HElium Component Testing Out-of-pile Research (HECTOR) Facility

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MRP Microreactor Program

HECTOR - Objective

Design a helium component testing loop that will be able to test various components such as heat exchangers, valves, circulators, etc. at operating conditions up to 8MPa and 800°C.

These conditions will help achieve technology maturation for high temperature gas cooled reactors (HTGR)

US Reactor Design Concepts

Developer	Name	Power Output (Mwe/NWth)	Fuel	Coolant	Moderator	Gas Pressure	Outlet Temperature
BWXT	BANR	17/50	TRISO	He	Graphite	–	–
HolosGen	Holos Quad	10-13/–	TRISO	He/CO_2	–	7 MPa	620°C
NuGen, LLC	NuGen Engine	2-4/–	TRISO	He	–	–	–
Radiant Nuclear	Kaleidos	1.2/–	TRISO	He	Graphite	–	700°C
Ultra Safe Nuclear	Micro Modular Reactor	5/15	TRISO	He	Graphite	3 MPa	565°C
X-energy	Xe-100	80/200	TRISO	He	Graphite	6 MPa	750°C
General Atomics	GA-EMS	50/112	UO_2	He	–	7 MPa	800°C

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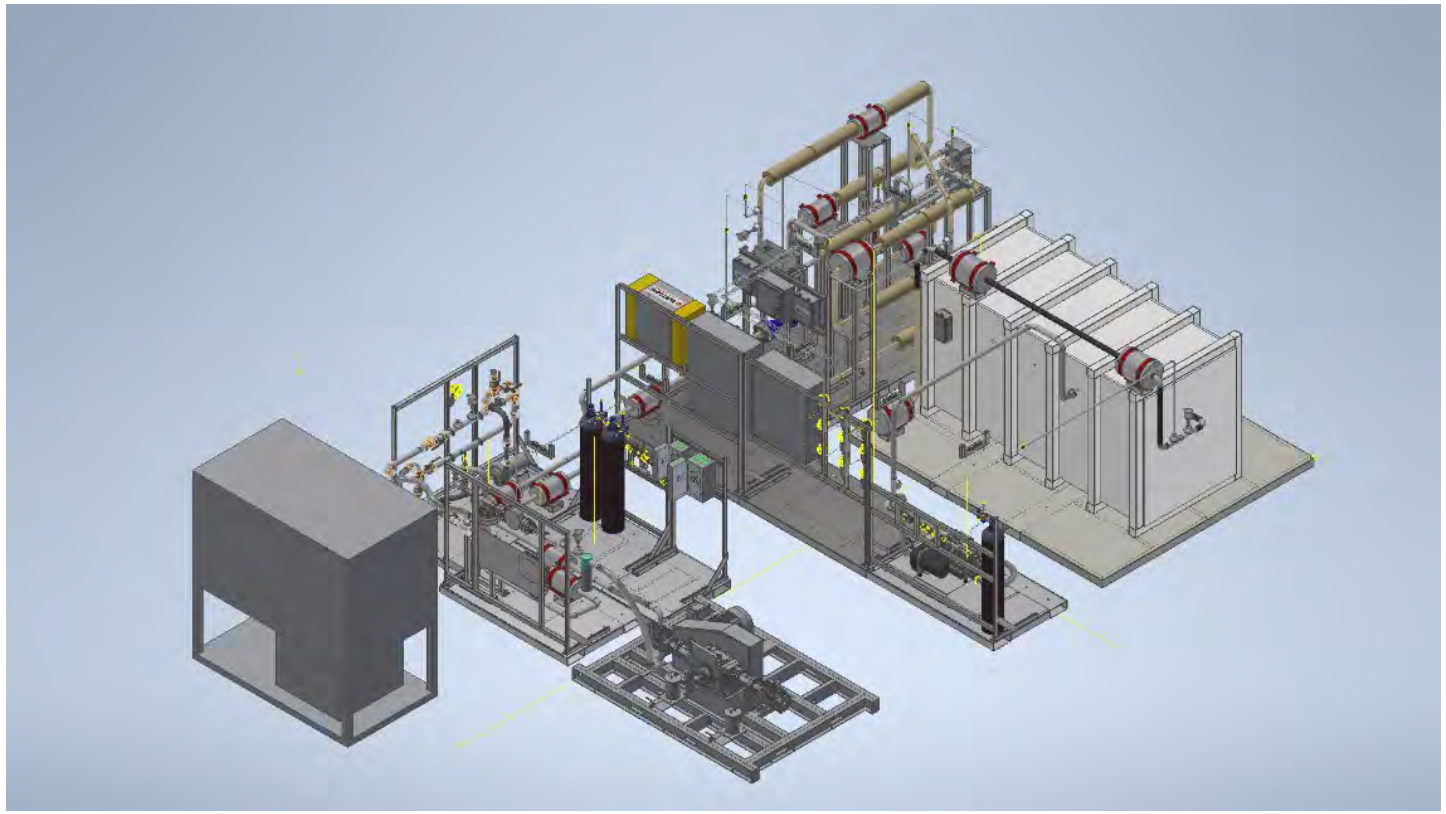
HECTOR – System Overview

Parameter	Value
Maximum Pressure	8MPa
Maximum Temperature	800 C
Flowrate	0.01 – 0.15 kg/s
Reynold's Number Range	11,700 – 1,610,000
Nusselt Number Range	35.2 – 1,810



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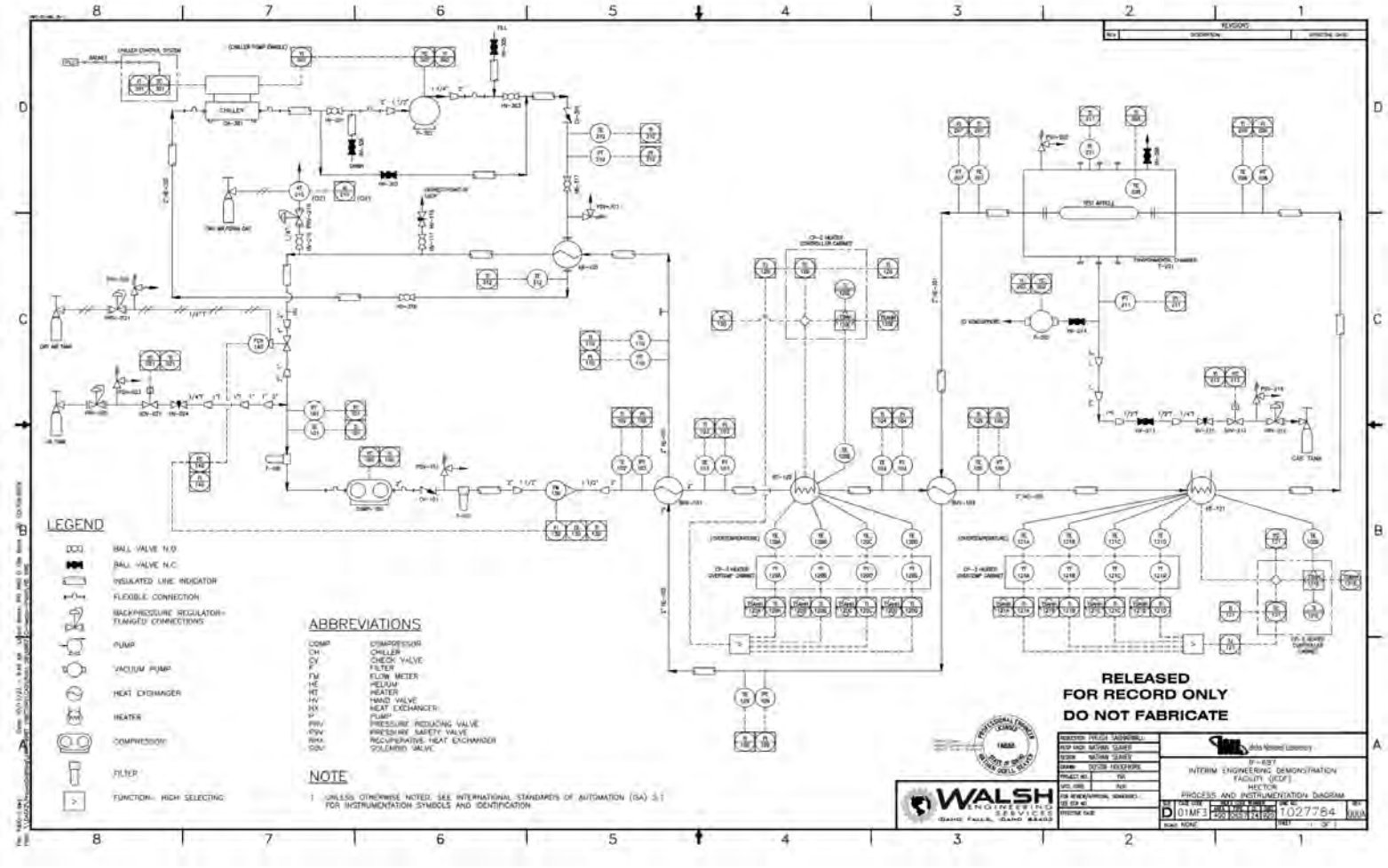
HECTOR – System Overview

Major Component List:

- Helium compressor
- Three printed circuit heat exchangers
- Two sets of radiative heaters
- Environmental chamber
- Chiller subsystem
  - Couples to one PCHE
  - Chiller and pump



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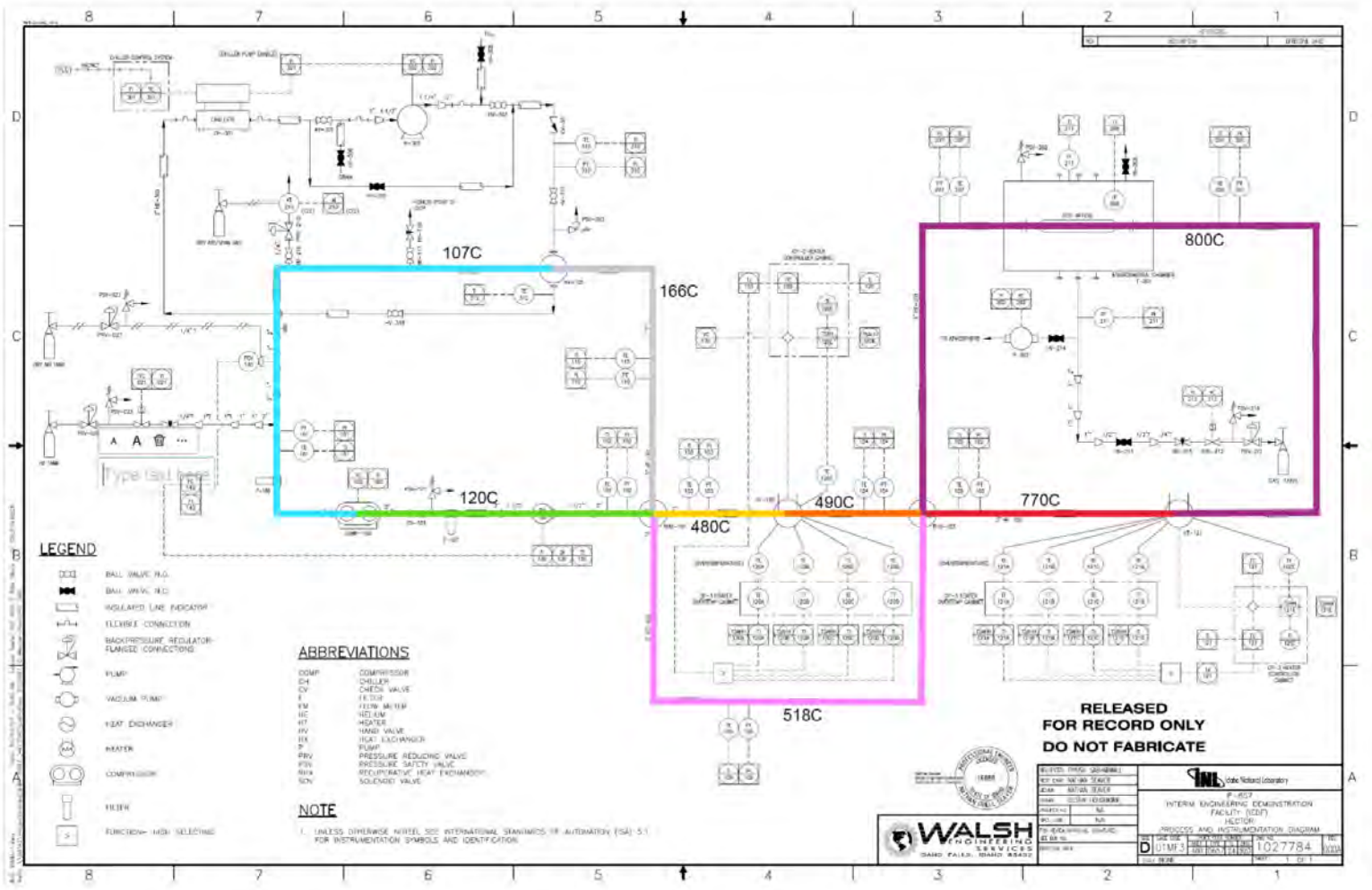
HECTOR – System Overview

Process Flow Description:



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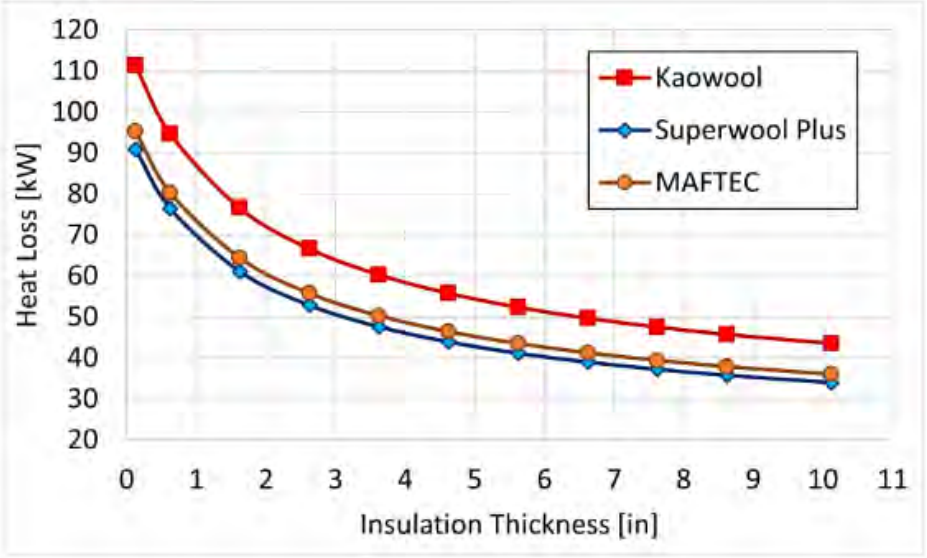
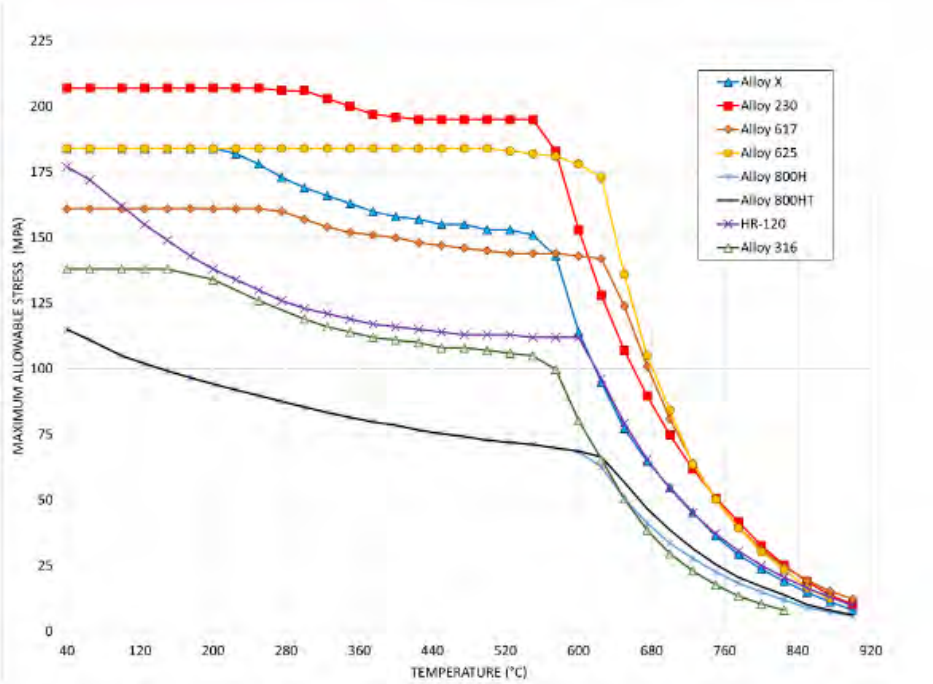
HECTOR – Material Selection

- Haynes Alloy 230 selected for piping material
- B31.3 Piping analysis completed
  - 2-inch SCH- XXS piping
- Insulated with either Superwool Plus or MAFTEC





Material	Max. Allowable Stress	Allowable Working Pressure (2 in. Pipe)			
	MPa @815°C	SCH-40 (MPa)	SCH-80 (MPa)	SCH-160 (MPa)	SCH-XXS (MPa)
Hastelloy X	20.9	3.0	4.4	7.6	10.3
Haynes 230	28.2	4.0	5.9	10.2	13.9
Inconel 617	27.3	3.9	5.7	9.9	13.5
Inconel 625	26.2	3.7	5.5	9.5	12.9
Incoloy 800H	13.1	1.9	2.8	4.8	6.5
Incoloy 800HT	15.1	2.2	3.2	5.5	7.5
Haynes HR-120	22.3	3.2	4.7	8.1	11.0
Haynes 282	35.9	5.1	7.6	13.0	17.7

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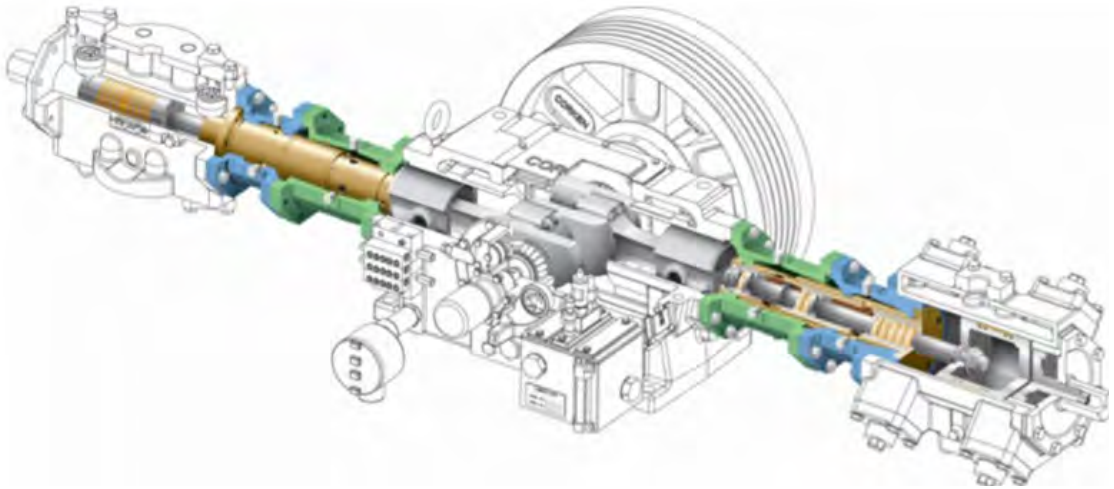
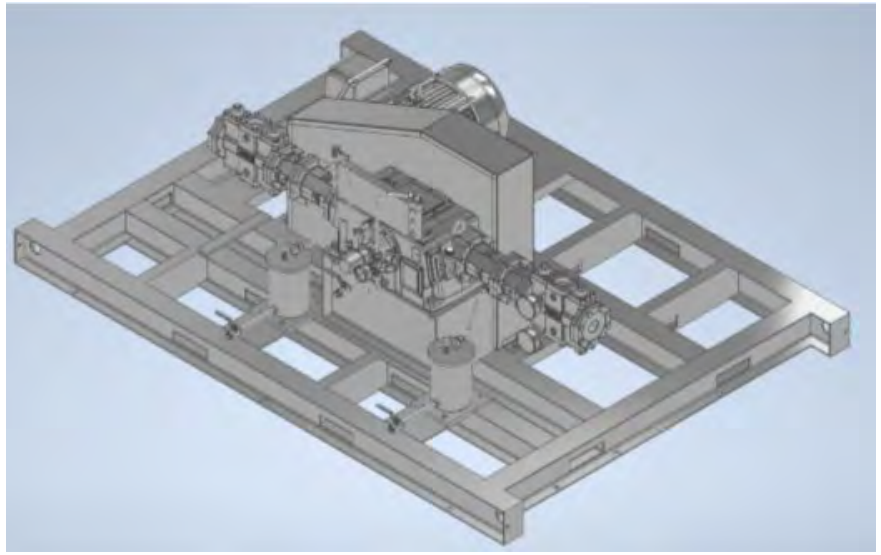
HECTOR - Compressor

- Provided by University of Idaho
  - Already in Idaho Falls
- Single-stage, double acting, air-cooled horizontally configured booster compressor
- Manufacturer ran multiple simulations at various pressures to verify mass flowrate





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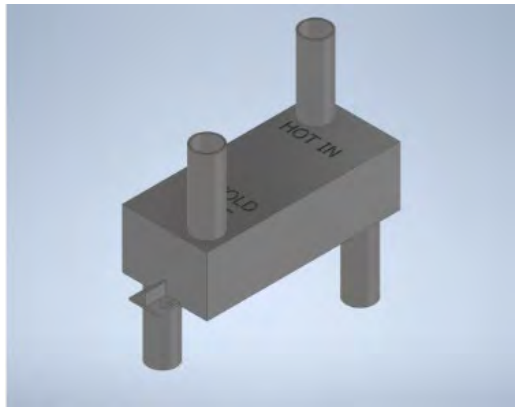
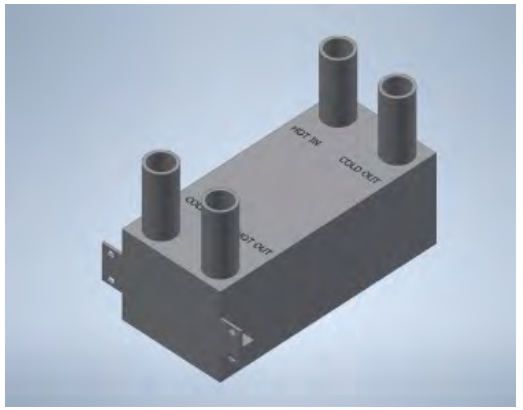
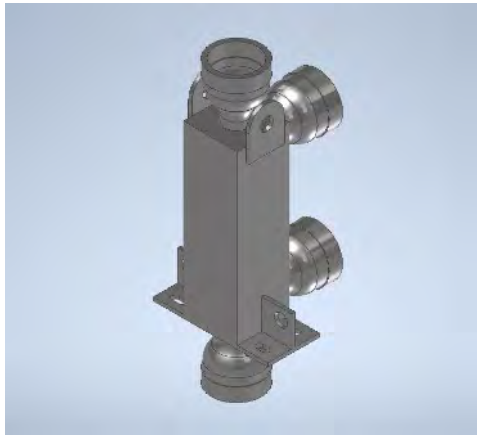
HECTOR – Recuperators and Heat Removal (PCHEs)

- Three printed circuit heat exchangers
  - Two for heat recuperation
  - One for heat removal to the chiller subsystem
- The high temperature PCHE is made of Alloy 617 SCH-160 wall with Grayloc flanges
- The medium temperature PCHE is made of SS-316 SCH-40 wall
- The heat removal PCHE is made of SS-316







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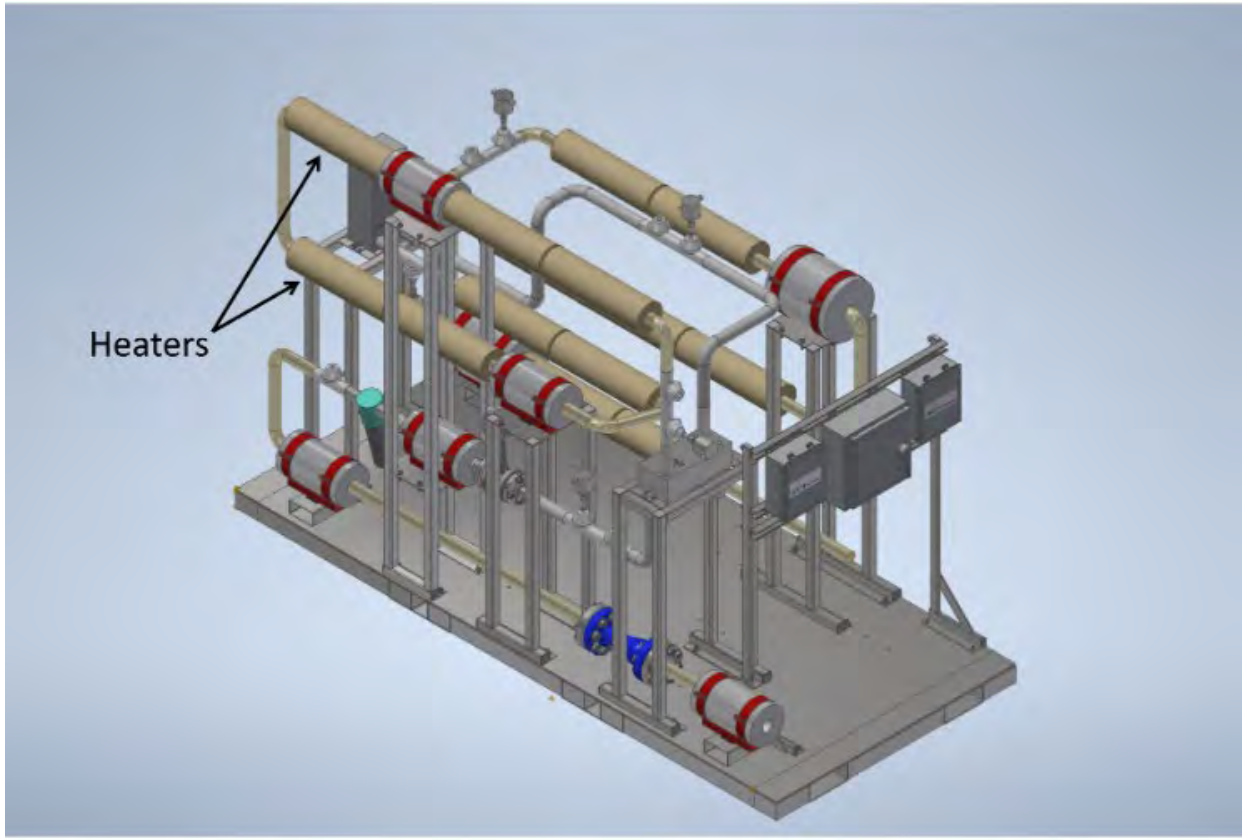
HECTOR - Heaters

- 480V, 2500W nominal ceramic fiber radiative heaters
- 28 heaters in total for 75kW of heat
- Allows for easy installation without worry of inline heaters (difficult to source due to pressure constraints)



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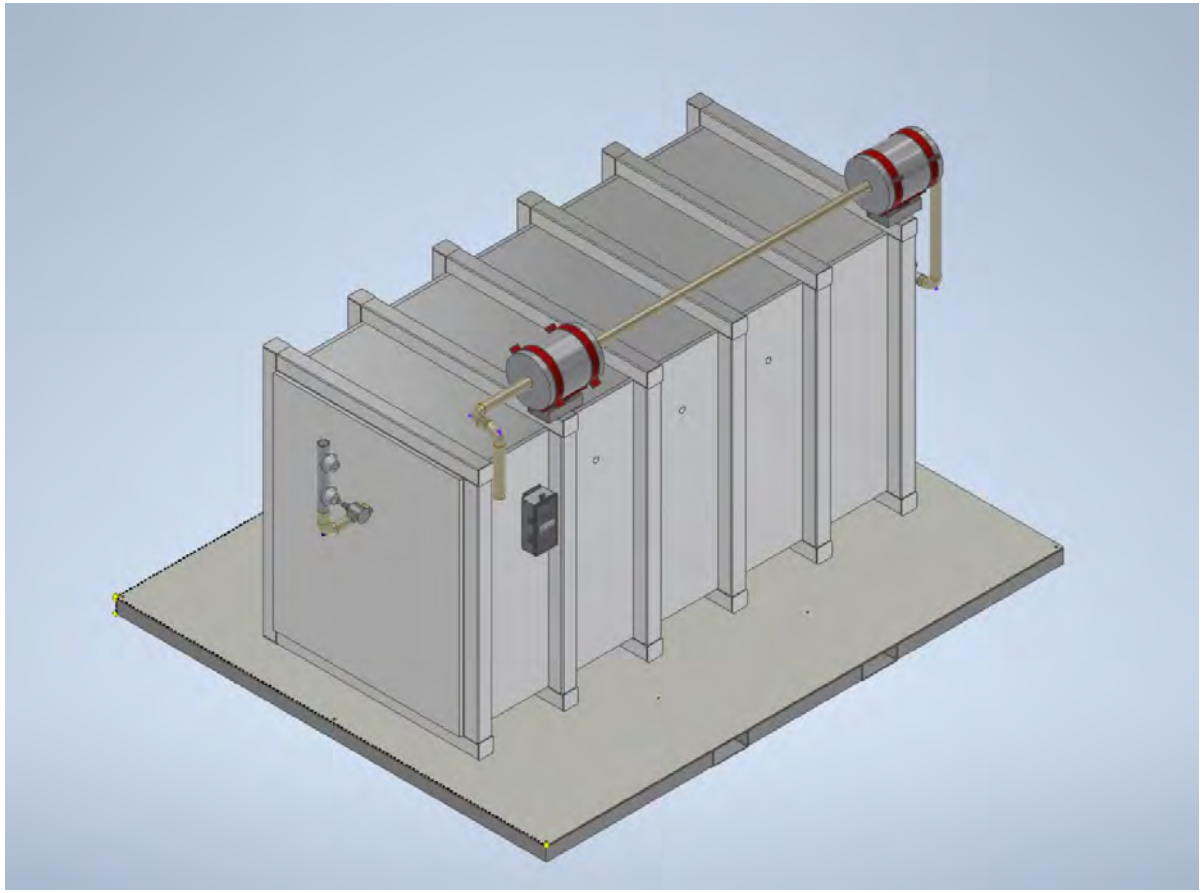
HECTOR - Environmental Chamber

- Goal was to be as versatile as possible
- Total dimensions: 4ft x 5ft x 10 ft
- Designed with a total of eight 8-inch blank flanges for instrumentation and gas feedthroughs
- Contains eight additional 1.5-inch flanges for connections for various experiments
- Equipped with mounting holes located at the bottom of the chamber for experiment installation



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HECTOR – Next Steps

Completed:

- 90% design
- B31.3 analysis
- Initial drawing package
  - Mechanical and electrical

Future work:

- Drawings to be reviewed by Walsh Engineering for release for construction
- Ready for construction contract

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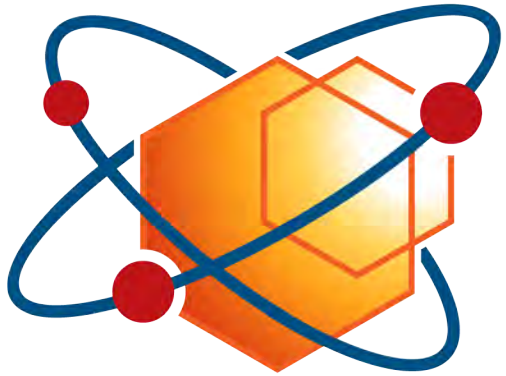

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