooling tower system (see Process Flow Diagram RCWS-1004). The cooling systems are treated or deionized closed loops. The RF cavities cooling system and the RF Power Amplifier cooling system flows through cartridge filters and deionizers. Heat rejection is to a cooling tower via heat exchangers. The RF Cooling System is an ozone system thereby eliminating the use of chemicals. Blowdown from the cooling tower system occurs automatically via conductivity measurement. This blowdown is discharged to the storm water drainage system at Outfall 002B (SPDES Permit No. NY 0005835). Outfall 002 includes three recharge basins located in the center of the RHIC ring.

Wastes generated include filter bags and spent resins from the deionization of the RF Power Amplifiers cooling system, cooling tower blowdown and cooling tower cleaning-waters. The deionization process includes an initial cartridge filter, two mixed resin (cation and anion) cartridge deionizers, and a final bag filter. The C-A Water Systems Group purchases regenerated resins and replaces spent resin in building 974. Deionizer cartridges are recycled and reused. The spent resin is drummed, sampled and disposed of through the Environmental and Waste Management Services Division according to the analysis results. Other wastes from this process (filter bags) are disposed as trash (subject to verification analysis). Wastes from the BNL potable makeup water deionization system are disposed of as trash with the resin regenerated and spent resins drummed, sampled and C-A-OPM 14.9

disposed of through the Environmental and Waste Management Services Division according to the analysis results. Wastes generated in the cooling tower system include cooling tower blowdown and cleaning waters. These wastes are discharged to the storm water drainage system at Outfall 002B (SPDES Permit No. NY 0005835). Outfall 002 includes three recharge basins located in the center of the RHIC ring.

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action
<div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">3.1</div> <div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">3.3</div>	Make-up water used filter bags. (potable water)	Non-hazardous solid waste to trash/process knowledge.	Used filter bags are dried, bagged and placed in a dumpster.	None
<div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">3.2</div>	Make-up water spent deionizer resins. (potable water)	Non-hazardous solid waste to disposal /process knowledge.	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	None
<div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">3.4</div>	Cooling water loop used filter bags.	Non-hazardous solid waste to trash/process knowledge. <sup>1</sup>	Used filter bags are dried, bagged and placed in a dumpster.	See footnote and Section IV.
<div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">3.5</div> <div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">3.6</div>	Cooling water loop spent deionizer resins.	Non-hazardous solid waste to disposal /process knowledge. <sup>1</sup>	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	See footnote and Section IV.

3.7	Cooling water loop used filter bags.	Non-hazardous solid waste to trash/process knowledge. <sup>1</sup>	Used filter bags are dried, bagged and placed in a dumpster.	See footnote and Section IV.
3.9.1	Water vapor.	Deminimis release of water treatment chemical to the atmosphere/process knowledge.	Released to the atmosphere.	None
3.9.2	Cooling tower blowdown.	Permitted discharge to groundwater (Outfall 002B)/SPDES Permit # NY 0005835	Blowdown water is transported to recharge basin.	None
3.9.3	Cooling tower cleaning waters.	Permitted discharge to groundwater (Outfall 002B)/SPDES Permit # NY 0005835	Blowdown water is transported to recharge basin.	None

<sup>1</sup> The spent resins will be tested as the beam intensity of the Collider increases to confirm waste determination. Test should include radiological analysis (gamma scan and gross beta). Spent filters will be checked with a meter to test for radioactivity.

#### 4.0 Cryogenic Compressor Cooling System (Building 1005P)

The Helium Compressor cooling system is located inside the RHIC ring at the 5 o'clock position, in Building 1005P. This cooling water system contains no radionuclides. Heat from the Helium Compressor System is transferred directly to the atmosphere via the cooling tower (see Process Flow diagram RCWS-1005P). Chemicals added to the cooling tower system include a microbiocide (Biosperse 254), a precursor (Drew BROM 1-L), and an antifoulant (Drew 2135). Blowdown from the cooling tower system occurs automatically via conductivity measurement and is discharged to Outfall 002HN (SPDES Permit # NY 0005835). Outfall 002HN includes three recharge basins located in the center of the RHIC ring.

Wastes generated in this system include cooling tower blowdown and tower cleaning waters. These wastes are discharged to the groundwater via the recharge basins located in the center of the RHIC ring (Outfall 002HN, SPDES Permit # NY 0005835).

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action
 4.1.1	Water vapor.	Deminimis release of water treatment chemicals to the atmosphere/process knowledge.	Released to the atmosphere.	None
 4.1.2	Cooling tower blowdown.	Permitted discharge to groundwater (Outfall 002HN)/SPDES Permit # NY 0005835.	Blowdown water is discharged to recharge basin.	None
 4.1.3	Cooling tower cleaning waters.	Permitted discharge to groundwater (Outfall 002HN)/SPDES Permit # NY 0005835.	Cleaning waters are transported to recharge basins.	None

## 5.0 Helium Reliquifier Cooling System (1005E)

A helium reliquifier has been installed at RHIC to reliquify helium boil-off from storage dewars. The equipment is located in Buildings 1005E, 1006B with controls located in Building 1005H. The compressor and helium purifier are located in 1005E, the refrigerator in 1006B and liquid helium storage outside of building 1006B. The compressor used in the reliquification process has a reservoir that contains 90 gallons of UCON LB 170 heat transfer fluid that is cooled using a dedicated cooling tower located outside of building 1005E. This cooling water system contains no radionuclides. Heat from the Reliquifier Compressor System is transferred directly to the atmosphere via the cooling tower (see Process Flow diagram RCWS-1005E). There are no chemicals added to the cooling tower. Blowdown from the cooling tower system occurs automatically via conductivity measurement and is discharged to Outfall 002HN (SPDES Permit # NY 0005835). Outfall 002HN includes three recharge basins located in the center of the RHIC ring.

Wastes generated in this system include cooling tower blowdown and tower cleaning waters. These wastes are discharged to the groundwater via the recharge basins located in the center of the RHIC ring (Outfall 002HN, SPDES Permit # NY 0005835).

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action
 5.1.1	Water vapor.	Deminimis release of water vapor to the atmosphere/process knowledge.	Released to the atmosphere.	None
 5.1.2	Cooling tower blowdown.	Permitted discharge to groundwater (Outfall 002HN)/SPDES Permit # NY 0005835.	Blowdown water is discharged to recharge basin.	None
 5.1.3	Cooling tower cleaning waters.	Permitted discharge to groundwater (Outfall 002HN)/SPDES Permit # NY 0005835.	Cleaning waters are transported to recharge basins.	None

## 6.0 STAR Experiment Cooling Systems (Building 1006)

The STAR Experiment Cooling System is located inside the RHIC ring at the 6 o'clock position, in Building 1006. This cooling water system contains no radionuclides. There are six process systems, a closed loop deionized water cooling system for the STAR magnets, a closed loop deionized water cooling system for the Modified Cooling Water System (MCW) system, a closed loop deionized water cooling system for the power supply systems, the Time Projection Chamber (TPC) system, the chilled water system, and a cooling tower system (see Process Flow Diagram RCWS-1006 – page one of the diagram has been added to include the Time Projection Chamber). The cooling tower system has been sized to also reject heat from two chillers. The four closed loop deionized water cooling-systems include bag filters before and after the deionizer (DI) systems. The STAR magnets and Time Projection Chamber closed loop DI water cooling-systems includes an initial mixed resin (cation and anion) cartridge, an oxygen scavenger and a polishing DI system. The two other cooling systems include bag filters and deionizers. Each cooling system also has deionized make-up from the BNL potable water supply. Heat from these three cooling loops is transferred via heat exchangers to the cooling tower/chiller system. The cooling tower system transfers this heat to the atmosphere. Chemicals added to the cooling tower system include a microbiocide (Biosperse 254), a precursor (Drew BROM One-L), and an antifoulant (Drew 2135). Blowdown (automatically via conductivity measurement) from the cooling tower system is discharged to Outfall 002HN (SPDES Permit# NY 0005835), three recharge basins located in the center of the RHIC ring.

Wastes generated include filter bags and resins from the deionization of the three closed loop cooling systems, cooling tower blowdown, and cooling tower cleaning wastes. In addition, deionization of the makeup water for the three cooling systems generates filter bags and resins. Wastes from the

deionization processes, used filter bags and deionizer resin, will be disposed as non-hazardous solid wastes. Used filter bags are dried, bagged and placed in dumpsters. The C-A Water Systems Group purchases regenerated resins, Oxygen resins, and replaces spent resin in building 974. Deionizer cartridges are recycled and reused. The spent resin is drummed, sampled and disposed of through the Environmental and Waste Management Services Division according to the analysis results. The resin cartridges will be screened as the beam intensity of the Collider increase to confirm they have not become contaminated with radioactivity. Wastes generated in the cooling tower system include cooling tower blowdown and cleaning waters. These wastes are discharged to recharge basins located in the center of the RHIC ring (Outfall 002HN, SPDES Permit # NY 0005835).

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action
<div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.1</div> <div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.2</div> <div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.12</div> <div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">6.17</div>	Make-up water deionizer resins. (potable water)	Non-hazardous solid waste to disposal /process knowledge	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	None
<div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.3</div> <div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.10</div> <div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">6.24</div>	Magnet cooling system filter bags.	Non-hazardous solid waste to trash/process knowledge. <sup>1</sup>	Used filter bags are dried, bagged and placed in a dumpster.	See footnote and Section IV.
<div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.4</div> <div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.5</div> <div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.8</div> <div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.9</div> <div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">6.25</div>	Magnet cooling system resins.	Non-hazardous solid waste to disposal /process knowledge. <sup>1</sup>	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	See footnote and Section IV.

<div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.6</div> <div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.7</div> <div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">6.26</div>	Magnet cooling system oxygen scavenger resins.	Non-hazardous solid waste to disposal /process knowledge. <sup>1</sup>	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	See footnote and Section IV.
<div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.13</div> <div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.15</div> <div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.27</div> <div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">6.28</div>	MCW cooling system filter bags.	Non-hazardous solid waste to trash/process knowledge. <sup>1</sup>	Used filter bags are dried, bagged and placed in a dumpster.	See footnote and Section IV.
<div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">6.14</div>	MCW cooling system resins.	Non-hazardous solid waste to disposal /process knowledge. <sup>1</sup>	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	See footnote and Section IV.
<div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.18</div> <div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">6.21</div>	Power supply cooling system filter bags.	Non-hazardous solid waste to trash/process knowledge. <sup>1</sup>	Used filter bags are dried, bagged and placed in a dumpster.	See footnote and Section IV.
<div style="border: 1px solid black; width: 30px; height: 20px; margin-bottom: 5px; text-align: center; line-height: 20px;">6.19</div> <div style="border: 1px solid black; width: 30px; height: 20px; text-align: center; line-height: 20px;">6.20</div>	Power supply cooling system resins.	Non-hazardous solid waste to disposal /process knowledge. <sup>1</sup>	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	See footnote and Section IV.

	Water vapor.	Deminimis release of water treatment chemicals to the atmosphere/process knowledge.	Released to the atmosphere.	None
	Cooling tower blowdown.	Permitted discharge to groundwater (Outfall 002HN)/SPDES Permit # NY 0005835.	Blowdown water is directed to recharge basins.	None
	Cooling tower cleaning waters.	Permitted discharge to groundwater (Outfall 002HN)/SPDES Permit # 0005835.	Cleaning waters are directed to recharge basins	None

<sup>1</sup> The spent resins will be tested as the beam intensity of the Collider increases to confirm waste determination. Test should include radiological analysis (gamma scan and gross beta). Spent filters will be checked with a meter to test for radioactivity.

## 7.0 PHENIX Experiment Cooling Systems (Building 1008C)

The PHENIX Experiment cooling systems are located outside the RHIC ring at the 8 o'clock position, in Building 1008C. This cooling water system contains no radionuclides. There are four process systems, a closed loop deionized water cooling-system for the PHENIX magnets and electronics, a closed loop deionized water cooling-system for the PHENIX power supply, a chilled water system, and a cooling tower system (see Process Flow Diagram RCWS-1008). The cooling tower system has been sized to also reject heat from chillers. The two closed loop deionized water cooling-systems include bag filters before and after the deionizer (DI) systems. The magnet/electronics DI system includes a make-up water mixed resin (cation and anion) cartridge and a polishing mixed resin cartridge.

The power supply cooling system includes a single mixed resin (cation and anion) cartridge. Each cooling system also has deionized BNL potable water make-up. Heat from the two cooling systems is transferred via heat exchangers to the cooling tower system. The cooling tower system transfers this heat to the atmosphere. Chemicals added to the cooling tower system include a microbiocide (Biosperse 254), a precursor (DrewBROM 1-L), and an antifoulant (Drew 2135). Blowdown (automatically via conductivity measurement) from the cooling tower system is discharged to a recharge basin (Outfall 002HN).

Wastes generated include filter bags and resins from the deionization of the two closed-loop cooling systems waters, cooling tower blowdown and cooling tower cleaning-wastes. In addition, deionization of the makeup potable water for the two cooling systems will generate spent resins. Wastes from the C-A-OPM 14.9

deionization processes, filter bags and deionizer resin will be disposed as non-hazardous solid wastes. Used filter bags will be dried, bagged and placed in dumpsters. The C-A Water Systems Group purchases regenerated resins and replaces spent resin in building 974. Deionizer cartridges are recycled and reused. The spent resin is drummed, sampled and disposed of through the Environmental and Waste Management Services Division according to the analysis results. The initial batch of resin will be screened to confirm they have not become activated. Wastes generated in the cooling tower system will include cooling tower blowdown and cleaning waters. These wastes are discharged to a recharge basin. (NPDES Permit # 0005835, Outfall 002HN)

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action
7.1 7.7	Make-up water deionizer resins.(potable water)	Non-hazardous solid waste to disposal /process knowledge.	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	None
7.2 7.5	Magnet/electronics cooling system filter bags.	Non-hazardous solid waste to trash/process knowledge. <sup>1</sup>	Used filter bags are dried, bagged and placed in a dumpster.	See footnote and Section IV.
7.3 7.4	Magnet/electronics cooling system resins.	Non-hazardous solid waste to disposal /process knowledge. <sup>1</sup>	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	See footnote and Section IV.
7.8 7.10	Power supply cooling system filter bags.	Non-hazardous solid waste to trash/process knowledge. <sup>1</sup>	Used filter bags are dried, bagged and placed in a dumpster.	See footnote and Section IV.

7.9	Power supply cooling system resin.	Non-hazardous solid waste to regeneration/disposal contractor/process knowledge. <sup>1</sup>	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	See footnote and Section IV.
7.12.1	Water vapor.	Deminimis release of water treatment chemicals to the atmosphere/process knowledge.	Released to the atmosphere.	None
7.12.2	Cooling tower blowdown.	Permitted discharge to groundwater (Outfall 002HN)/SPDES Permit # 0005835.	Blowdown water is discharged to monitored recharge basin.	None
7.12.3	Cooling tower cleaning waters.	Permitted discharge to groundwater (Outfall 002HN)/SPDES Permit # 0005835.	Cleaning waters are discharged to monitored recharge basin.	None

<sup>1</sup> The spent resins will be tested as the beam intensity of the Collider increases to confirm waste determination. Test should include radiological analysis (gamma scan and gross beta). Spent filters will be checked with a meter to test for radioactivity.

## 8.0 PHOBOS Cooling System (Building 1010)

### **SYSTEM NOT OPERATIONAL – Magnets & Power Supplies Drained and Tower Shut Down**

The PHOBOS cooling system is located inside the RHIC ring at the 10 o'clock position, in Building 1010. This cooling water system contains no radionuclides. The system includes two processes, a closed loop deionized water magnet cooling system and a cooling tower system (see Process Flow Diagram RCWS-1010). Heat from the cooling system is transferred via a heat exchanger to the cooling tower system. The cooling tower system transfers this heat to the atmosphere. An Aqua-Flow Ozone System, located outdoors, is used to treat the cooling tower's water. Blowdown from the cooling tower system occurs automatically via conductivity measurement. Blowdown from the cooling tower system is discharged to the storm water drainage system at Outfall 002A (SPDES Permit No. NY 0005835). Outfall 002 includes three recharge basins located in the center of the RHIC ring.

Wastes generated include filter bags and resins from the deionization of the closed loop cooling system water, cooling tower blowdown and cooling tower cleaning-wastes. In addition, deionization of the BNL potable water makeup for the cooling system generates used filter bags and spent resins. Wastes from the deionization processes, filter bags and deionizer resin, are disposed as non-hazardous solid wastes. Filter bags are dried, bagged and placed in dumpsters. The C-A Water Systems Group purchases regenerated resins and replaces spent resin in building 974. Deionizer cartridges are recycled and reused. The spent resin is drummed, sampled and disposed of through the Environmental and Waste Management Services Division according to the analysis results. The initial batch of resin will be screened as the collider beam intensity increases to confirm they have not become contaminated with radioactivity. Wastes generated in the cooling tower system will include cooling tower blowdown and cleaning waters. These wastes are both discharged to the storm water drainage system at Outfall 002 (SPDES Permit No. NY 0005835). Outfall 002 includes three recharge basins located in the center of the RHIC ring.

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action
8.1	Make-up water deionizer resins.(potable water)	Non-hazardous solid waste to disposal /process knowledge.	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	None
8.2	Make-up water filter bags. (potable water)	Non-hazardous solid waste to trash/process knowledge.	Used filter bags are dried, bagged and placed in a dumpster.	None
8.3	PHOBOS cooling system deionizer resins.	Non-hazardous solid waste to disposal /process knowledge. 1	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	See footnote and Section IV.

<div style="border: 1px solid black; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 10px auto;">8.4</div>	PHOBOS cooling system filter bags.	Non-hazardous solid waste to trash/process knowledge. <sup>1</sup>	Used filter bags are dried, bagged and placed in a dumpster.	See footnote and Section IV.
<div style="border: 1px solid black; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 10px auto;"> <div style="border: 1px solid black; width: 20px; height: 20px; transform: rotate(45deg); margin: 0 auto;"></div> </div>	Water vapor.	Deminimis release of water treatment chemicals to the atmosphere/process knowledge.	Released to the atmosphere.	None
<div style="border: 1px solid black; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 10px auto; border-radius: 50%;">8.6.2</div>	Cooling tower blowdown.	Permitted discharge to groundwater (Outfall 002A)/SPDES Permit # NY 0005835	Blowdown water is transported to recharge basin.	None
<div style="border: 1px solid black; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 10px auto; border-radius: 50%;">8.6.3</div>	Cooling tower cleaning waters.	Permitted discharge to groundwater (Outfall 002A)/SPDES Permit # NY 0005835	Blowdown water is transported to recharge basin.	None

<sup>1</sup> The spent resins will be tested as the beam intensity of the Collider increases to confirm waste determination. Test should include radiological analysis (gamma scan and gross beta). Spent filters will be checked with a meter to test for radioactivity.

## 9.0 Spin Polarimeter Cooling System (Building 1012)

This system is currently not installed. The Spin Polarimeter cooling system will be located inside the RHIC Ring at the 12 o'clock position. This "temporary" system is currently in the planning stage and is anticipated to operate for a 2-week duration. There will be two process systems, a 100-gpm closed-loop deionized water, cooling system for some magnets and a 200 gpm cooling tower system (see Process Flow Diagram RCWS-1012). The cooling tower has been sized to accommodate the anticipated high (37°F) temperature rise in the closed loop cooling system. The closed loop cooling system includes a full flow filter and a mixed resin (cation and anion) bed. Heat from the cooling system will be transferred via heat exchanger to the cooling tower system. The cooling tower system will transfer this heat to the atmosphere. No chemicals will be used in the cooling tower system due to the "temporary" nature of this experiment. Cooling tower blowdown will be discharged locally to the ground surface.

Wastes generated at this location will include filter solids and spent resins from the deionization of the closed loop cooling system water and cooling tower blowdown wastes from the deionization process will be disposed as non-hazardous solid wastes. Filter solids will be placed in a dumpster. The C-A Water Systems Group purchases regenerated resins and replaces spent resin in building 974. Deionizer cartridges are recycled and reused. The spent resin is drummed, sampled and disposed of through the Environmental and Waste Management Services Division according to the analysis results. Cooling tower system blowdown will be discharged locally to the ground surface. NYSDEC will be notified and BNL will receive their authorization prior to any discharge.

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action
9.1	Spin polarimeter cooling system filter solids.	Non-hazardous solid waste to trash/process knowledge. <sup>1</sup>	Filter solids will be collected and disposed.	See footnote and Section IV.
9.2	Spin polarimeter cooling system spent deionizer resins.	Non-hazardous solid waste to disposal /process knowledge. <sup>1</sup>	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	See footnote and Section IV.
9.4.1	Water Vapor	Non-hazardous atmospheric discharge.	Released to atmosphere.	None
9.4.2	Cooling tower blowdown.	Discharge to ground surface. Notification will be provided to NYSDEC.	Blowdown waters will be discharged locally to the ground surface.	None

<sup>1</sup> The spent resins will be tested as the beam intensity of the Collider increases to confirm waste determination. Test should include radiological analysis (gamma scan and gross beta). Spent filters will be checked with a meter to test for radioactivity.

## 10.0 Jet Target Cooling System (Building 1012)

The Jet Target cooling system is located inside the RHIC Ring at the 12 o'clock position. This system operates for duration of when polarized protons are run. The jet utilizes a closed loop cooling system (10-12 gallons per minute at 100 psi) with a heat exchanger in the service building. The primary side of the cooling loop consists of a 100-gpm closed-loop deionized water, cooling system for the target, for some magnets and turbo pumps. The closed loop cooling system includes a full flow filter and a mixed resin (cation and anion) bed. The secondary side of the cooling system uses a chiller to cool the system. Periodically water is added to the chiller due to evaporation. During periods of high heat load once through domestic supplements the chiller to cool the system. A Liquid Effluent form has been submitted and approval has been given to discharge to the Sanitary System for this run. A 200 gpm cooling tower system is a possible future upgrade (see Process Flow Diagram RCWS-1012).

Wastes generated at this location will include filter solids and spent resins from the deionization of the closed loop cooling system water. The deionization process will be disposed as non-hazardous solid wastes. Filter solids will be placed in a dumpster. The C-A Water Systems Group purchases regenerated resins and replaces spent resin in building 974. Deionizer cartridges are recycled and reused. The spent resin is drummed and disposed of as low-level radioactive waste.

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action
10.1	Jet Target cooling system filter solids.	Non-hazardous solid waste to trash/process knowledge.	Filter solids will be collected and disposed.	None
10.2	Jet Target cooling system spent deionizer resins.	Non-hazardous solid waste to disposal /process knowledge.	Spent resin is removed from cartridges and sent to WMD and subsequently transported off-site as LLW for disposal.	None
10.4.2	Cooling Water	Discharge to Sanitary Sewer System per Liquid Effluent Evaluation - when high heat load requires once through domestic water.	Discharge to Sanitary Sewer System per Liquid Effluent Evaluation.	None

## 11.0 RHIC Cooling Systems Equipment Maintenance

Equipment for the RHIC cooling systems is maintained to ensure availability. This maintenance includes the pumps and electric motors for the water cooling and cooling tower systems. Maintenance on these systems results in the generation of some used lubricating oils. These oils are collected in drums and sent to EWMSD for disposal as industrial waste.

Maintenance on RHIC cooling systems also generates solid waste. Used parts, equipment, etc. are placed in containers and disposed as trash. Trash is transported off-site by contractor for disposal. Process Flow Diagram RHIC-Maintenance shows the equipment maintenance waste-streams.

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action
11.1.1	Waste hydraulic and lubricating oil.	Non-hazardous liquid waste/process knowledge.	Waste oil is placed in drums and removed by EWMSD for disposal.	None
11.1.2	Oil soaked rags.	Industrial waste/process knowledge.	Oil soaked rags are placed in containers and removed by EWMSD for disposal.	None
11.1.3	Used parts, equipment, etc.	Solid waste (trash)/process knowledge.	Wastes are placed in trash containers and subsequently transported off-site by Contractor for disposal.	None
11.2	Used parts, equipment etc.	Solid waste (trash)/process knowledge.	Wastes are placed in trash containers and subsequently transported off-site by contractor for disposal.	None

### **III. Waste Minimization, Opportunities for Pollution Prevention**

#### **1.0 Cooling Tower System Chemicals**

Several chemicals are used in the cooling tower systems. These chemicals include a microbiocide (Biosperse 254), a precursor (DrewBROM 1-L), and an antifoulant (Drew 2135). BNL relies on Drew Chemical, a subcontractor, to manage the chemicals used in cooling waters. These waters, with low concentrations of chemicals, are discharged to the groundwaters of New York State. NYSDEC, SPDES Permit (No. NY 0005835) Monitoring of the discharge is required for certain compounds, including HEDP and tolytriazole. An occasional exceedence for these two compounds has occurred and BNL is pursuing two approaches to eliminating usage of the current chemicals used in cooling tower systems.

The first approach has been to replace the use of Drewgard 187 (a corrosion inhibitor which contains HEDP and tolytriazole) with Drew 2215. NYSDEC has indicated that monitoring (and effluent limits) for HEDP and tolytriazole may cease once Drewgard 187 is replaced. This will also eliminate the discharge of HEDP and tolytriazole to the groundwater. All RHIC systems have eliminated the use of Drewgard 187. The only C-A Water System using Drewgard 187 is the g-2 cooling system and this system is currently non-operational.

BNL is also implementing the use of a non-chemical water treatment system. Initially this was piloted in the BRAHMS cooling tower system and the PHOBOS cooling tower system. The Aqua Flow, self-contained water treatment plant begins with a suction pump to draw water out of the tower sump. The water then goes through a permanent, magnetic energy inducer to increase the water solubility factor and begin the scale inhibition process. This process also de-scales the existing scale build-up in the system. When this process takes place, a slight reduction in surface tension occurs which increases solubility; thus allowing more solids to stay in solution or colloidal suspension before precipitating. The next stage of the unit is ozone addition.

Ozone's oxidizing properties kills algae, slime, and bacteria and enhance the magnetic de-scaling process. Ozone is used commercially as a disinfectant throughout the world. Besides bacterial and viral inactivation, its properties are used to oxidize both organic and inorganic substances, and to clarify and de-complex organically bound minerals. The cost savings for using this process at one cooling tower system (BRAHMS) was estimated by BNL to be \$9,000 per year, resulting in a pay back period of approximately 3 years. The use of ozone appears to be successful and the use of this process has been expanded to other cooling tower systems at the RHIC ring and AGS in an effort to eliminate the use of chemicals, where feasible, in secondary water systems. It is currently used at the AGS SEM cooling water system (2001) and is installed at the NSRL cooling water system (to be operational in late 2002) and RHIC RF cooling water system.

**IV. Assessment Prevention and Control**

Spent Demineralizer Resin Exchange/ Filter Disposal

Spent filters from the RHIC closed loop cooling systems are disposed as solid waste. The spent demineralizer resins are drummed, sampled and disposed of through the Environmental and Waste Management Services Division according to the analysis results. BNL should continue to monitor these waste streams as RHIC intensity increases.

Prevention Assessment and Control Initiatives					
Process ID	Waste Stream ID				SOP, Inspection, or other APC Measures Recommended
Spent Demineralizer Resin Exchange/ Disposal	2.3	2.4			Sample and analyze spent resins for radiological contamination (gamma scan, gross beta) to confirm characterization as solid waste. Test filters with a meter for radioactivity.
	3.4	3.5	3.6	3.7	
	5.3	5.4	5.5	5.6	
	5.7	5.8	5.9	5.10	
	5.13	5.14	5.15		
	5.18	5.19	5.20	5.21	
	6.2	6.3	6.4	6.5	
	6.8	6.9	6.10		
7.3	7.4				
8.1	8.2				

**Attachment 1: Tables II-1 and II-2**

<b>Building Description</b>	<b>Location on Ring</b>	<b>Operational Status</b>	<b>Discharge Location</b>
1000P – RHIC Injection Cooling Systems	Outside and away from ring at 6 o'clock	Operational	Outfall 002HN (Recharge Basins)
1002 – BRAHMS	Inside ring at 2 o'clock	Non-Operational	Outfall 002A (Recharge Basins)
1004 – RF Cooling Systems	Inside ring at 4 o'clock	Operational	Outfall 002B (Recharge Basins)
1005P – Cryogenic Compressor Cooling System	Inside ring at 5 o'clock	Operational	Outfall 002HN (Recharge Basins)
1005E – Helium Reliquifier Compressor Cooling System	Inside ring at 5 o'clock	Operational	Outfall 002HN (Recharge Basins)
1006 – STAR Experiment	Inside ring at 6 o'clock	Operational	Outfall 002HN (Recharge Basins)
1008C – PHENIX Experiment	Outside ring at 8 o'clock	Operational	Outfall 002HN (Recharge Basins)
1010 – PHOBOS	Inside ring at 10 o'clock	Non-Operational	Outfall 002A (Recharge Basins)
1012 – Spin Polarimeter (not installed)	Inside ring at 12 o'clock	Conceptual Drawing (temporary system)	N/A
1012 – Jet Target	Inside ring at 12 o'clock	Operational	Sanitary Sewer System

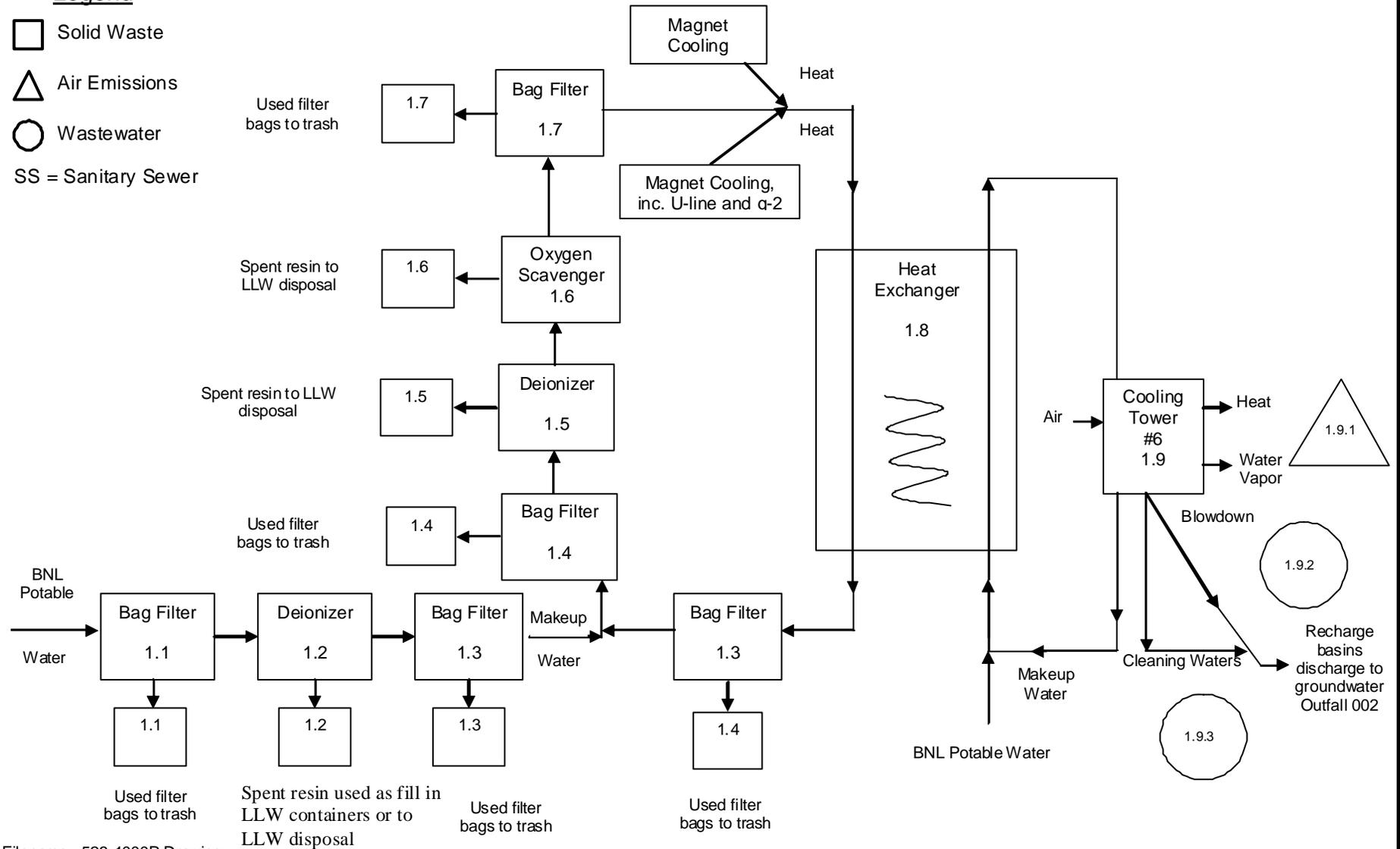
<b>Building Description</b>	<b>Chemicals Used</b>
1000P – RHIC Injection Cooling System	None
1002 – BRAHMS	Ozone
1004 – RF Cooling Systems	Ozone
1005P – Cryogenic Compressor Cooling System	Biosperse 254, Drew 2135, DrewBrom 1-L
1005E – Helium Reliquifier Compressor Cooling System	None
1006 – STAR Experiment	Biosperse 254, Drew 2135, DrewBrom 1-L
1008 – PHENIX Experiment	Biosperse 254, Drew 2135, DrewBrom 1-L
1010 – PHOBOS	Ozone
1012 – Spin Polarimeter (not installed)	None (not installed)
1012 – Jet Target	None

<p><b>Authorized Water Treatment Chemicals:</b>                  Drew 261T, Drew 739, Drew 187, Sodium Hydroxide, Drewbrom 1-L, Drew 2235, Drew 2135, Protcsol 629P, Drew Biosperse 254</p>
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**ATTACHMENT 2**  
**PROCESS FLOW DIAGRAMS**

Legend

- Solid Waste
- △ Air Emissions
- Wastewater
- SS = Sanitary Sewer

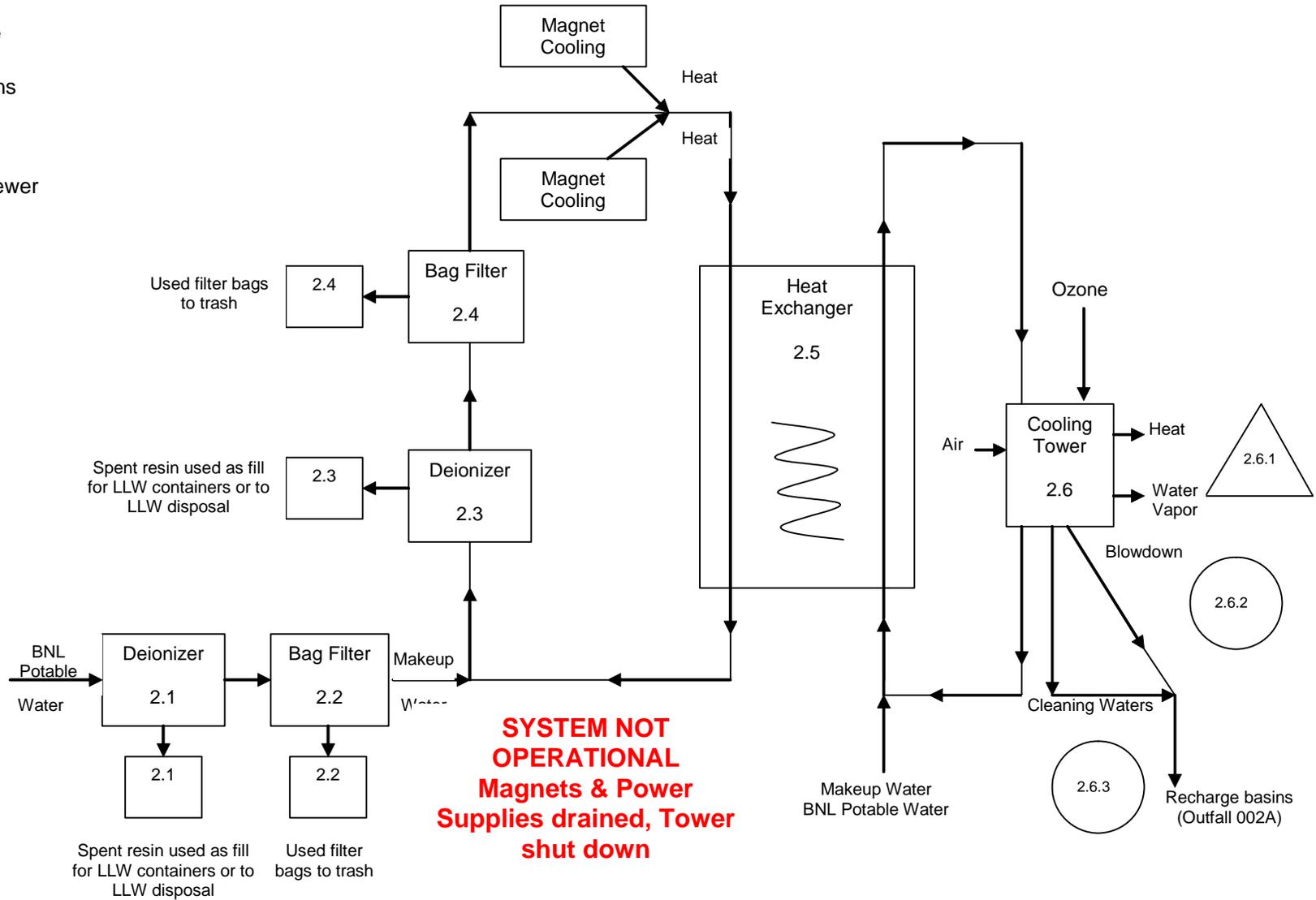


Filename: 523-1000P Drawing

BROOKHAVEN NATIONAL LABORATORY  
 PROCESS EVALUATION PROJECT  
**1000P Injection Cooling System**  
**RHIC Cooling Water Systems**

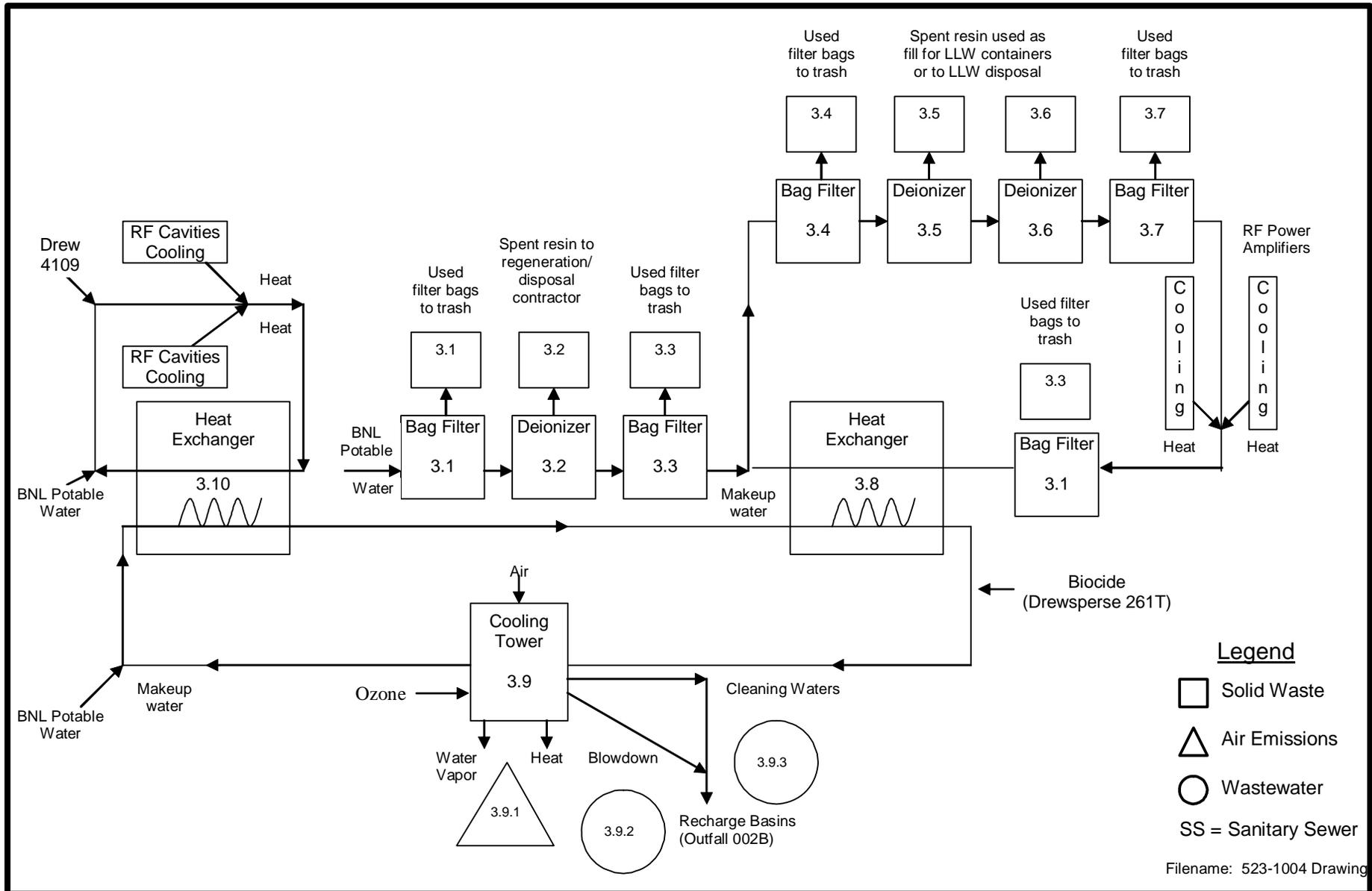
Legend

- Solid Waste
- △ Air Emissions
- Wastewater
- SS = Sanitary Sewer



Filename: 523-1002 Drawing

BROOKHAVEN NATIONAL LABORATORY  
PROCESS EVALUATION PROJECT  
**1002 BRAHMS Cooling System**  
**RHIC Cooling Water Systems**

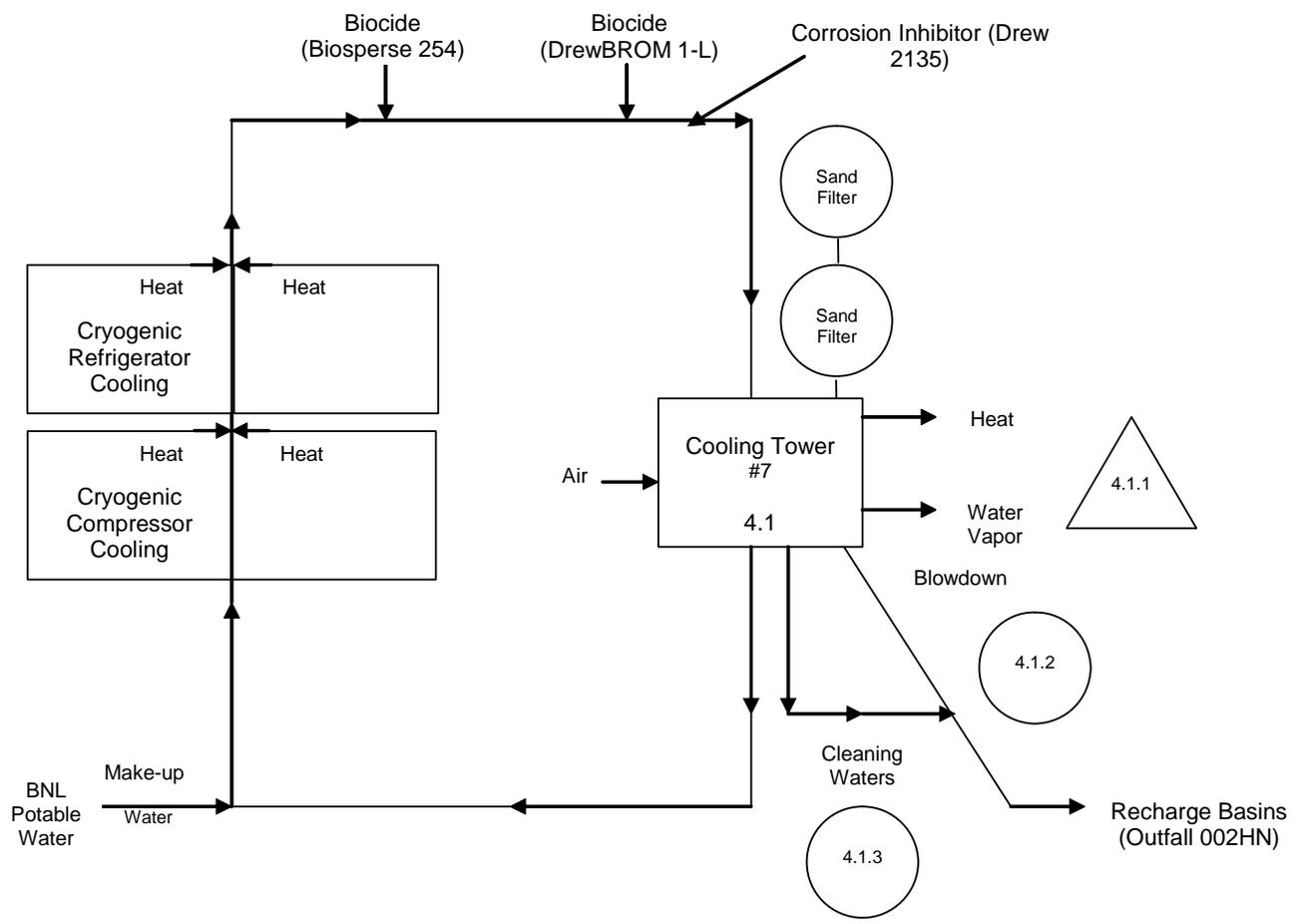


**Legend**

- Solid Waste
- △ Air Emissions
- Wastewater
- SS = Sanitary Sewer

Filename: 523-1004 Drawing

BROOKHAVEN NATIONAL LABORATORY  
 PROCESS EVALUATION PROJECT  
**1004 RF Cavity & P.A. Cooling System**  
**RHIC Cooling Water Systems**



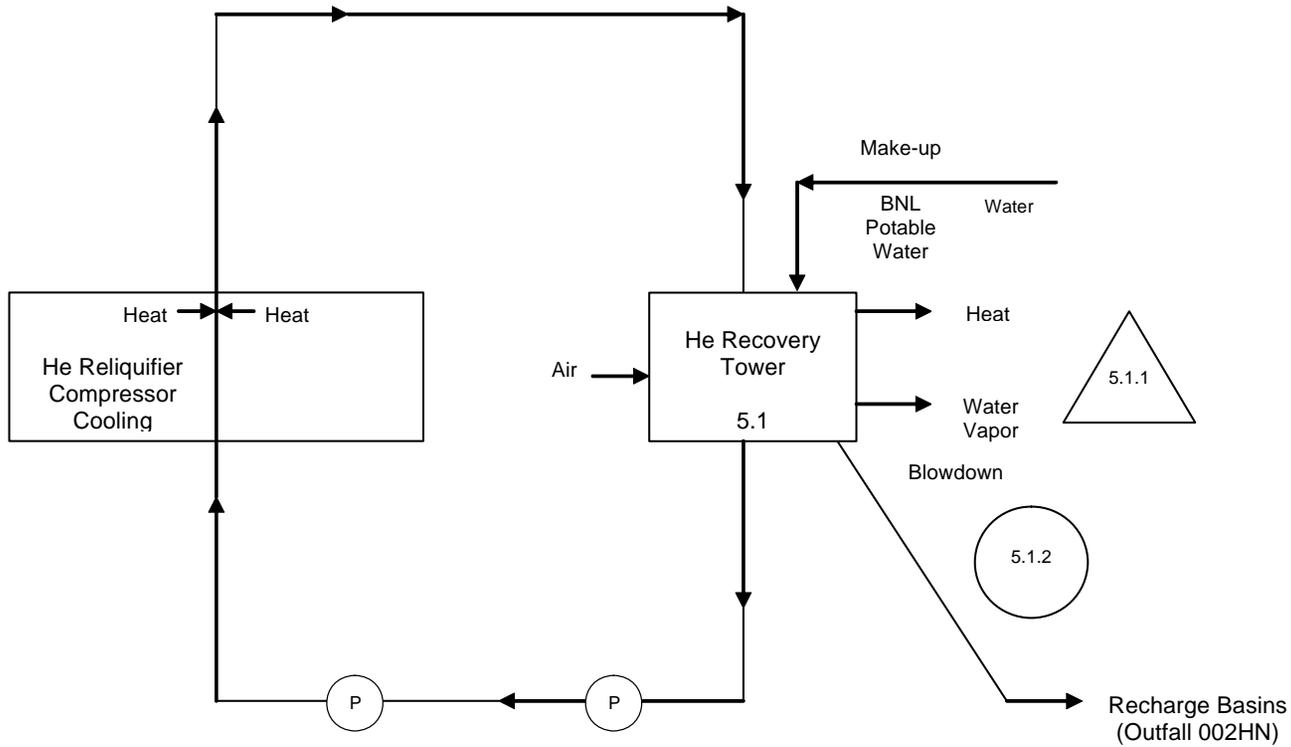
**Legend**

- Solid Waste
- △ Air Emissions
- Wastewater
- SS = Sanitary Sewer

Filename: 523-1005P Drawing

BROOKHAVEN NATIONAL LABORATORY  
PROCESS EVALUATION PROJECT

**1005P Cryogenic Compressor Cooling System  
RHIC Cooling Water Systems**



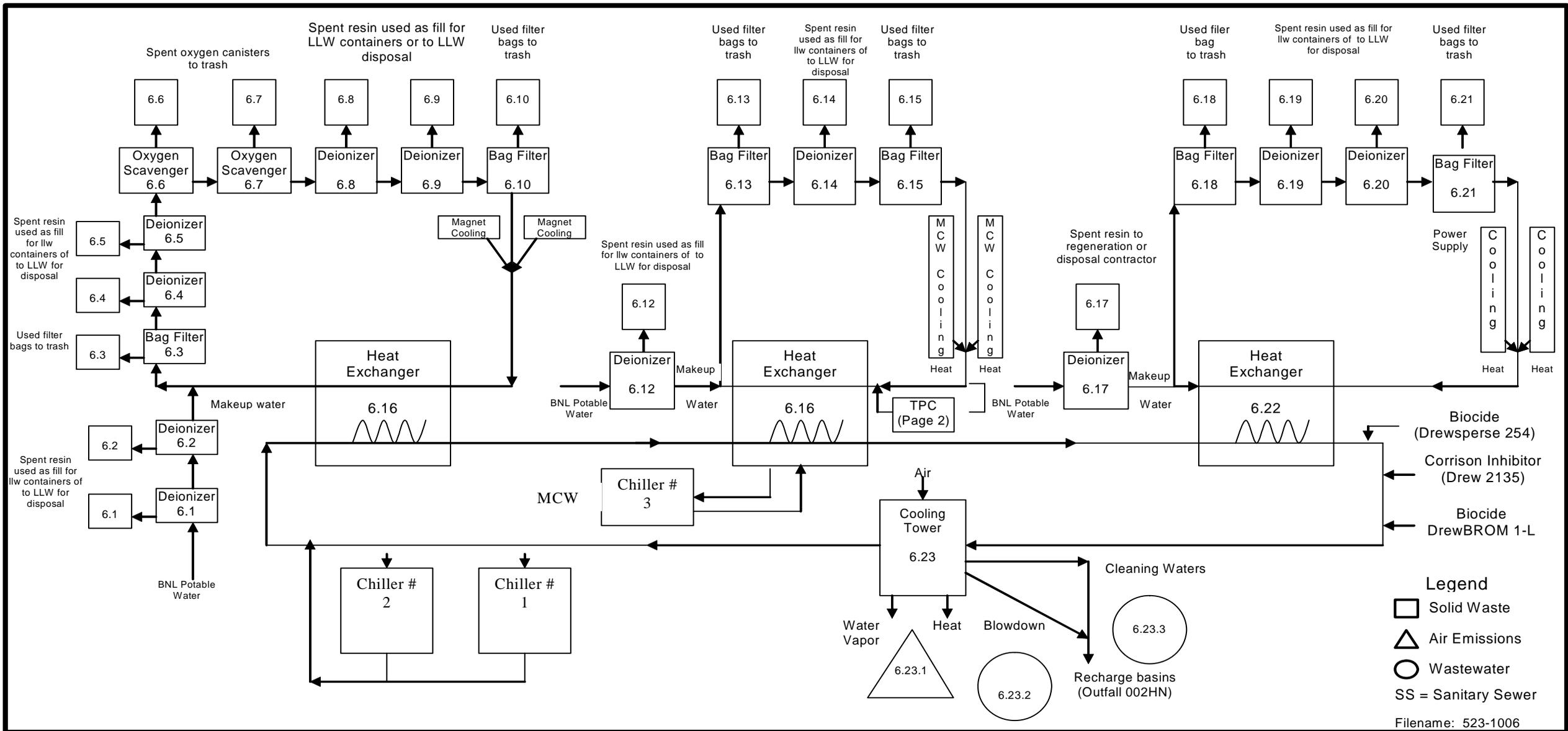
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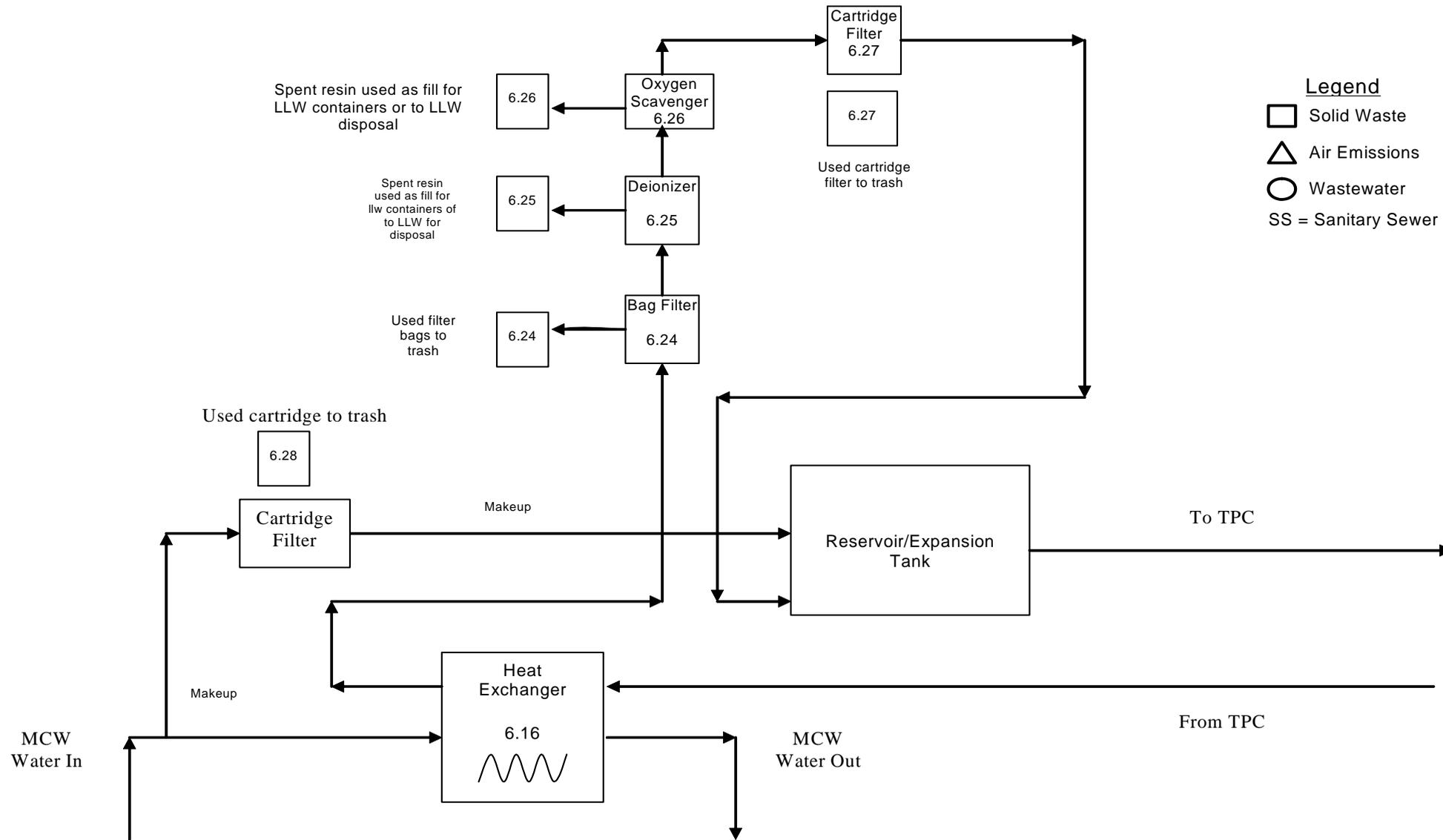
- Solid Waste
- △ Air Emissions
- Wastewater
- SS = Sanitary Sewer

Filename: 523-1005P Drawing

BROOKHAVEN NATIONAL LABORATORY  
PROCESS EVALUATION PROJECT

**1005E Helium Reliquifier Compressor Cooling System  
RHIC Cooling Water Systems**

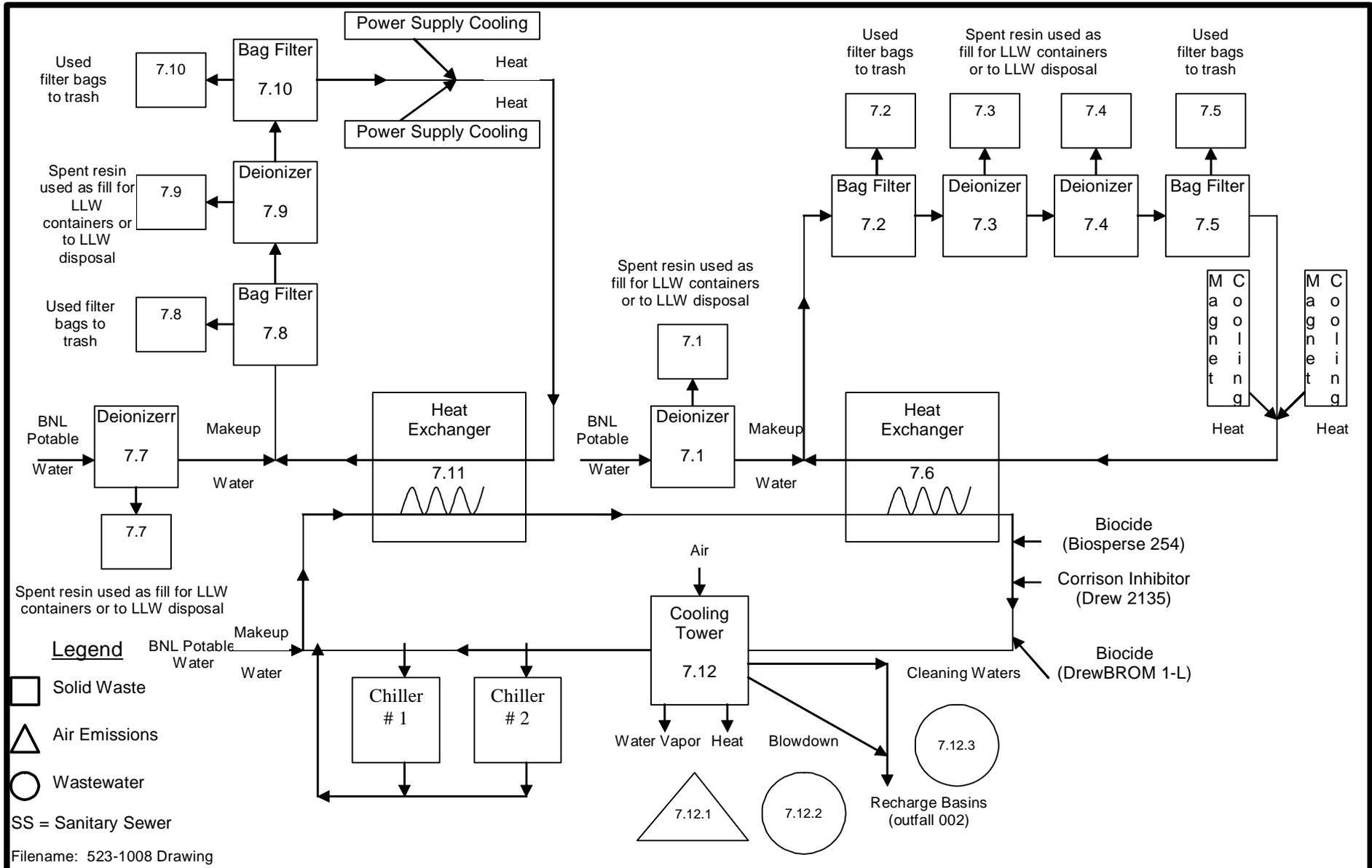




**Legend**  
 □ Solid Waste  
 △ Air Emissions  
 ○ Wastewater  
 SS = Sanitary Sewer

Filename: 523-1006

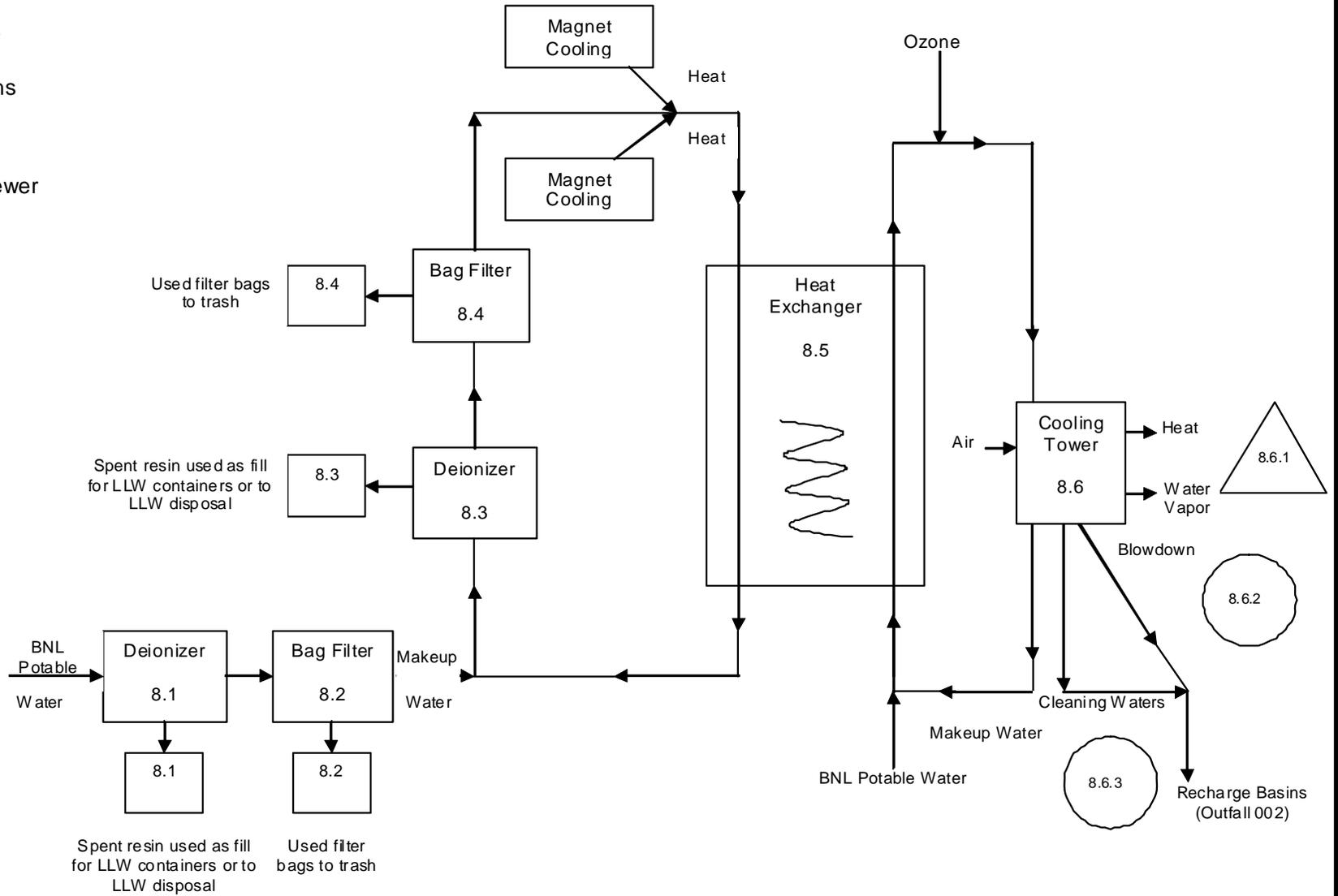
BROOKHAVEN NATIONAL LABORATORY  
 PROCESS EVALUATION PROJECT  
**1006 STAR Time Projection Chamber (TPC) Cooling Water Systems**  
**RHIC Cooling Water Systems**



BROOKHAVEN NATIONAL LABORATORY  
 PROCESS EVALUATION PROJECT  
**1008C PHENIX Cooling System**  
**RHIC Cooling Water Systems**

Legend

- Solid Waste
- △ Air Emissions
- Wastewater
- SS = Sanitary Sewer

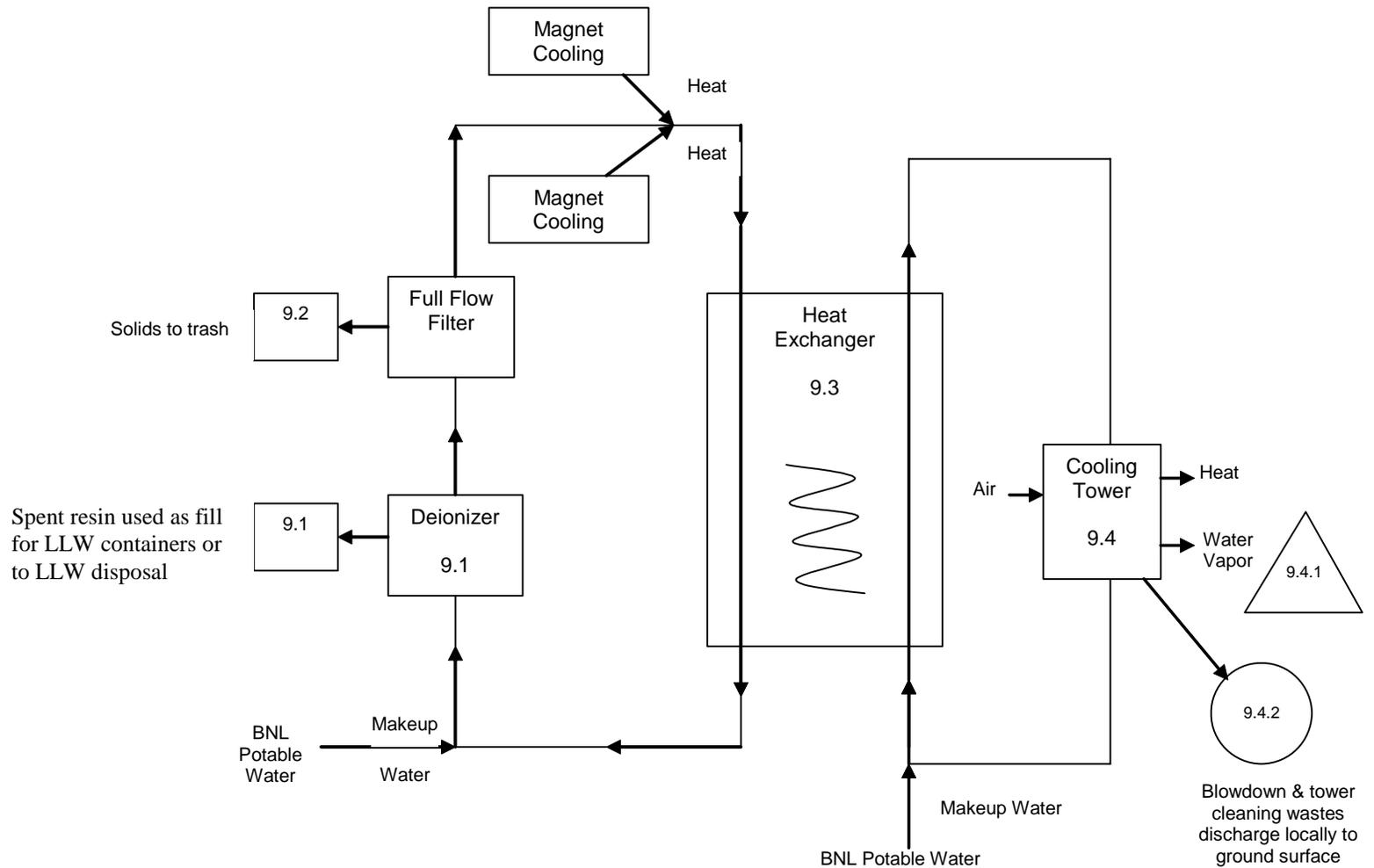


Filename: 523-1010 Drawing

BROOKHAVEN NATIONAL LABORATORY  
 PROCESS EVALUATION PROJECT  
**1010 PHOBOS Cooling System**  
**RHC Cooling Water Systems**

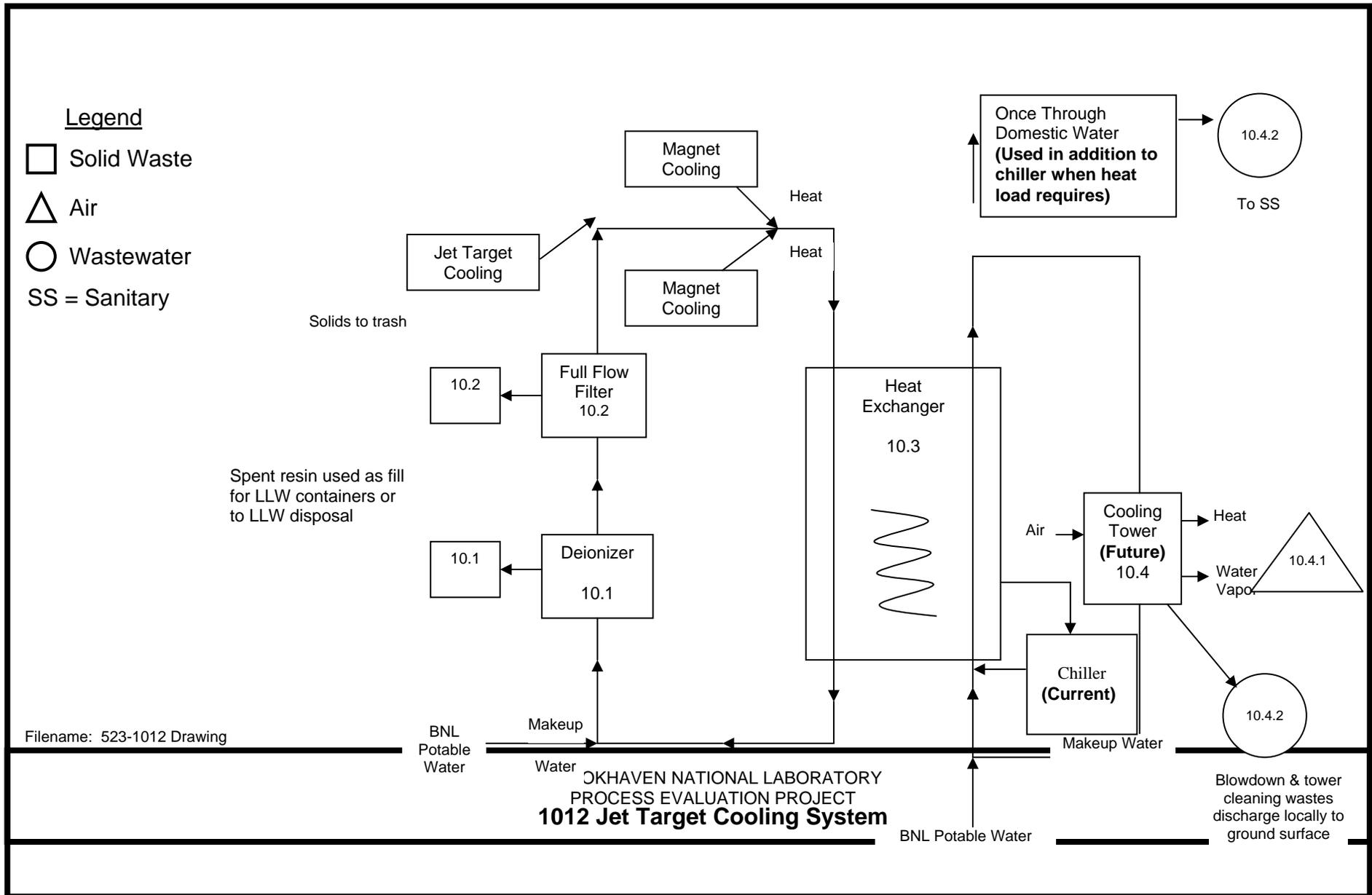
Legend

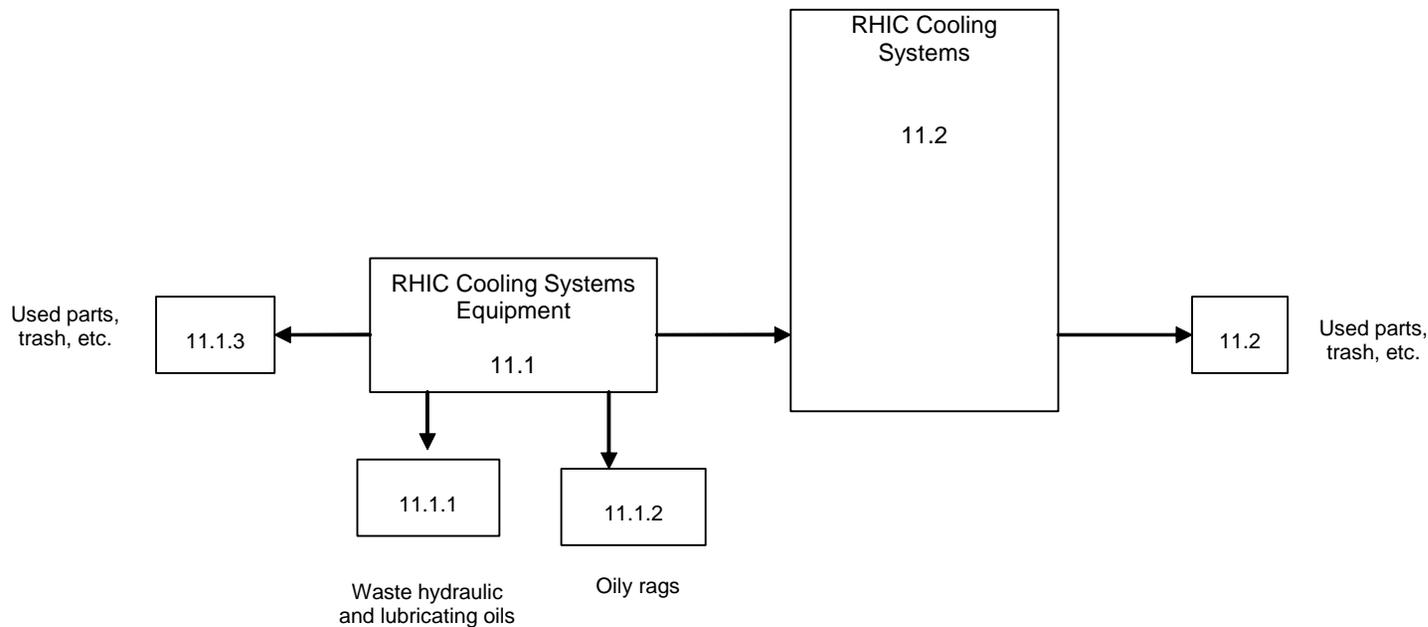
- Solid Waste
- △ Air Emissions
- Wastewater
- SS = Sanitary Sewer



Filename: 523-1012 Drawing

BROOKHAVEN NATIONAL LABORATORY  
 PROCESS EVALUATION PROJECT  
**1012 Spin Polarimeter Cooling System**  
**RHIC Cooling Water Systems (FUTURE)**





Legend

- Solid Waste
- △ Air Emissions
- Wastewater
- SS = Sanitary Sewer

Filename: 523-1013 Drawing

BROOKHAVEN NATIONAL LABORATORY  
 PROCESS EVALUATION PROJECT  
**Cooling Systems Equipment Maintenance**  
**RHIC Cooling Water Systems**