Auxiliary Systems

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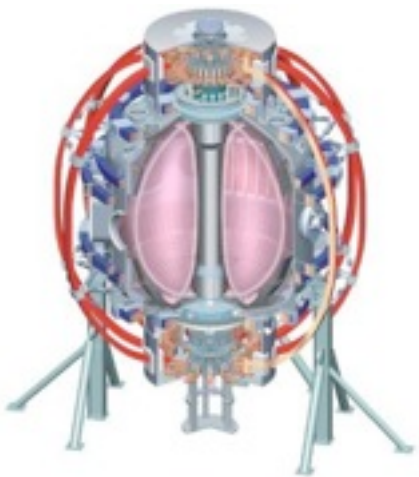
Princeton Plasma Physics Laboratory

NSTX Upgrade Project
Final Design Review
LSB, B318
June 22-24, 2011



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Outline

- Scope
  - Bakeout
  - Gas Injection
  - Cooling Water
- Requirements
- Description of the Design
- Previous Chits / Recomendations
- Risks
- Cost and Schedule

Bakeout System Description

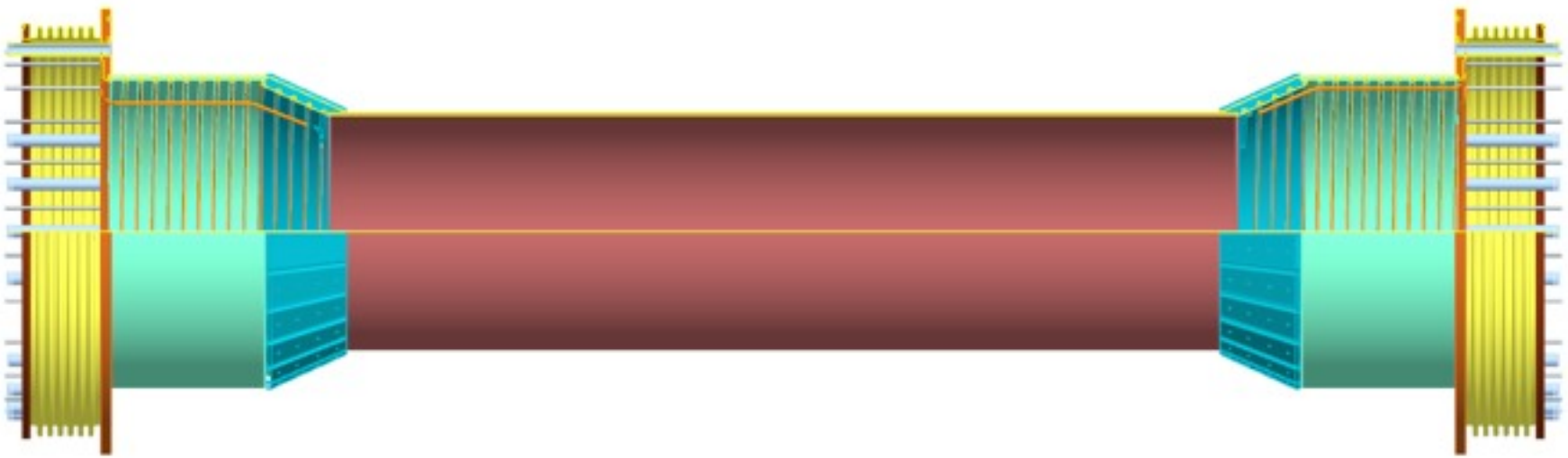
- In NSTX the Vessel is divided into two parts
  - INNER Vessel & OUTER Vessel
  - These are insulated by providing ceramic breaks at top & bottom of the machine
- This design is to enable Coaxial Helicity Injection (CHI)
  - Flags are provided at the top of the machine from
    - a) INNER Vessel and b) Outer Vessel.
  - Two Ring Buses are provided at the bottom for CHI – one each connected to a) Inner Vessel and b) Outer Vessel.
  - Ohmic heating is accomplished by injecting current through the Vessel
    - By keeping the top of the vessel electrodes shorted at the flags
    - By connecting a suitable power supply to the bottom ring buses
    - Resistance of CS casing is such that ohmic heating can be done using a small power supply
    - Resistance does not change much over the temp. range.

Power System Equipment

- Requirements – See Circuit:
  - Resistance calculated of the vessel part – 324uOhms
  - Total resistance up to flag – 500uΩ
  - Power required for heating - 8513 Watts
  - Current required to be injected – 4479 Amps

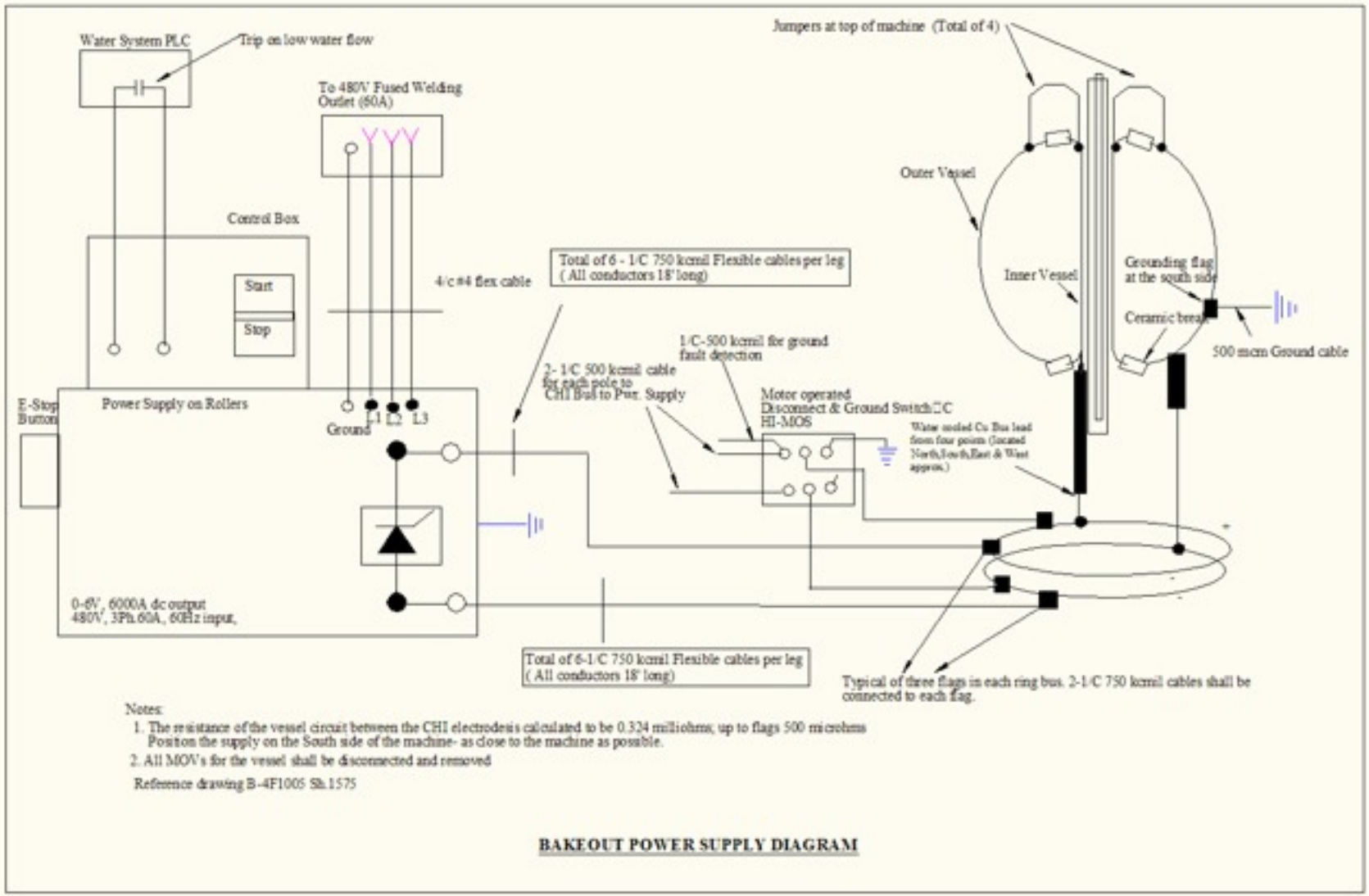
  - PURCHASE & USE 0-6V , 6kA DC Pwr Supply -allowing for lead drop

Center Stack Casing



CS Casing is used as a large resistive heating element

Bakeout Circuit



Notes:

1. The resistance of the vessel circuit between the CHI electrodesis calculated to be 0.324 milliohms; up to flags 500 microhms Position the supply on the South side of the machine- as close to the machine as possible.
2. All MOV's for the vessel shall be disconnected and removed

Reference drawing B-4F1005 Sh.1575

BAKEOUT POWER SUPPLY DIAGRAM

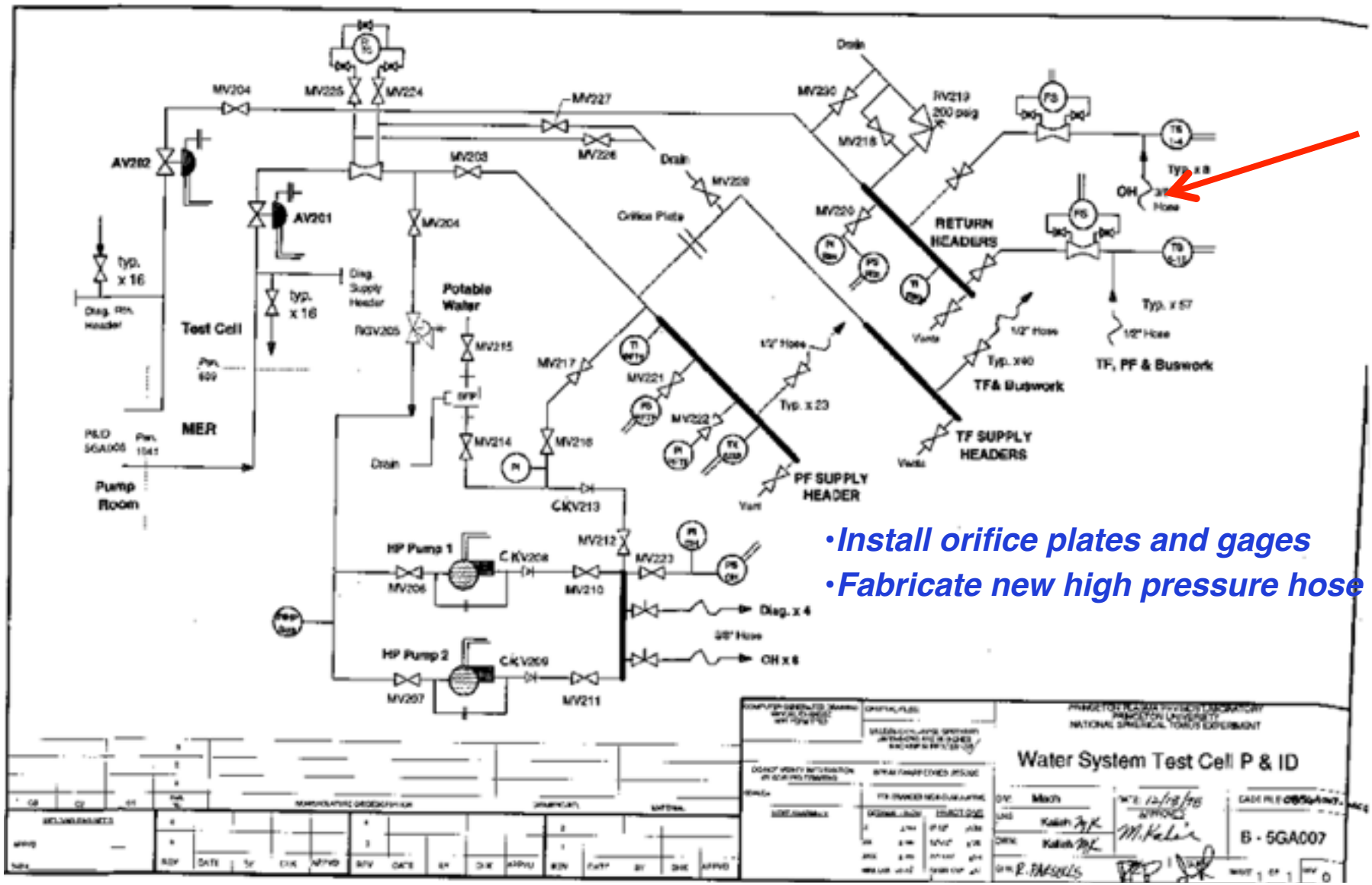
Cooling Water Requirements

- Upgrade 8 OH Flow Paths
  - Existing
    - Eight (8) OH flow paths @ 1 GPM, 400 psi each
    - Inner PF Coils (PF1a, b, c)
  - Upgrade
    - Orifice plates to provide unequal flow to equalize temperature of coil conductors
    - Add local pressure monitoring gage
    - Add remote pressure monitoring point
    - Replace aging hoses with new material
- Upgrade water supply for bus work cooling
  - Add one connection to an existing tap on existing manifold from the PF coil cooling system
  - 1-3 GPM @ 120 psi, 10 C
- Upgrade TF Cooling water
  - Replace aging cooling hoses with new materials

Cooling Water Design - Pumps

- Existing pumps achieve sufficient pressure and flow

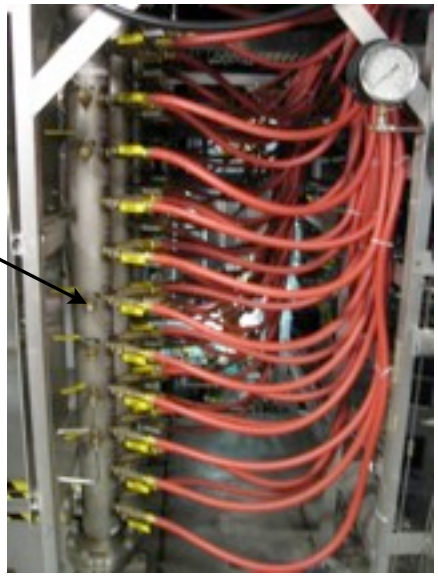
Cooling Water P & ID

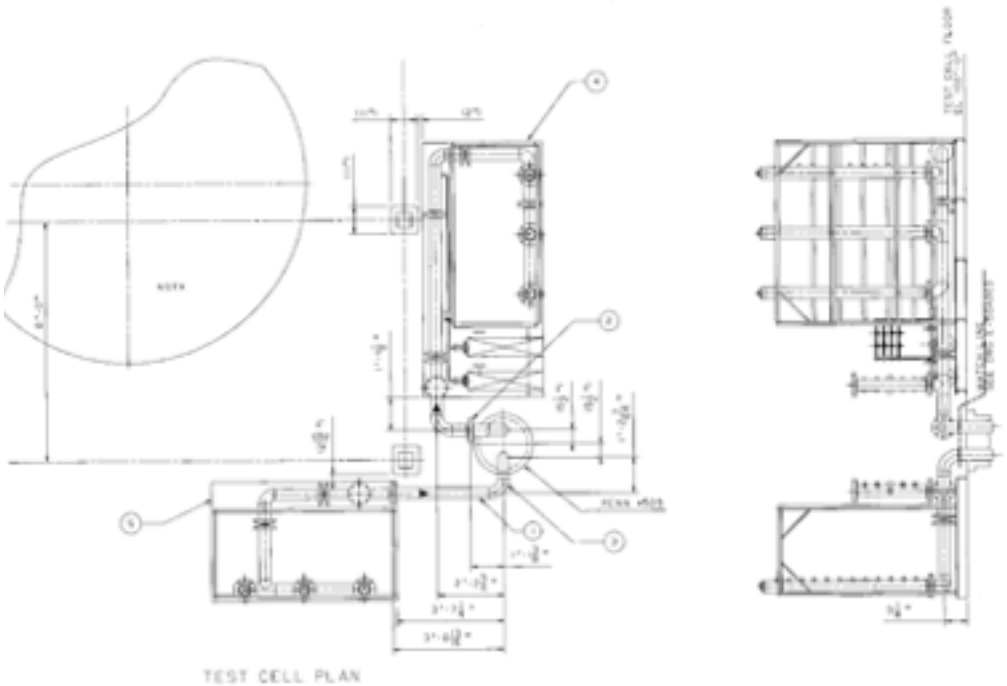


- *Install orifice plates and gages*
- *Fabricate new high pressure hose*

Cooling Water - Existing Manifolds

- Spare taps are available



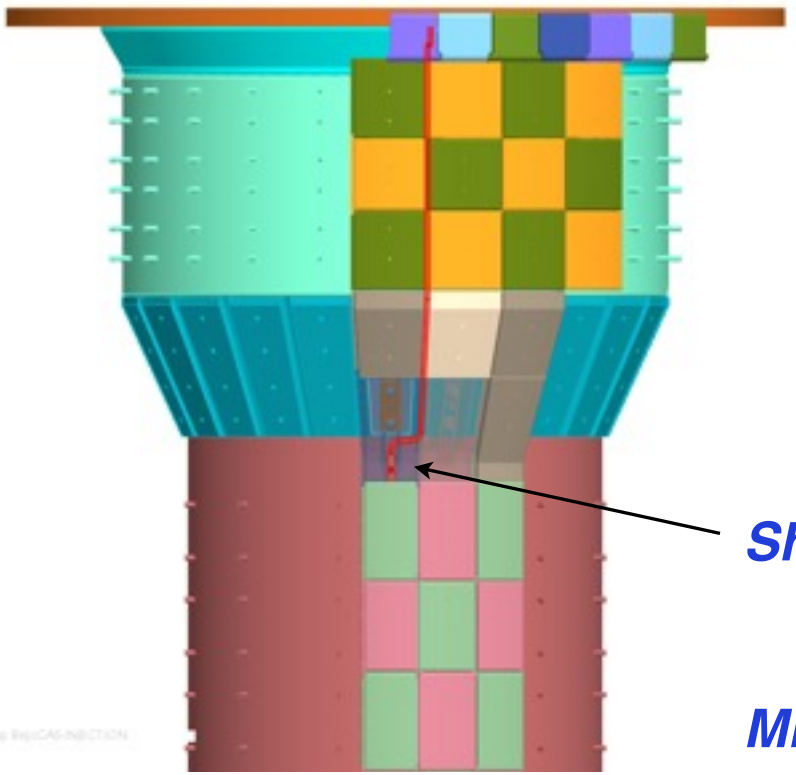


Gas Injection Requirements

- The plasma is fueled by a small gas injection pipe on the centerstack
- The new centerstack will require a replacement of the pipe which is routed beneath the graphite tiles on the centerstack casing
- Requirement is to replace the tubing to supply shoulder and midplane injection points with SS tubing at least as large as existing system (1/8” OD)

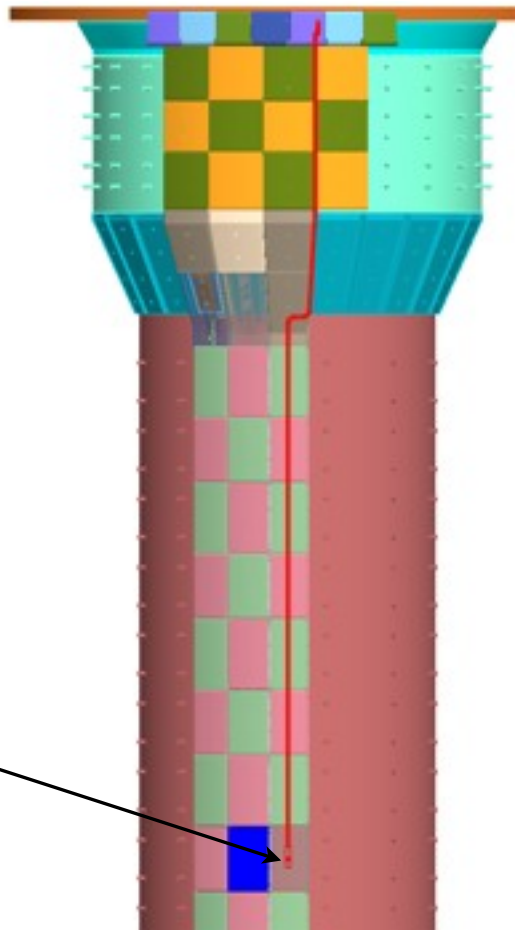
Gas Injection Design

- Gas Injection tubing design, .250" OD x .210" ID



Shoulder Injection

Midplane Injection



Chits from Previous Reviews

- Bakeout
  - Determine if an upgrade is required for the bakeout power supply to account for the change in resistance of the Inconel tube
    - A new Power supply is planned as shown in the preceding slide
- Cooling Water
  - Prepare designs for the cooling water needed for the new bus runs.
    - Design is using the existing drawings with revision

CONCLUSION

- Bakeout
  - 0-6V, 6kA DC Power Supply shall be purchased and used
  - Pwr. Supply to be with Rollers
  - Use 6 cables for each pole.
  - Cost based on input from vendors and previous experience.
  - Ready to proceed to Procurement & Installation.
- Cooling Water
  - Upgrade is a modest upgrade to the existing system using the same water pumps and piping system
- Gas Injection
  - Design is complete and ready for fabrication