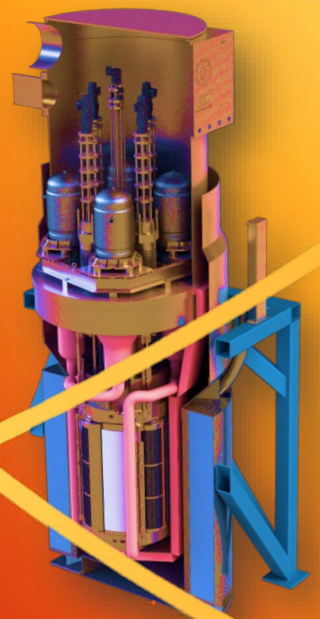
INL/MIS-26-90602

(Microreactor Applications Research, Validation & EvaLuation),



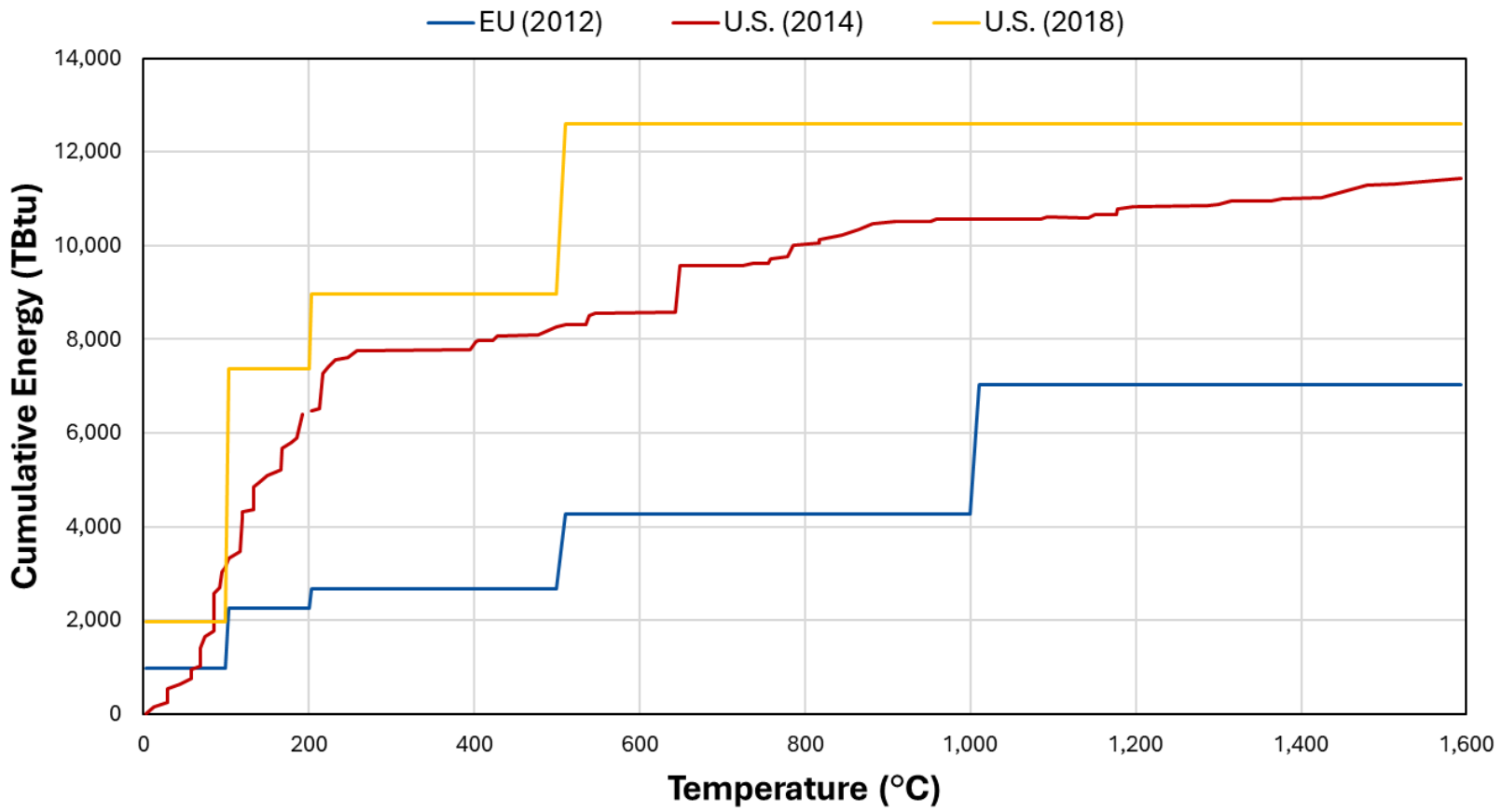
Process Heat: Microreactor Thermal Energy Loop (MTEL)

Feb 2026

Rami M. Saeed (Presenter), B. Baker, J. Johnson, A. Abou-Jaoude

Why This Matters

- Across the entire U.S. industrial sector, ~70% of heat requirements (9000 TBtu) are for temperatures below 400°C.



Cumulative annual process heat demand by temperature

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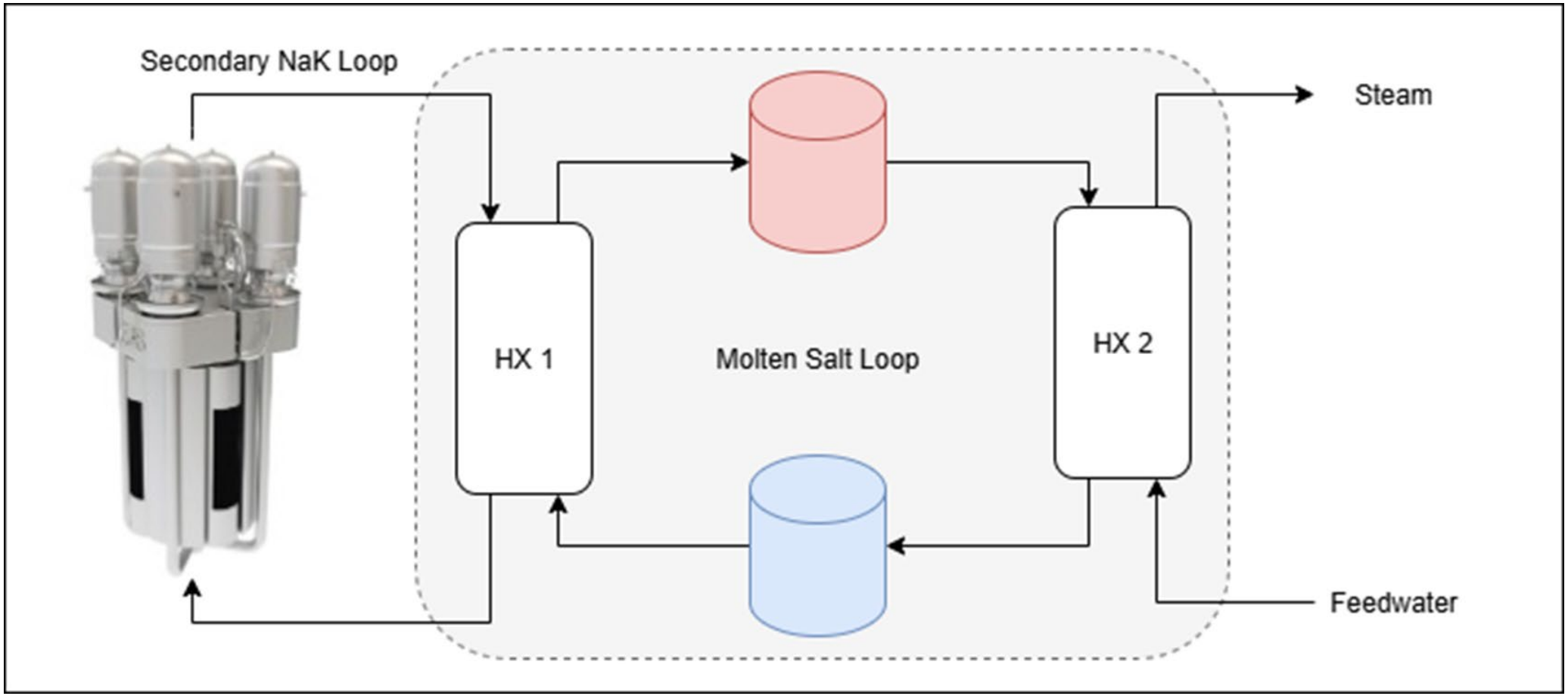
MRP Microreactor Program

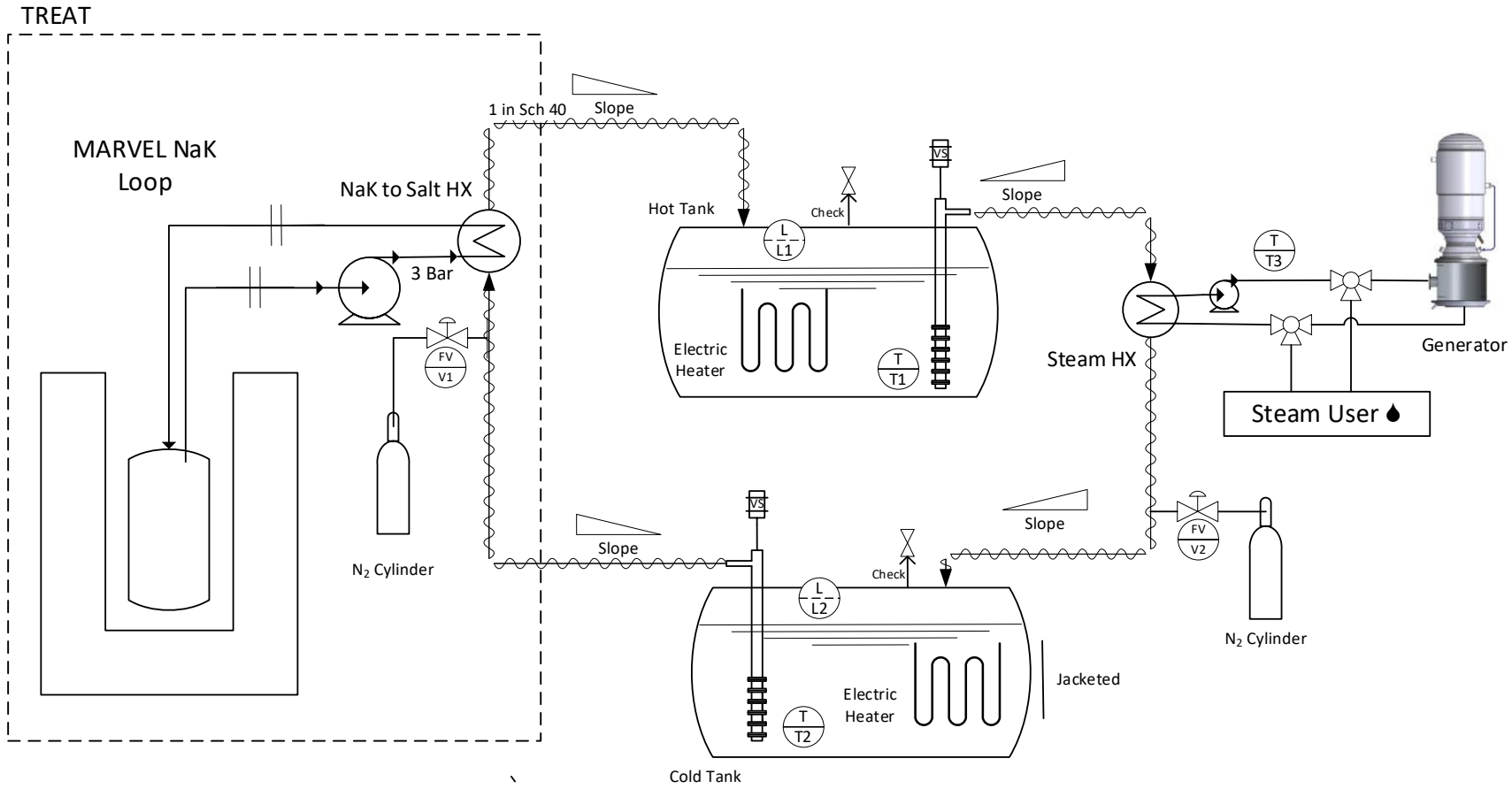
MARVEL can provide power for heat and electric applications



MRP Microreactor Program

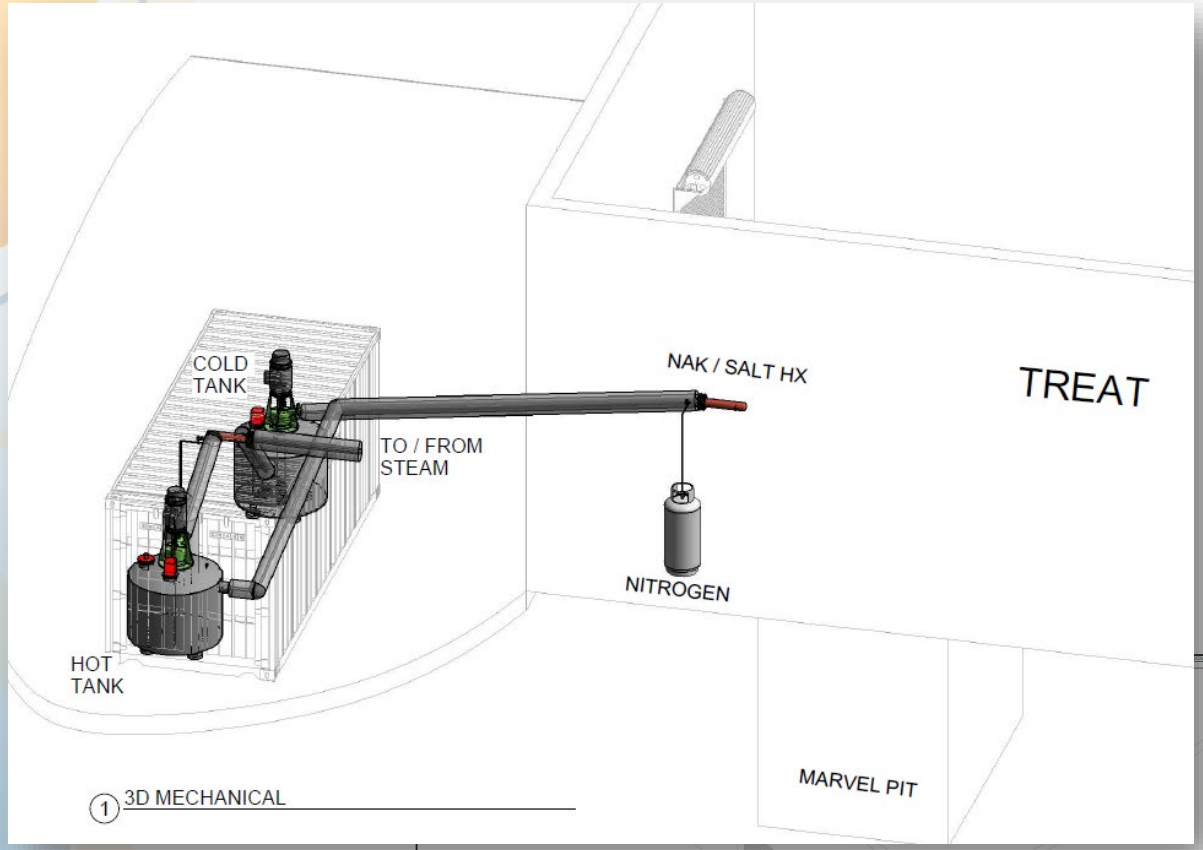
Concept of Operation

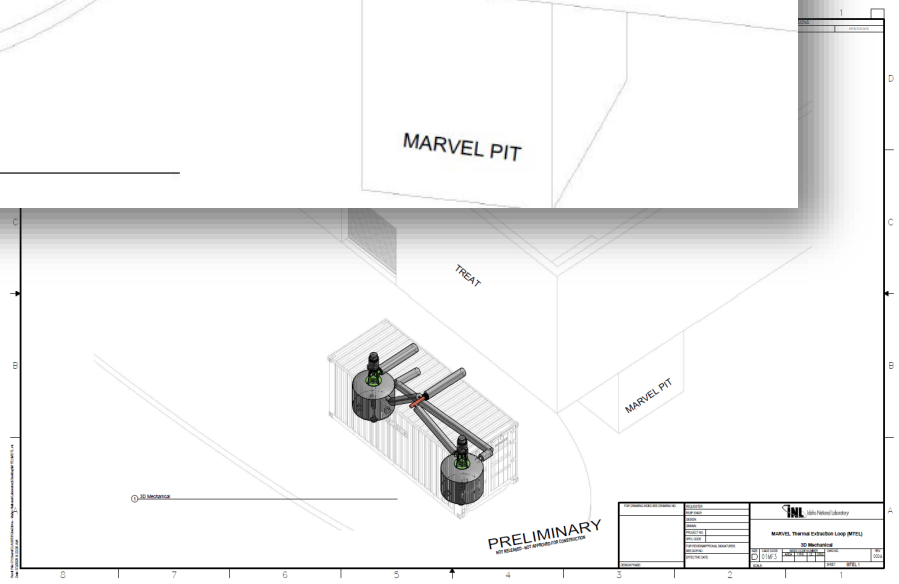
- Heat source: MARVEL reactor → NaK loop → HX1 → molten salt
- Storage: Heated salt stored in hot tank
- Heat user: HX2 transfers heat to steam loop (e.g. Stirling engine kits)
- Capacity: ~160 kWh thermal storage; discharge up to 160 kWth for 1 hour



MRP Microreactor Program

MARVEL Thermal Energy Loop (MTEL)



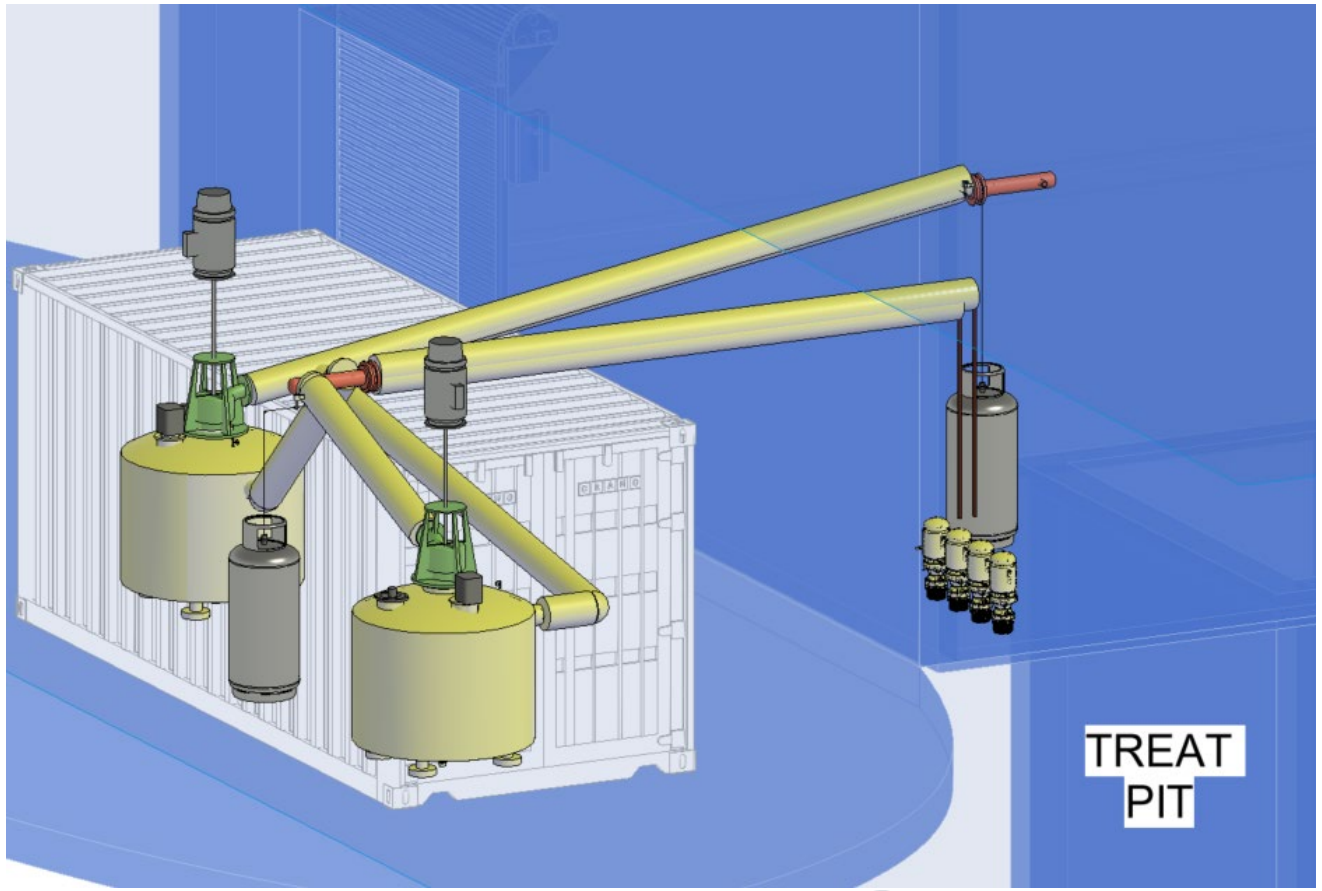


- Intermediate loop:
  - Secondary NaK → Salt/oil/gas→ steam
- Modular, transportable and scalable
- Thermal Energy Loop Specifications:
  - 85 kWth nominal heat delivery
  - >400°C salt
  - Up to 360-390°C steam @2MPa
- Example use cases: Food & beverage skids, petroleum refinery, chemical, pulp & paper, high temperature steam electrolysis (HTSE)
- End user feedback: heat needs, transients, reliability, duration of tests, etc.

MRP Microreactor Program

Scope of Work

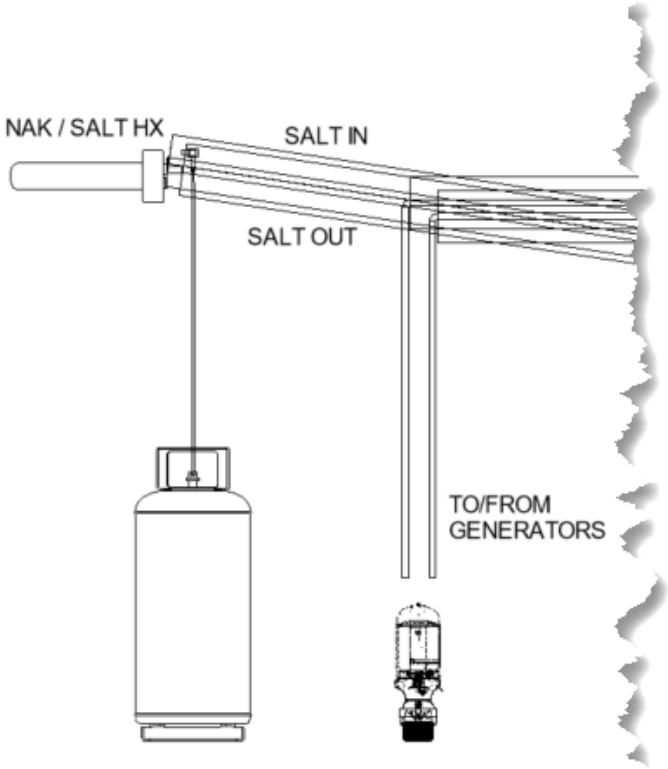
- Design, fabricate, and test MTEL outside TREAT Facility
- Two molten salt tanks (300 gal each), heat exchangers, pumps, heaters
- Containerized system fits in 20-ft Conex
  - The “Containerized” concept is an option but not required

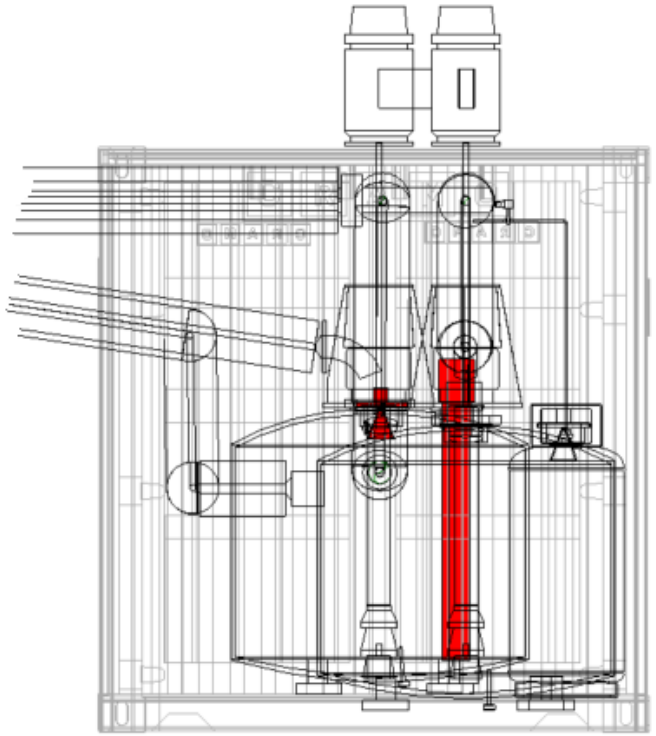


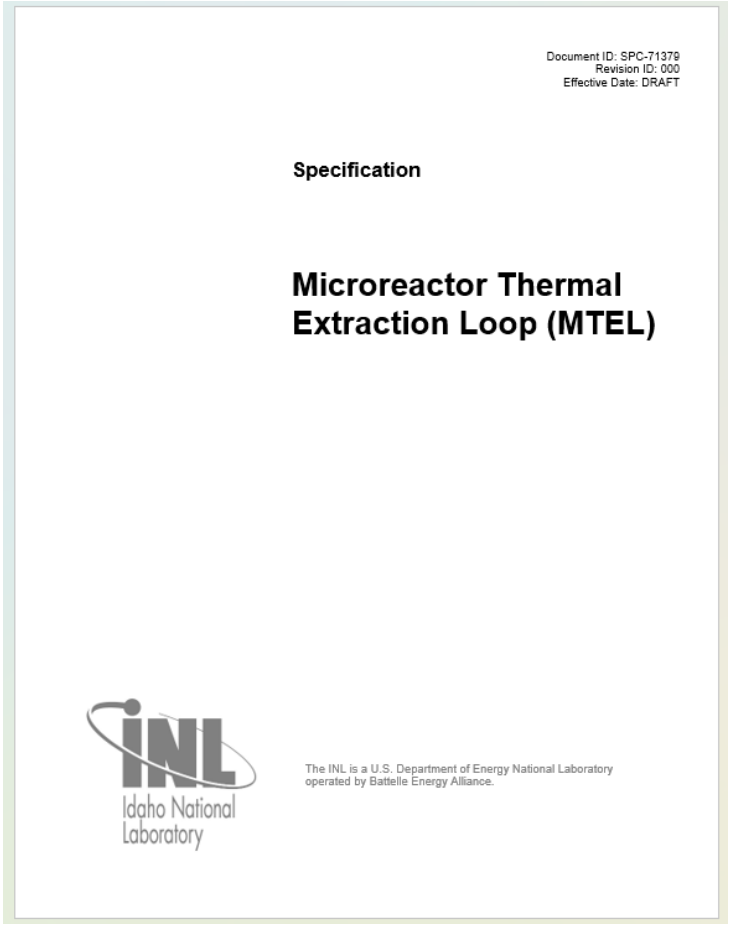
MRP Microreactor Program

Current Status

- Specification complete (SPC-71379)
- Design phase: Draft drawings and P&ID in progress
- Vendor engagement underway



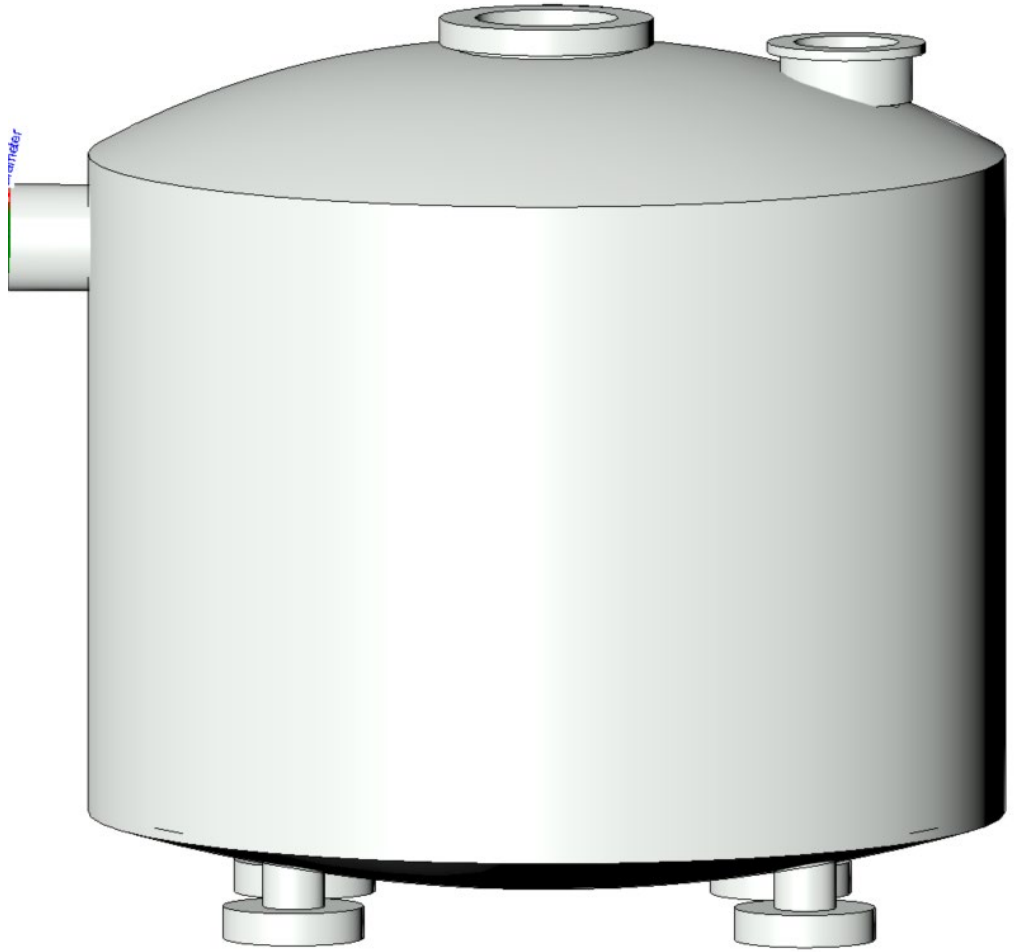




MRP Microreactor Program

Next Steps

- Finalize design reviews:
  Conceptual → Preliminary → Final
- Fabrication & FAT at vendor site
- Delivery & integration at INL
- Commissioning & testing



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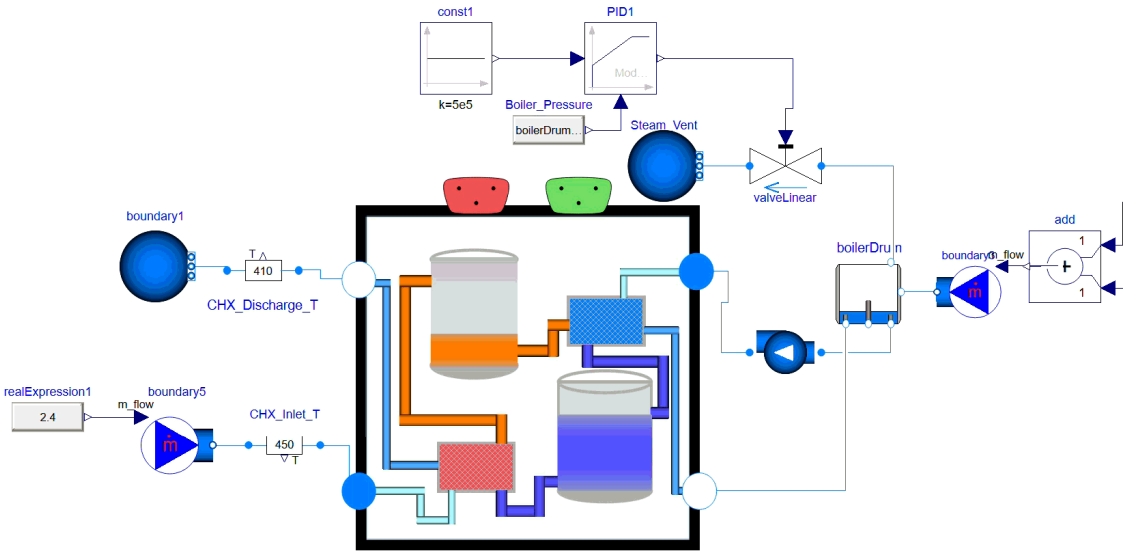
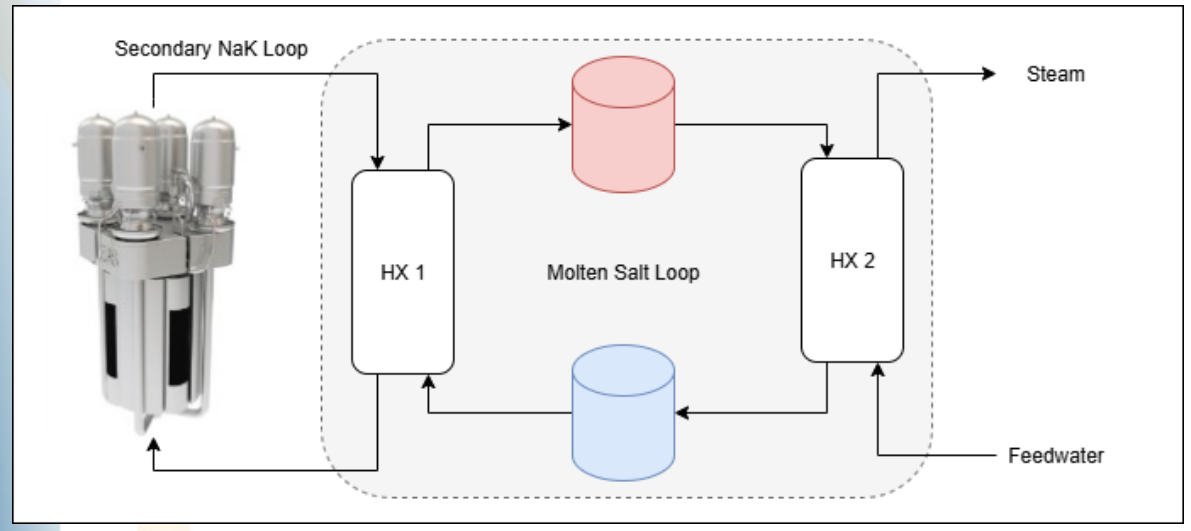
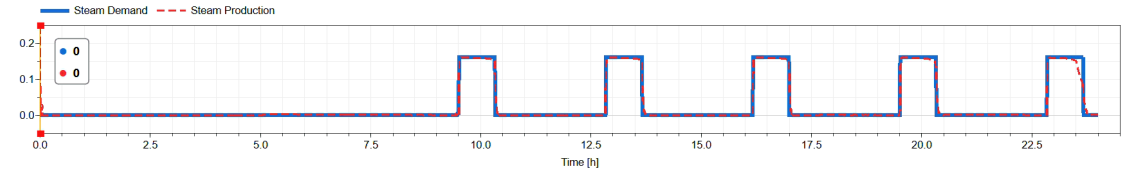
Thermal Decoupling & Transient Heat (Steam) Extraction

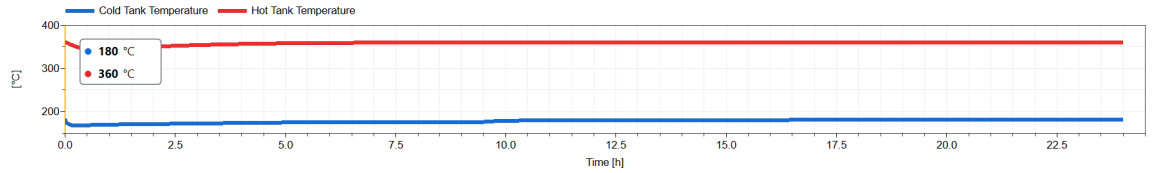




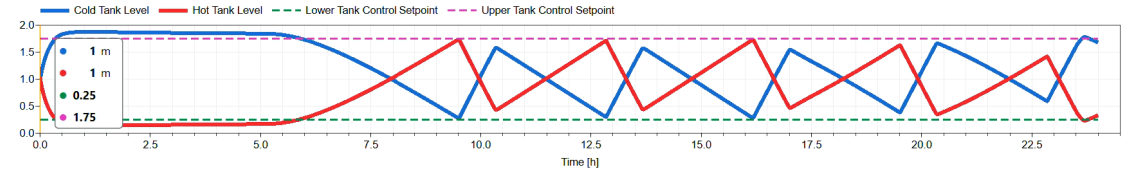
Transient Steam Demand



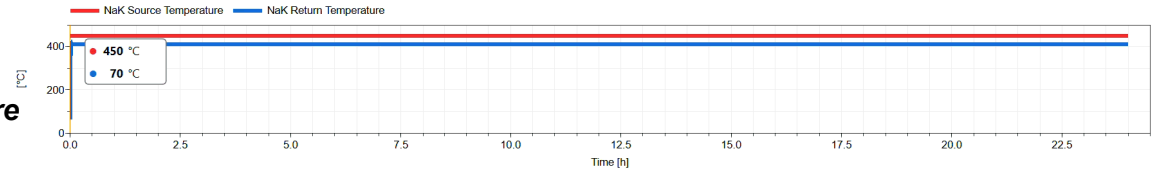
Salt loop Temperature



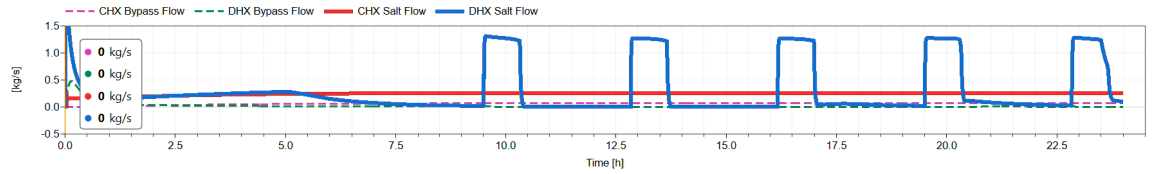
Tanks level



NaK Temperature



Steam Output



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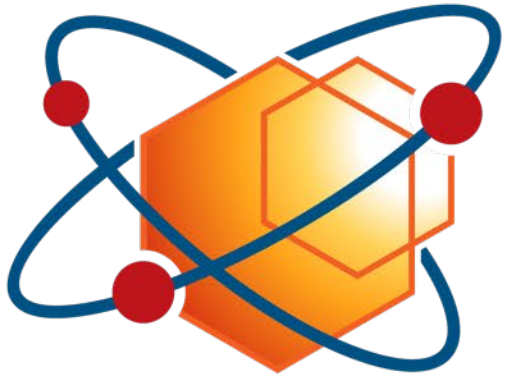
Questions?

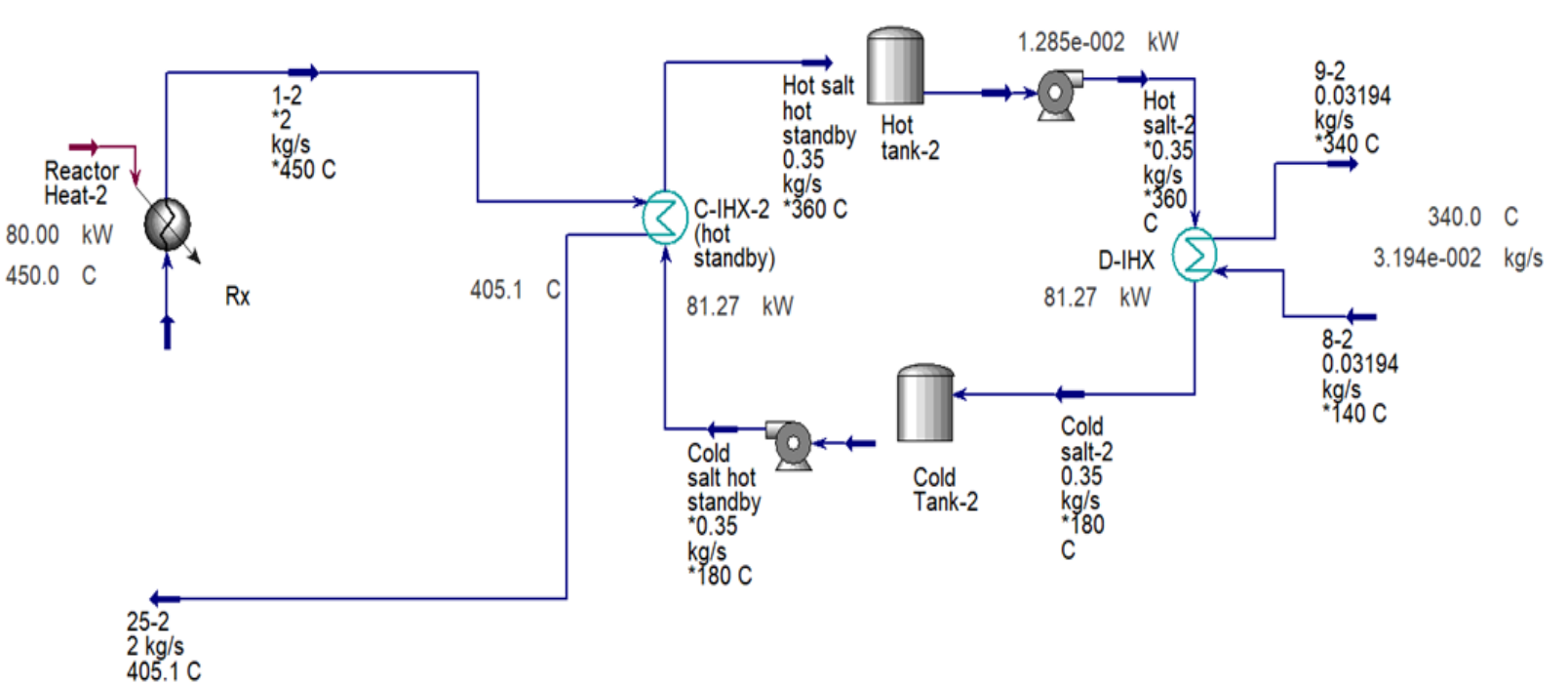
MRP Microreactor Program



MRP Microreactor Program

Key Technical Highlights

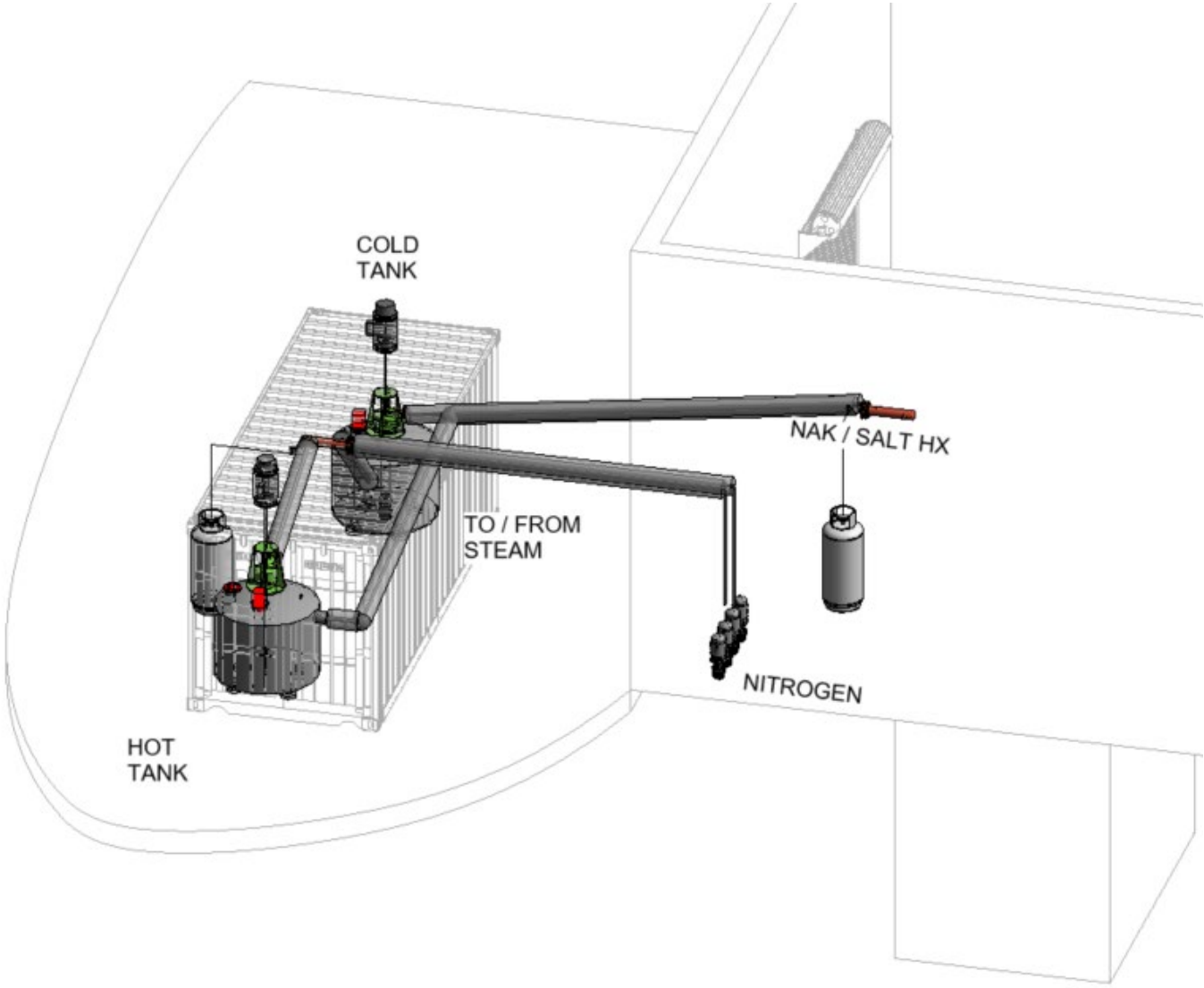
- Operating Range: Salt 142–454°C; NaK loop 450°C inlet
- Heat Transfer: HX1 duty 80 kWth; HX2 duty 160 kWth
- Materials: Nickel alloys or SS316/347 for corrosion resistance
- Safety Features: PID control, trace heating, nitrogen blanketing



MRP Microreactor Program

Deliverables

- Design drawings, 3D models, P&ID
- Requirement compliance matrix
- QA documentation, FAT checklist
- O&M manuals, NRTL certification



MRP Microreactor Program

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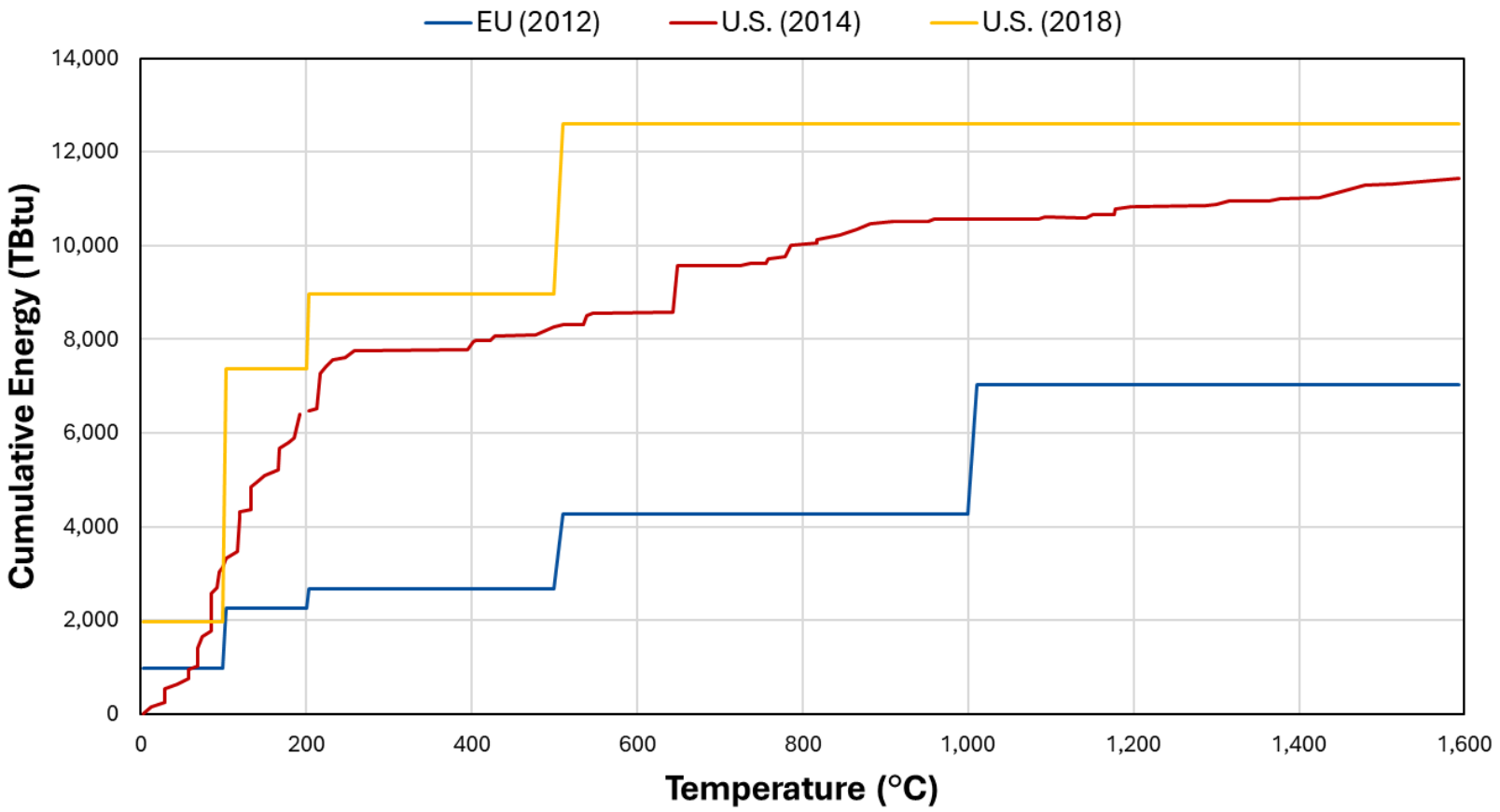

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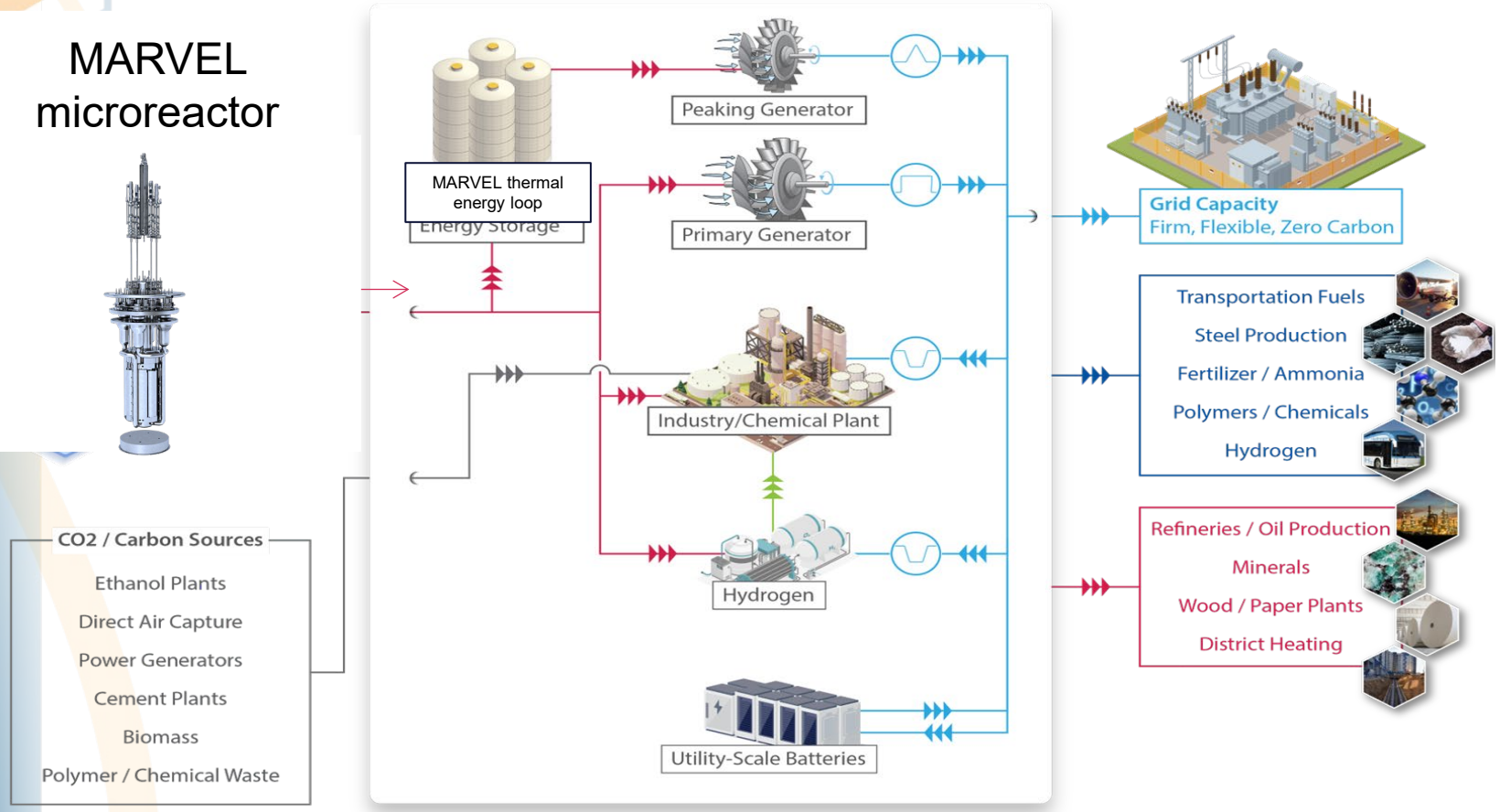
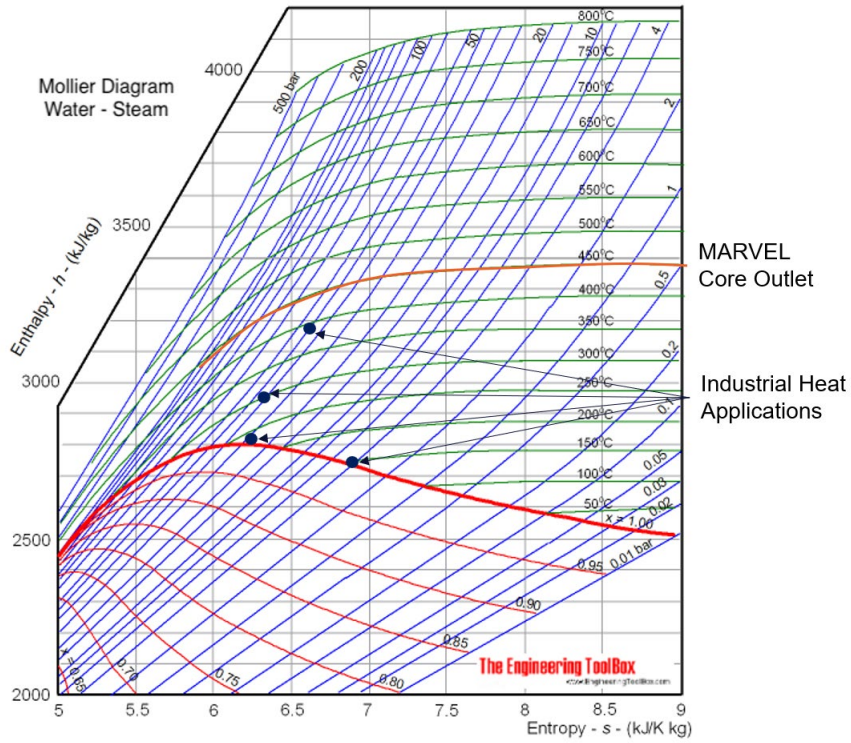
MARVEL microreactor



Relevant industrial heat end-use cases for MARVEL



MRP Microreactor Program

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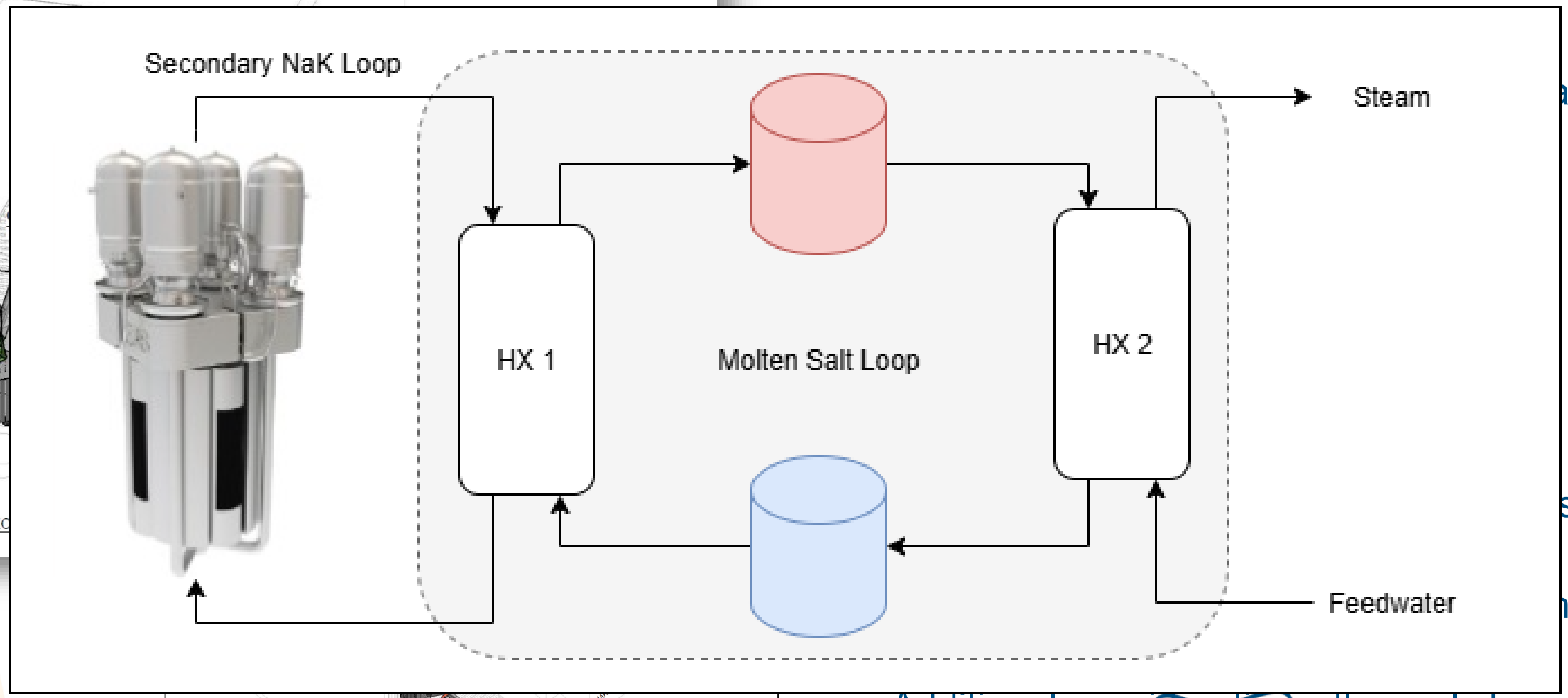

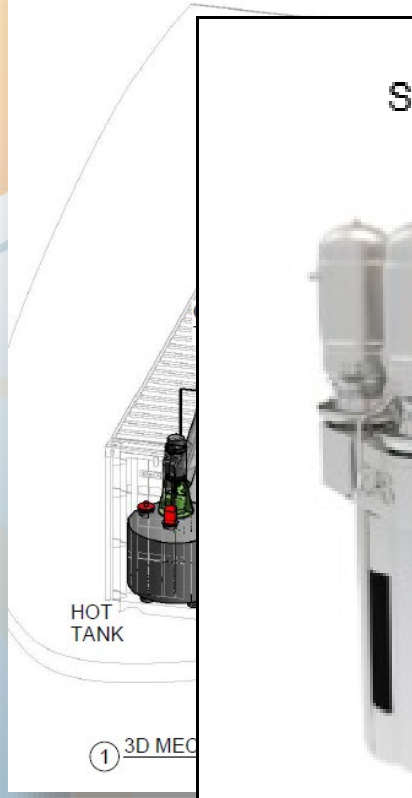

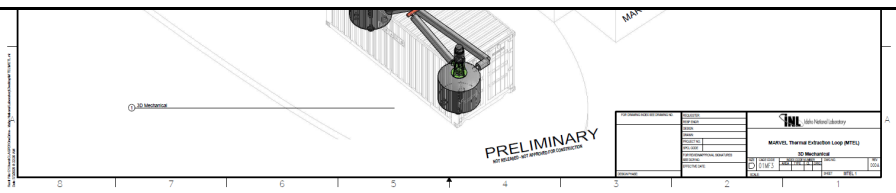

- Additional considerations: thermal storage, thermal/heat boosters

MRP Microreactor Program

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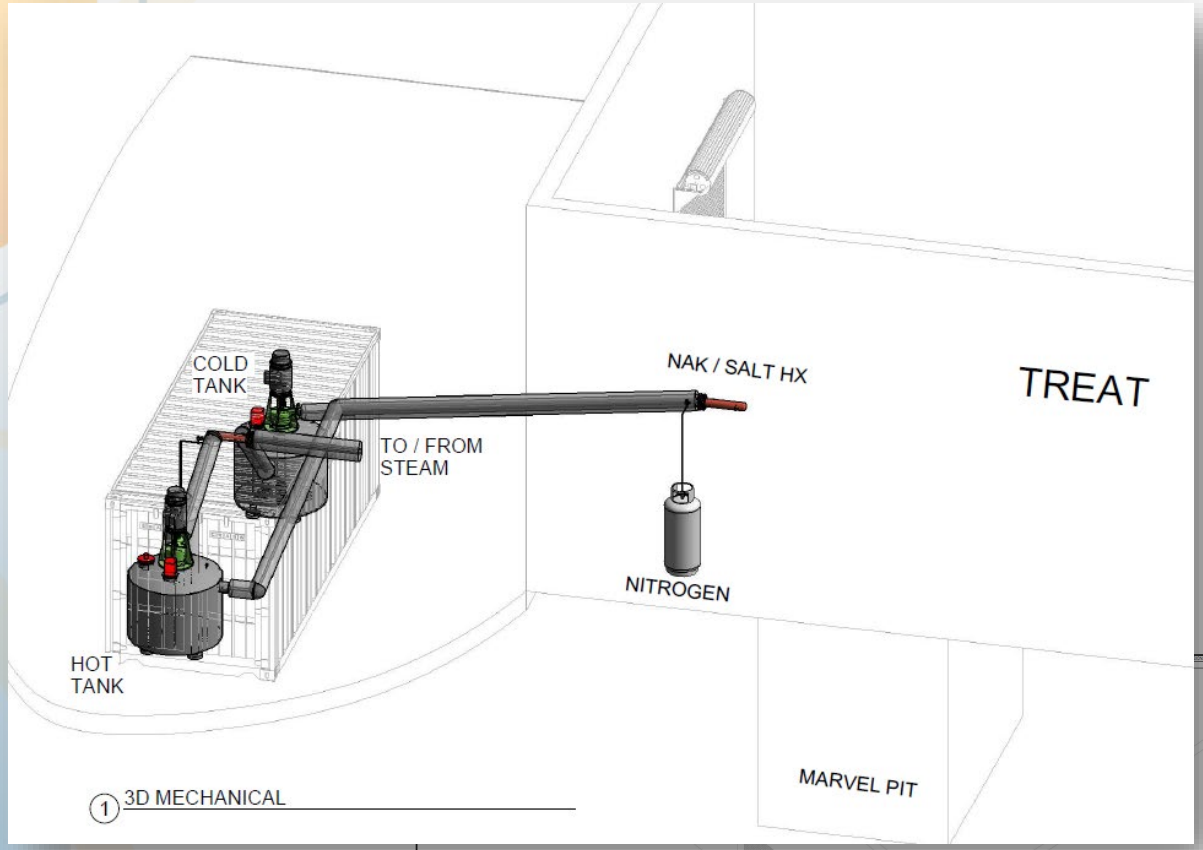

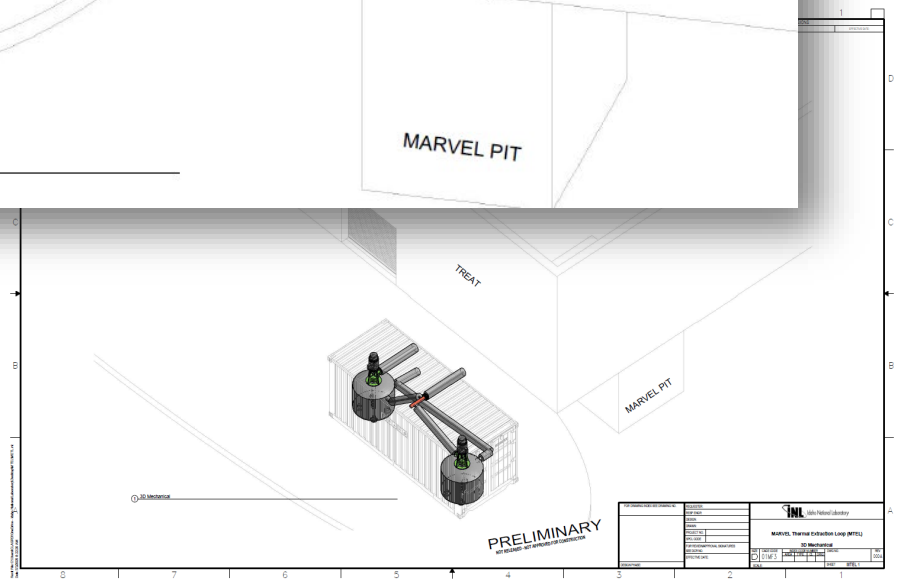

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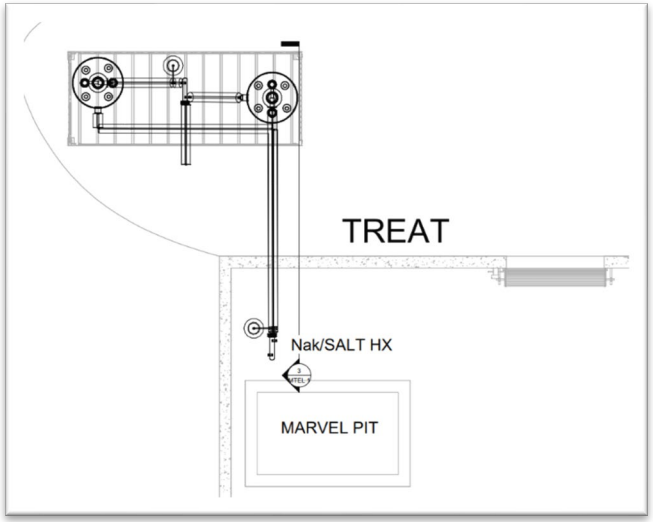
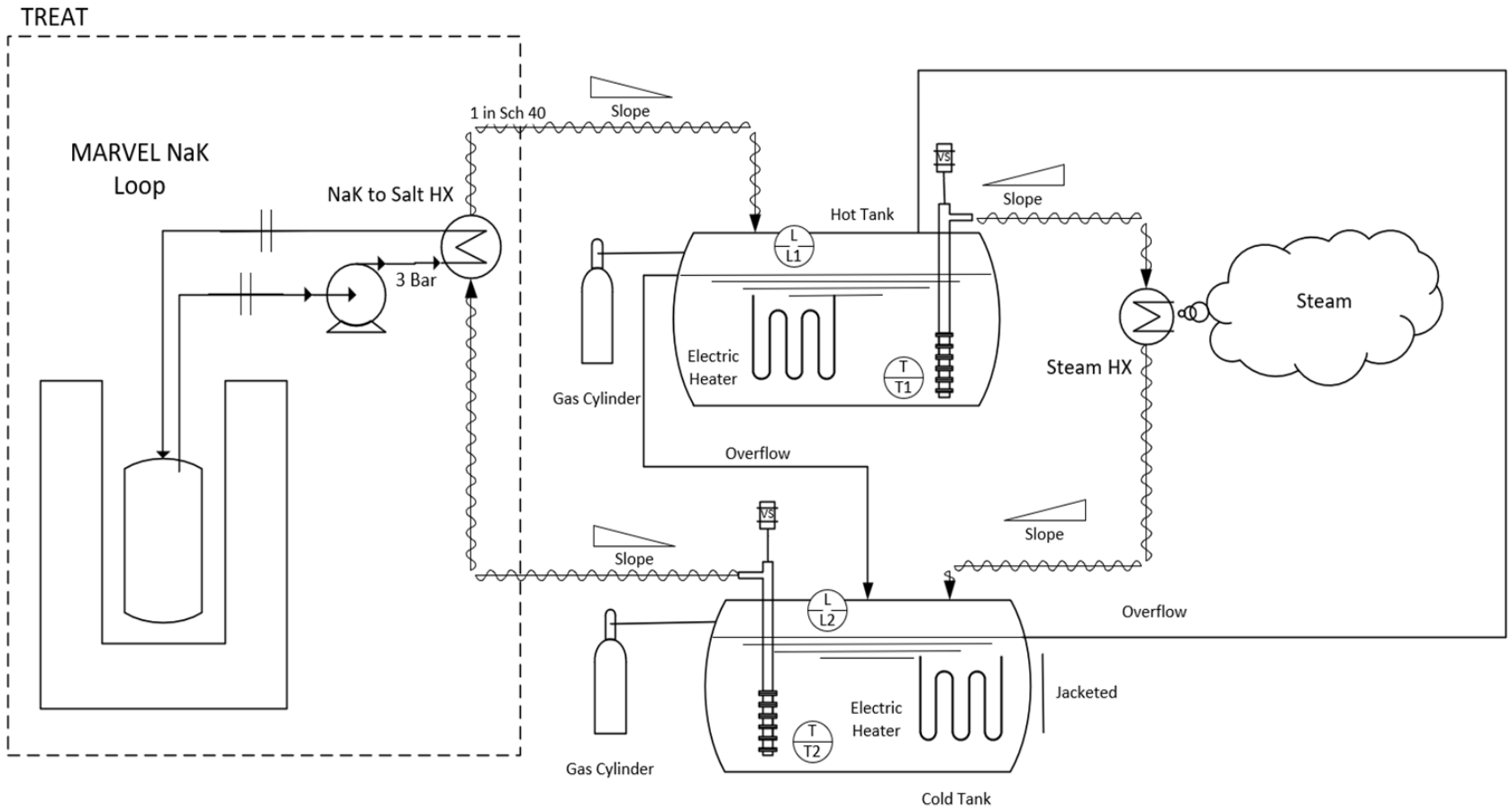


MARVEL Thermal Extraction Loop (storage option)



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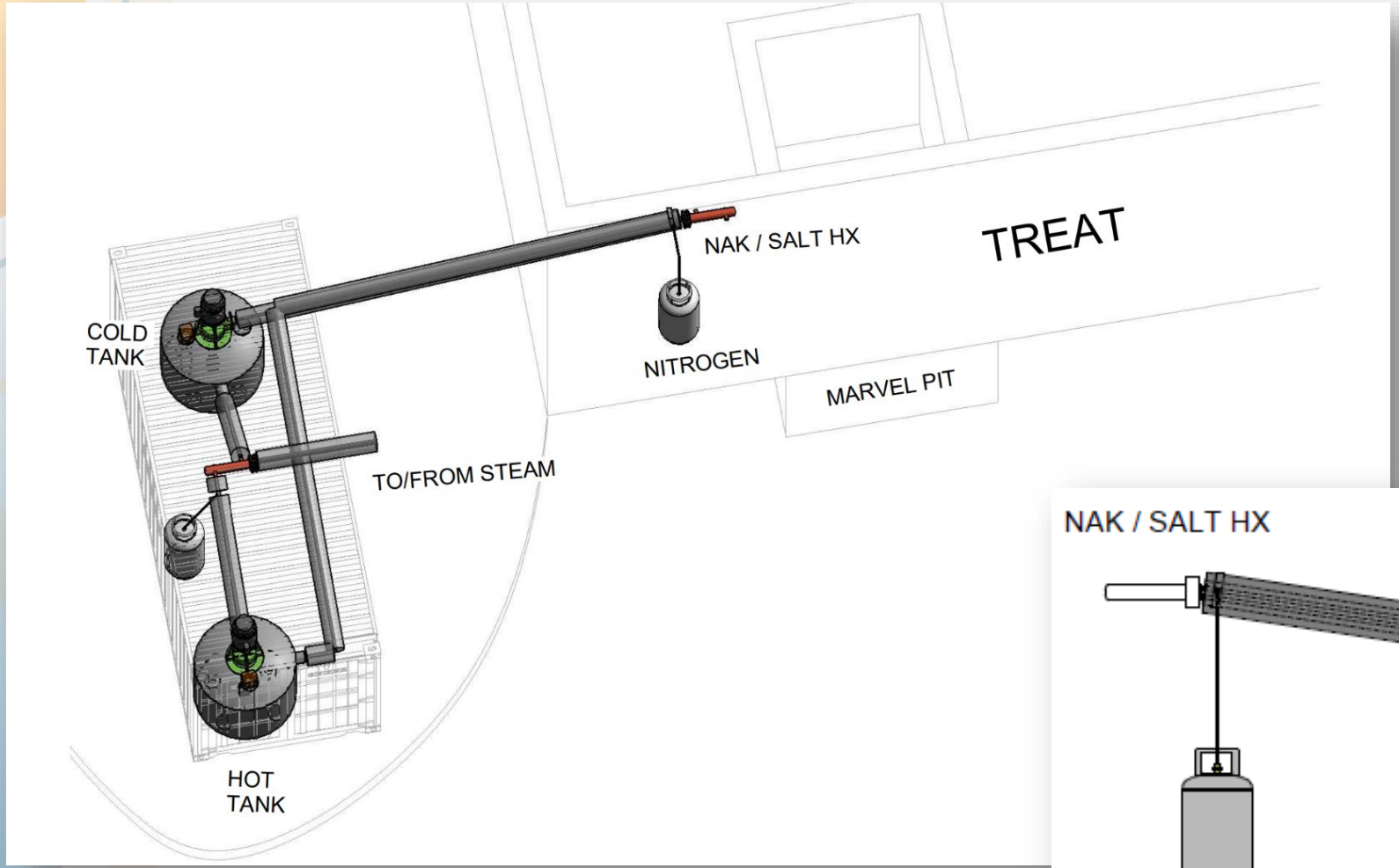

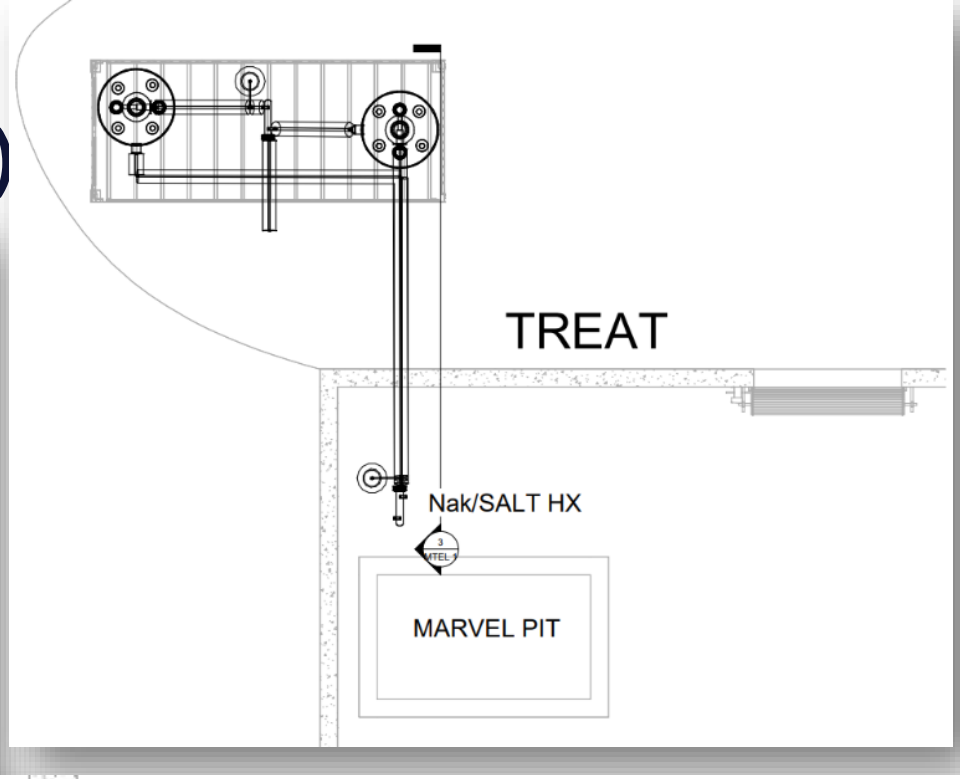

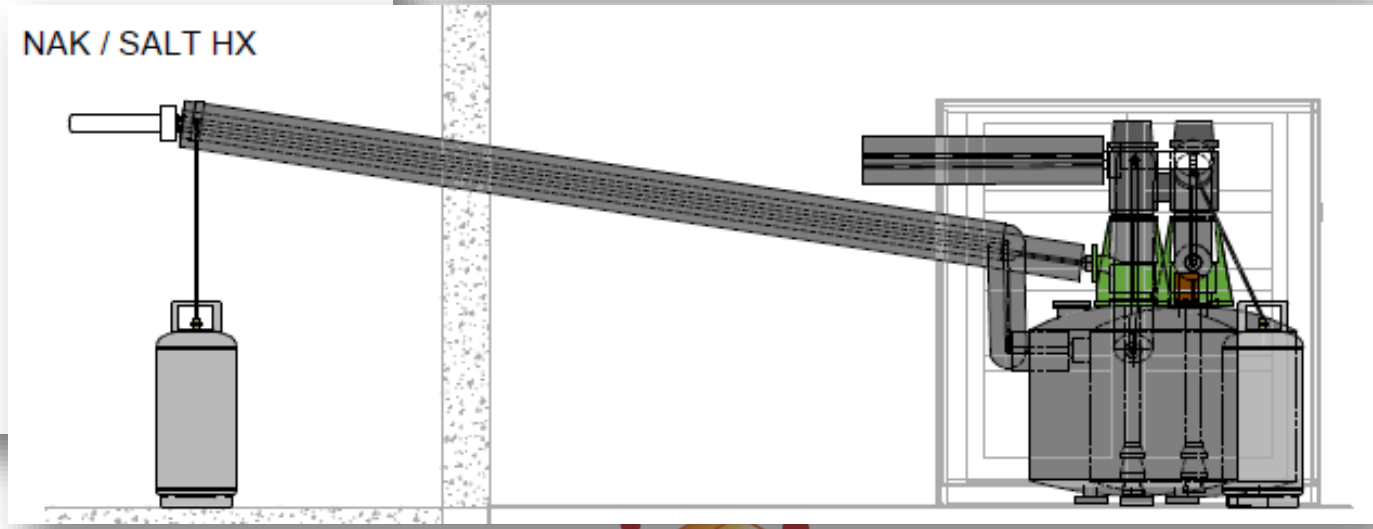

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