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- LIGO -
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How to Build the Hanford Right End Station EPICS Vacuum Controls System
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Distribution of this draft:
Hanford CDS, Operators

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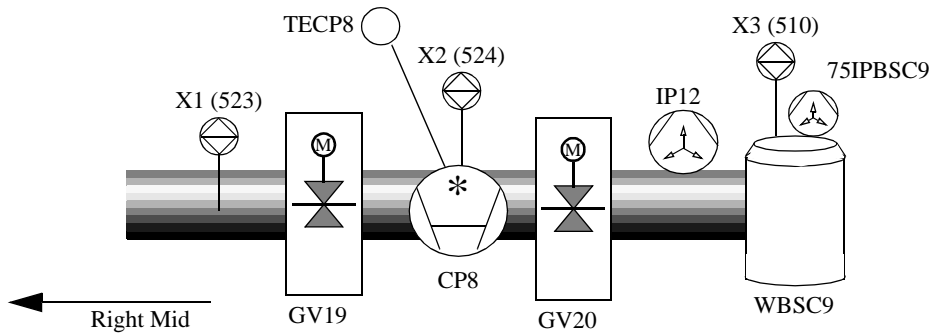
1.0 The Hanford right End Station.

The Hanford right End Vacuum Station is designated EX.
 The Vacuum system comprises:

Table 1: Hanford EX Vacuum Systems.

System	#1	#2	#3
Gauge Pairs	X1	X2	X3
Gate Valve	GV19	GV20	
Cryo Pumps	CP8		
Thermocouples	TECP8		
2500l/s Ion Pumps	IP12		
75l/s Ion Pumps	75IP BSC9		

The vacuum equipment is arranged in the following order:



2.0 File Definitions.

Table 2: File Macro Definitions.

Macro	Path
\$(GENERIC)	/opt/ligo/b/epics/apple/Hanford/VE/GENERIC
\$(OPI_GENERIC)	/opt/ligo/b/epics/apple/Hanford/VE/opi/medm/GENERIC
\$(EX_TEST)	/opt/ligo/b/epics/apple/Hanford/VE/hanford60/test
\$(CONFIG_EX_TEST)	/opt/ligo/b/epics/apple/Hanford/VE/CONFIG/EX/test
\$(OPI_EX)	/opt/ligo/b/epics/apple/Hanford/VE/opi/medm/EX
\$(ALH_GEN)	/opt/ligo/b/epics/apple/Hanford/VE/alh/GENERIC
\$(ALH_EX)	/opt/ligo/b/epics/apple/Hanford/VE/alh/EX

3.0 Database Generation.

3.1 Gauge Pairs (GP)

Gauge Pairs have two databases; the main database and the emulation database. Makefile is \$(CONFIG_EX_TEST)/makefile linked into the \$(EX_TEST) directory. Build the GP system in the \$(EX_TEST) directory with the command:

```
> make GP
```

3.1.1 Main Database.

Generic db file is \$(GENERIC)/test/database/VE_GP_GEN.db (gdct generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-MX:GP.config linked into the \$(EX_TEST) directory.

Output files are HVE-EX:Xn.db and HVE-EX:XnS.db (n=1,2,3).

3.1.2 Emulation Database.

Generic db file is \$(GENERIC)/test/database/VE_GPE_GEN.db (gdct generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:GPE.config linked into the \$(EX_TEST) directory.

Output files are HVE-EX:XnE.db (n=1,2,3).

3.2 Electric Gate Valves (GVE).

Only one main db file. Emulation records are in this file. Makefile is \$(CONFIG_EX_TEST)/makefile linked into the \$(EX_TEST) directory. GVE requires access to the Gauge Pair configuration files. Build the GVE system with the command:

```
> make GVE
```

3.2.1 Main Database.

Generic db file is \$(GENERIC)/test/database/VE_GVE_GEN.db (gdct generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:GVE.config linked into the \$(EX_TEST) directory.

Output files are HVE-EX:GVn.db and HVE-EX:GVnS.db (n=19,20).

3.3 Thermocouples.

Only main db file. Makefile is \$(CONFIG_EX_TEST)/makefile linked into the \$(EX_TEST) directory. Build the TE system with the command:

```
> make TE
```

3.3.1 Main Database.

Generic db file is \$(GENERIC)/test/database/VE_TE_GEN.db (gdct generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:TE.config linked into the \$(EX_TEST) directory.

Output files are HVE-EX:TECP8.db and HVE-EX:TECP8S.db.

3.4 Cryo Pumps.

Two database systems are built, the main database and the emulation database. Makefile is \$(CONFIG_EX_TEST)/makefile linked into the \$(EX_TEST) directory. Build the CP system with the command:

```
> make CP
```

3.4.1 Main Database.

Generic db file is \$(GENERIC)/test/database/VE_CP_GEN.db (gdct generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:CP.config linked into the \$(EX_TEST) directory.

Output files are HVE-EX:CP8.db and HVE-EX:CP8S.db.

3.4.2 Emulation Database.

Generic db file is \$(GENERIC)/test/database/VE_CPE_GEN.db (gdct generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:CPE.config linked into the \$(EX_TEST) directory.

Output files are HVE-EX:CP8E.db.

3.5 2500l/s Ion Pumps.

Only main db file. Makefile is \$(CONFIG_EX_TEST)/makefile linked into the \$(EX_TEST) directory. Build the IP system with the command:

```
> make IP
```

3.5.1 Main Database.

Generic db file is \$(GENERIC)/test/database/VE_IP_GEN.db (gdct generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:IP.config linked into the \$(EX_TEST) directory.

Output files are HVE-EX:IP12.db and HVE-EX:IP12S.db.

3.6 75I/s Ion Pumps.

Only main db file. Makefile is \$(CONFIG_EX_TEST)/makefile linked into the \$(EX_TEST) directory. Build the 75IP system with the command:

```
> make 75IP
```

3.6.1 Main Database.

Generic db file is \$(GENERIC)/test/database/VE_75IP_GEN.db (gdct generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:75IP.config linked into the \$(EX_TEST) directory.

Output files are HVE-MX:75IPBSC9.db and HVE-MX:75IPBSC9S.db.

3.7 Pump Carts.

TBD

3.8 Full List of Database Files.

Table 3: Full database db file list.

System	File #1	File #2	File #3
GP X1	HVE-EX:X1.db	HVE-EX:X1S.db	HVE-EX:X1E.db
GP X2	HVE-EX:X2.db	HVE-EX:X2S.db	HVE-EX:X2E.db
GP X3	HVE-EX:X3.db	HVE-EX:X3S.db	HVE-EX:X3E.db
GVE GV19	HVE-EX:GV19.db	HVE-EX:GV19S.db	
GVE GV20	HVE-EX:GV20.db	HVE-EX:GV20S.db	
TE TECP8	HVE-TE:TECP8.db	HVE-TE:TECP8S.db	
CP CP8	HVE-CP:CP8.db	HVE-CP:CP8S.db	HVE-CPE:CP8.db
IP IP12	HVE-IP:IP12.db	HVE-IP:IP12S.db	
75IP 75IPBSC9	HVE-MX:75IP BSC9.db	HVE-MX:75IP BSC9S.db	

3.9 Database Totals.

Table 4: right Mid Station Totals.

Number of db files	22
Number of records	229

4.0 Sequencer Generation.

4.1 Gauge Pairs (GP)

Gauge Pairs have two sequencers; Rate of Rise and RR emulation. Code build makefile is \$(CONFIG_EX_TEST)/makefile linked into the \$(EX_TEST) directory. Build the GP system with the command:

```
> make GP
```

Source code is moved into \$(EX_TEST)/src. Code compile makefile is in \$(EX_TEST)/src. Recompile the code for the 162 by running make in \$(EX_TEST)/target/mv162/obj.

4.1.1 Rate of Rise.

Generic st file is \$(GENERIC)/test/src/VE_GP_RR_GEN.st.

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:GP.config linked into the \$(EX_TEST) directory.

Output files are HVE_EX_XnRR.st (n=1,2,3).

4.1.2 RR Emulation.

Generic st file is \$(GENERIC)/test/src/VE_GP_RRE_GEN.st

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:GPE.config linked into the \$(EX_TEST) directory.

Output files are HVE_EX_XnERRE.st (n=1,2,3).

4.2 Electric Gate Valves (GVE).

Gate Valves have two sequencers; open and emulation. Code build makefile is \$(CONFIG_EX_TEST)/makefile linked into the \$(EX_TEST) directory. Build the GP system with the command:

```
> make GVE
```

Source code is moved into \$(EX_TEST)/src. Code compile makefile is in \$(EX_TEST)/src. Recompile the code for the 162 by running make in \$(EX_TEST)/target/mv162/obj.

4.2.1 Open.

Generic st file is \$(GENERIC)/test/src/VE_GVE_OPEN_GEN.st.

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:GVE.config.

Output files are HVE_EX_GVnOPEN.st (n=19,20).

4.2.2 Emulation.

Generic st file is \$(GENERIC)/dev/src/VE_GVEE_GEN.st.

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:GVE.config.

Output files are HVE_EX_GVnGVEE.st (n=19,20).

4.3 Thermocouples.

No Sequencers.

4.4 Cryo Pumps.

Two sequencers per Cryo Pump; Liquid Nitrogen Consumption Rate calculation and its emulation system. Code build makefile is \$(CONFIG_EX_TEST)/makefile linked into the \$(EX_TEST) directory. Build the CP system with the command:

```
> make CP
```

Source code is moved into \$(EX_TEST)/src. Code compile makefile is in \$(EX_TEST)/src. Recompile the code for the 162 by running make in \$(EX_TEST)/target/mv162/obj.

4.4.1 LN2 Rate.

Generic st file is \$(GENERIC)/test/src/VE_CP_LNRATE_GEN.st.

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:CPE.config.

Output files are HVE_EX_CP8LNRATE.st.

4.4.2 Emulation.

Generic st file is \$(GENERIC)/dev/src/VE_CP_LNE_GEN.st.

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:CPE.config.

Output files are HVE_EX_CP8ELNE.st.

4.5 2500l/s Ion Pumps.

No Sequencers

4.6 75l/s Ion Pumps.

No Sequencers

4.7 Pump Carts.

TBD

4.8 Sequencer Code File Totals.

Table 5: C Code Object File List.

HVE_EX_X1RR.o	HVE_EX_X1ERRE.o
HVE_EX_X2RR.o	HVE_EX_X2ERRE.o
HVE_EX_X3RR.o	HVE_EX_X3ERRE.o
HVE_EX_GV19OPEN.o	HVE_EX_GV19GVEE.o
HVE_EX_GV20OPEN.o	HVE_EX_GV20GVEE.o
HVE_EX_CP8LNRATE.o	HVE_EX_CP8ELNE.o

5.0 C Code Generation.

5.1 Gauge Pairs.

C code used for Pirani gauge vacuum calculation. No code generation is needed. Source code is in \$(GENERIC)/test/src and is linked into the \$(EX_TEST)/src directory. Code compile makefile is in the \$(EX_TEST)/src directory. Recompile the code for the 162 by running make in \$(EX_TEST)/test/target/mv162/obj.

5.1.1 Pirani Vacuum.

Source code is \$(GENERIC)/test/src/VE_GP_PIRANI_CVT_TORR.c

No generation needed. This code is re-entrant and only one copy of the object code is required on the IOC.

Output file is in \$(EX_TEST)/test/target/mv162/obj directory, file is VE_GP_PIRANI_CVT_TORR.o.

5.2 Electric Gate Valves.

No C Code.

5.3 Thermocouples.

No C Code.

5.4 Cryo Pumps.

C code used to perform pump LN2 level control. No code generation is needed. Source code is in \$(GENERIC)/test/src and is linked into the \$(EX_TEST)/src directory. Code compile makefile is in the \$(EX_TEST)/src directory. Recompile the code for the 162 by running make in \$(EX_TEST)/test/target/mv162/obj.

5.4.1 Pump LN2 Level Control.

Source code is \$(GENERIC)/test/src/VE_CP_LVLNTRL.c

No generation needed. This code is re-entrant and only one copy of the object code is required on the IOC.

Output file is in \$(EX_TEST)/test/target/mv162/obj directory, file is VE_CP_LVLNTRL.o.

5.5 2500l/s Ion Pumps.

No C Code.

5.6 75l/s Ion Pumps.

C code used to convert Pump Current to Vacuum. Used for the ion pumps in the 75IP systems and in the Gate Valve systems. Source code is in \$(GENERIC)/test/src and is linked into the \$(EX_TEST)/src directory. Code compile makefile is in the \$(EX_TEST)/src directory. Recompile the code for the 162 by running make in \$(EX_TEST)/test/target/mv162/obj.

5.6.1 Pump current to vacuum conversion.

Source code is \$(GENERIC)/test/src/VE_GVE_AMPS_TO_TORR.c

No generation needed. This code is re-entrant and only one copy of the object code is required on the IOC.

Output file is in \$(EX_TEST)/test/target/mv162/obj directory, file is VE_GVE_AMPS_TO_TORR.o.

5.7 Pump Carts.

TBD.

5.8 C Code File Totals.**Table 6: C Code Object File List.**

VE_GP_PIRANI_CVT_TORR.o
VE_CP_LVLCTRL.o
VE_AMPS_TO_TORR.o

6.0 MEDM Screens Generation.**6.1 Gauge Pairs (GP).**

Gauge Pairs have three displays; main, simulation and emulation. Makefile is \$(OPI_EX)/makefile, build the GP displays with the command;

```
make GP
```

Configuration files are symbolic linked from \$(CONFIG_EX_TEST) to the current directory.

6.1.1 Main.

Generic adl file is \$(OPI_GENERIC)/VE_GP_GEN.adl (MEDM generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:GP.config.

Output file is \$(OPI_EX)/HVE-EX:Xn.adl (n=1,2,3).

6.1.2 Simulation.

Generic adl file is \$(OPI_GENERIC)/VE_GP_GEN_S.adl (MEDM generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:GP.config.

Output file is \$(OPI_EX)/HVE-EX:XnS.adl (n=1,2,3).

6.1.3 Emulation

Generic adl file is \$(OPI_GENERIC)/VE_GP_GEN_E.adl (MEDM generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:GPE.config.

Output file is \$(OPI_EX)/HVE-EX:XnEE.adl (n=1,2,3).

6.2 Electric Gate Valves (GVE).

Gate Valves have two displays; main and emulation. Makefile is \$(OPI_EX)/makefile, build the GVE displays with the command;

```
make GVE
```

Configuration files are symbolic linked from \$(CONFIG_EX_TEST) to the current directory.

6.2.1 Main.

Generic adl file is \$(OPI_GENERIC)/VE_GVE_GEN.adl (MEDM generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:GVE.config.

Output file is \$(OPI_EX)/HVE-EX:GVn.adl (n=19,20).

6.2.2 Emulation.

Generic adl file is \$(OPI_GENERIC)/VE_GVE_GEN_E.adl (MEDM generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:GVE.config.

Output file is \$(OPI_EX)/HVE-EX:GVnE.adl (n=19,20).

6.3 Thermocouples.

Thermocouples have two displays; main and simulation. Makefile is \$(OPI_EX)/makefile, build the TE displays with the command;

```
make TE
```

Configuration files are symbolic linked from \$(CONFIG_EX_TEST) to the current directory.

6.3.1 Main.

Generic adl file is \$(OPI_GENERIC)/VE_TE_GEN.adl (MEDM generated).
 Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:TE.config.
 Output file is \$(OPI_EX)/HVE-EX:TECP8.adl.

6.3.2 Simulation.

Generic adl file is \$(OPI_GENERIC)/VE_TE_GEN_S.adl (MEDM generated).
 Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:TE.config.
 Output file is \$(OPI_EX)/HVE-EX:TECP8S.adl.

6.4 Cryo Pumps.

Cryo Pumps have three displays; main, simulation and emulation. Makefile is \$(OPI_EX)/makefile, build the CP displays with the command;

make CP

Configuration files are symbolic linked from \$(CONFIG_EX_TEST) to the current directory.

6.4.1 Main.

Generic adl file is \$(OPI_GENERIC)/VE_CP_GEN.adl (MEDM generated).
 Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:CP.config.
 Output file is \$(OPI_EX)/HVE-EX:CP8.adl.

6.4.2 Simulation.

Generic adl file is \$(OPI_GENERIC)/VE_CP_GEN_S.adl (MEDM generated).
 Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:CP.config.
 Output file is \$(OPI_EX)/HVE-EX:CP8S.adl.

6.4.3 Emulation

Generic adl file is \$(OPI_GENERIC)/VE_CP_GEN_E.adl (MEDM generated).
 Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:CPE.config.
 Output file is \$(OPI_EX)/HVE-EX:CP8EE.adl.

6.5 2500l/s Ion Pumps.

Large ion pumps have two displays;main and simulation. Makefile is \$(OPI_EX)/makefile, build the IP displays with the command;

make IP

Configuration files are symbolic linked from \$(CONFIG_EX_TEST) to the current directory.

6.5.1 Main.

Generic adl file is \$(OPI_GENERIC)/VE_IP_GEN.adl (MEDM generated).
 Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:IP.config.
 Output file is \$(OPI_EX)/HVE-EX:IP12.adl.

6.5.2 Simulation.

Generic adl file is \$(OPI_GENERIC)/VE_IP_GEN_S.adl (MEDM generated).
 Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:IP.config.
 Output file is \$(OPI_EX)/HVE-EX:IP12S.adl.

6.6 75l/s Ion Pumps.

75l/s ion pumps have two displays;main and simulation. Makefile is \$(OPI_EX)/makefile, build the 75IP displays with the command;

make 75IP

Configuration files are symbolic linked from \$(CONFIG_EX_TEST) to the current directory.

6.6.1 Main.

Generic adl file is \$(OPI_GENERIC)/VE_75IP_GEN.adl (MEDM generated).
 Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:75IP.config.
 Output file is \$(OPI_EX)/HVE-EX:75IPBSC9.adl.

6.6.2 Simulation.

Generic adl file is \$(OPI_GENERIC)/VE_75IP_GEN_S.adl (MEDM generated).

Configuration file is \$(CONFIG_EX_TEST)/HVE-EX:75IP.config.

Output file is \$(OPI_EX)/HVE-EX:75IPBSC9S.adl.

6.7 Pump Carts.

TBD

6.8 MEDM File Totals.

Table 7: MEDM File List.

HVE-EX:X1.adl	HVE-EX:X1S.adl	HVE-EX:X1EE.adl
HVE-EX:X2.adl	HVE-EX:X2S.adl	HVE-EX:X2EE.adl
HVE-EX:X3.adl	HVE-EX:X3S.adl	HVE-EX:X3EE.adl
HVE-EX:GV19.adl	HVE-EX:GV19E.adl	
HVE-EX:GV20.adl	HVE-EX:GV20E.adl	
HVE-EX:TECP8.adl	HVE-EX:TECP8S.adl	
HVE-EX:CP8.adl	HVE-EX:CP8S.adl	HVE-EX:CP8EE.adl
HVE-EX:IP12.adl	HVE-EX:IP12S.adl	
HVE-MX:75IPBSC9.adl	HVE-MX:75IPBSC9S.adl	

Total number of adl files=22.

Total number of channels monitored and/or controlled = 378.

7.0 Alarm Handler Generation.

7.1 Gauge Pairs.

Generic alh config include file is \$(ALH_GEN)/VE_GP_GEN.alhConfig linked into \$(ALH_EX). EX Vacuum template file is \$(ALH_EX)/VacTemplate.alhConfig. Makefile is \$(ALH_EX)/makefile, build the Alarm Handler files with the command;

make

Configuration files are symbolic linked from \$(CONFIG_EX_TEST) to the current directory. Output file for the EX system is EX.alhConfig.

7.2 Thermocouples.

Generic alh config include file is \$(ALH_GEN)/VE_TE_GEN.alhConfig linked into \$(ALH_EX). EX Vacuum template file is \$(ALH_EX)/VacTemplate.alhConfig. Makefile is \$(ALH_EX)/makefile, build the Alarm Handler files with the command;

make

Configuration files are symbolic linked from \$(CONFIG_EX_TEST) to the current directory. Output file for the EX system is EX.alhConfig.

7.3 Gate Valves.

Generic alh config include file is \$(ALH_GEN)/VE_GVE_GEN.alhConfig linked into \$(ALH_EX). EX Vacuum template file is \$(ALH_EX)/VacTemplate.alhConfig. Makefile is \$(ALH_EX)/makefile, build the Alarm Handler files with the command;

make

Configuration files are symbolic linked from \$(CONFIG_EX_TEST) to the current directory. Output file for the EX system is EX.alhConfig.

7.4 Cryo Pumps.

Generic alh config include file is \$(ALH_GEN)/VE_CP_GEN.alhConfig linked into \$(ALH_EX). EX Vacuum template file

is \$(ALH_EX)/VacTemplate.alhConfig. Makefile is \$(ALH_EX)/makefile, build the Alarm Handler files with the command;
make

Configuration files are symbolic linked from \$(CONFIG_EX_TEST) to the current directory. Output file for the EX system is EX.alhConfig.

7.5 2500l/s Ion Pumps.

Generic alh config include file is \$(ALH_GEN)/VE_IP_GEN.alhConfig linked into \$(ALH_EX). EX Vacuum template file is \$(ALH_EX)/VacTemplate.alhConfig. Makefile is \$(ALH_EX)/makefile, build the Alarm Handler files with the command;
make

Configuration files are symbolic linked from \$(CONFIG_EX_TEST) to the current directory. Output file for the EX system is EX.alhConfig.

7.6 75l/s Ion Pumps.

Generic alh config include file is \$(ALH_GEN)/VE_75IP_GEN.alhConfig linked into \$(ALH_EX). EX Vacuum template file is \$(ALH_EX)/VacTemplate.alhConfig. Makefile is \$(ALH_EX)/makefile, build the Alarm Handler files with the command;
make

Configuration files are symbolic linked from \$(CONFIG_EX_TEST) to the current directory. Output file for the EX system is EX.alhConfig.

7.7 Pump Carts.

TBD

7.8 Final Files

The output from alh generation is a single alh config file for the entire building.

Table 8: Alarm Handler Configuration File List.

EX.alhConfig

Total number of channels monitored for alarm activity on right Mid Station = 39.

8.0 SAMMI Screens Generation.

8.1 Gauge Pairs.

TBD

8.2 Thermocouples.

TBD

8.3 Gate Valves.

TBD

8.4 Cryo Pumps.

TBD

8.5 2500l/s Ion Pumps.

TBD

8.6 75l/s Ion Pumps.

TBD

8.7 Pump Carts.

TBD

9.0 BURT Generation.

9.1 Gauge Pairs.

TBD

9.2 Thermocouples.

TBD

9.3 Gate Valves.

TBD

9.4 Cryo Pumps.

TBD

9.5 2500l/s Ion Pumps.

TBD

9.6 75l/s Ion Pumps.

TBD

9.7 Pump Carts.

TBD

10.0 Archiver Generation.

10.1 Gauge Pairs.

TBD

10.2 Thermocouples.

TBD

10.3 Gate Valves.

TBD

10.4 Cryo Pumps.

TBD

10.5 2500l/s Ion Pumps.

TBD

10.6 75l/s Ion Pumps.

TBD

10.7 Pump Carts.

TBD