COUPP-60 Installation and Operations SNOLAB Safety Review

Hugh Lippincott
May 18

COUPP-60

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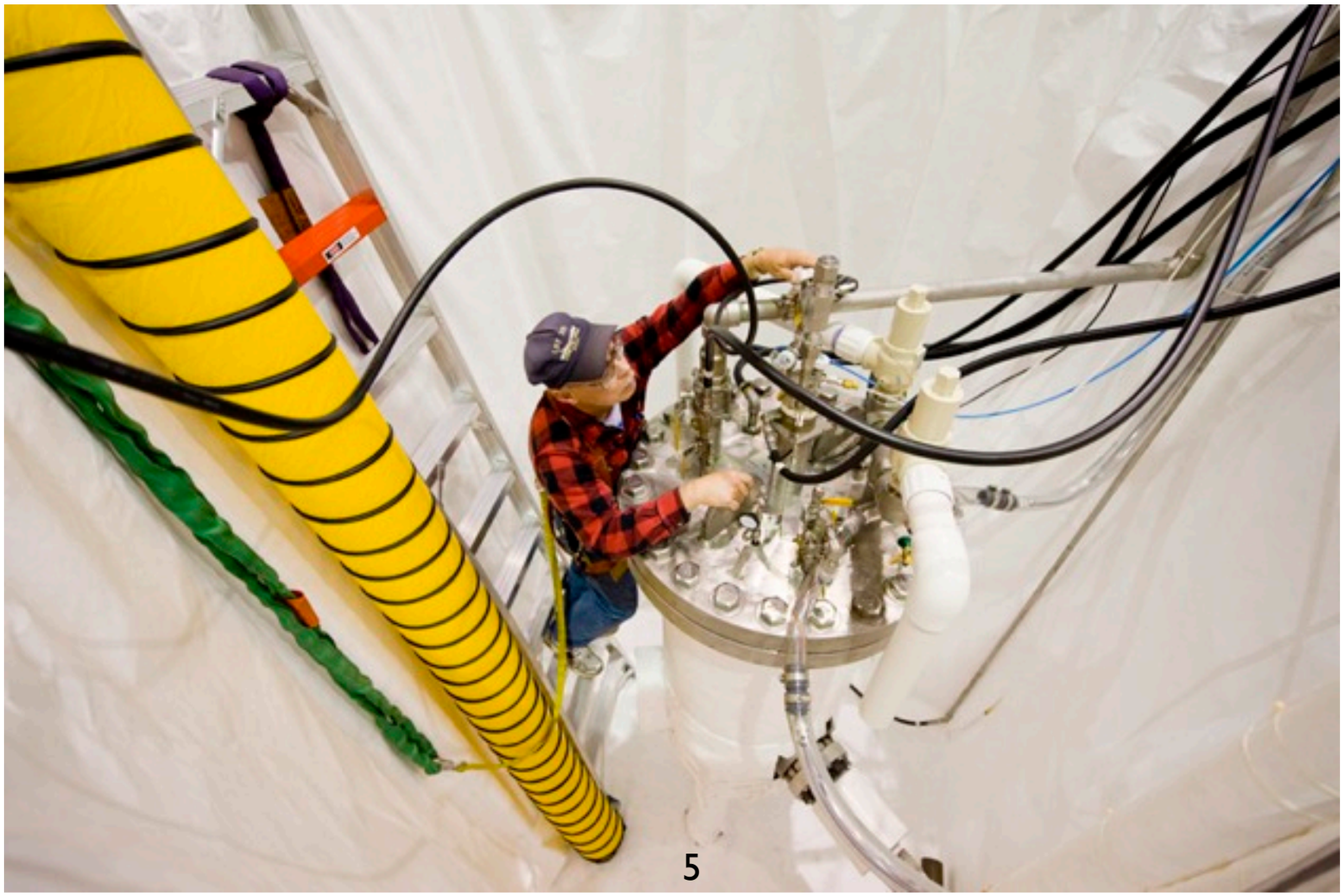

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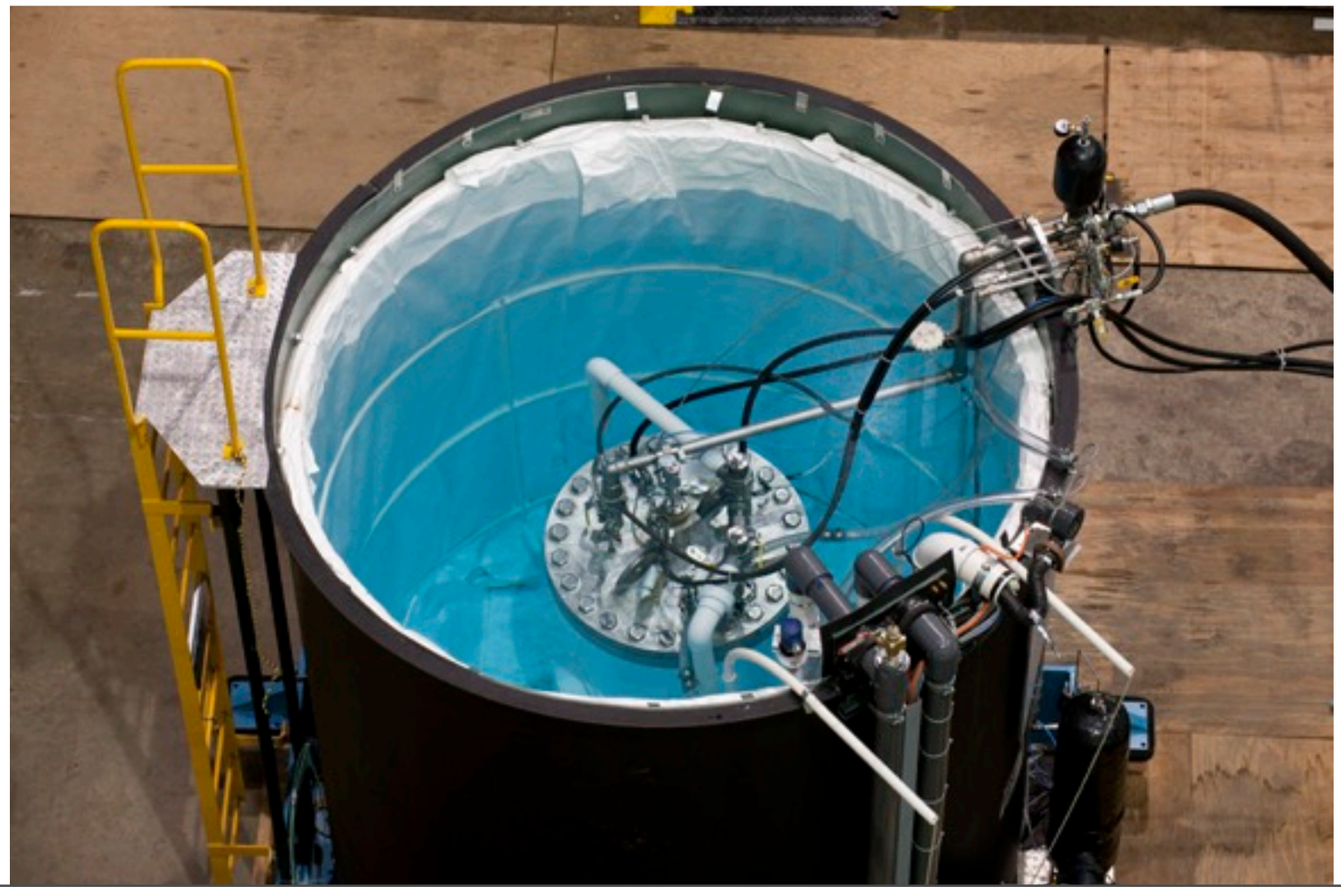

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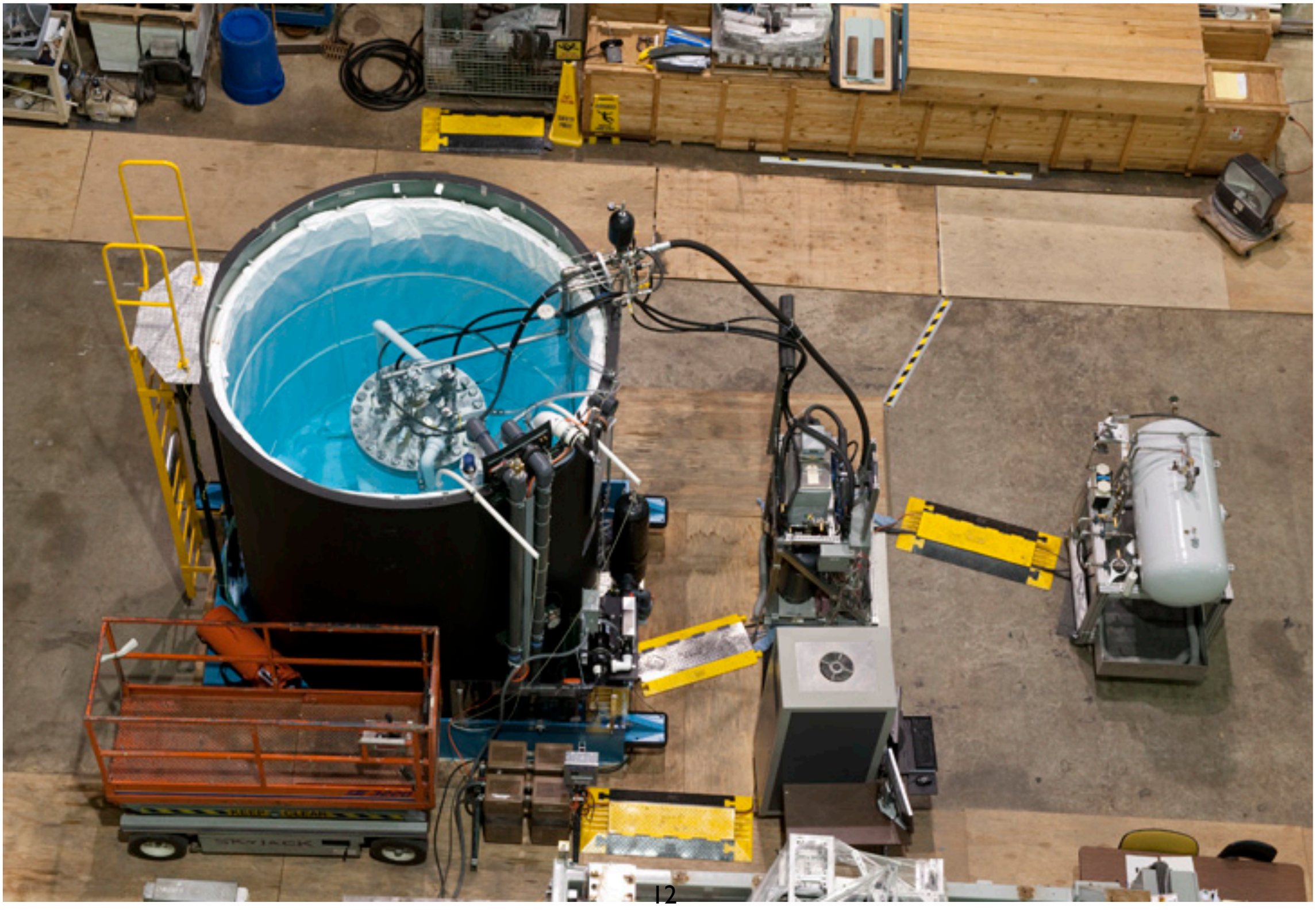
  - Degassing tank - storage of hydraulic fluid (propylene glycol), degassing of fluid
  - Distillation or High purity fluid cart (HPFC) - storage of CF3I, source of distillation into the IV
  - Water pump - for temperature control of water bath ("Spaguts")
  - Electronics rack

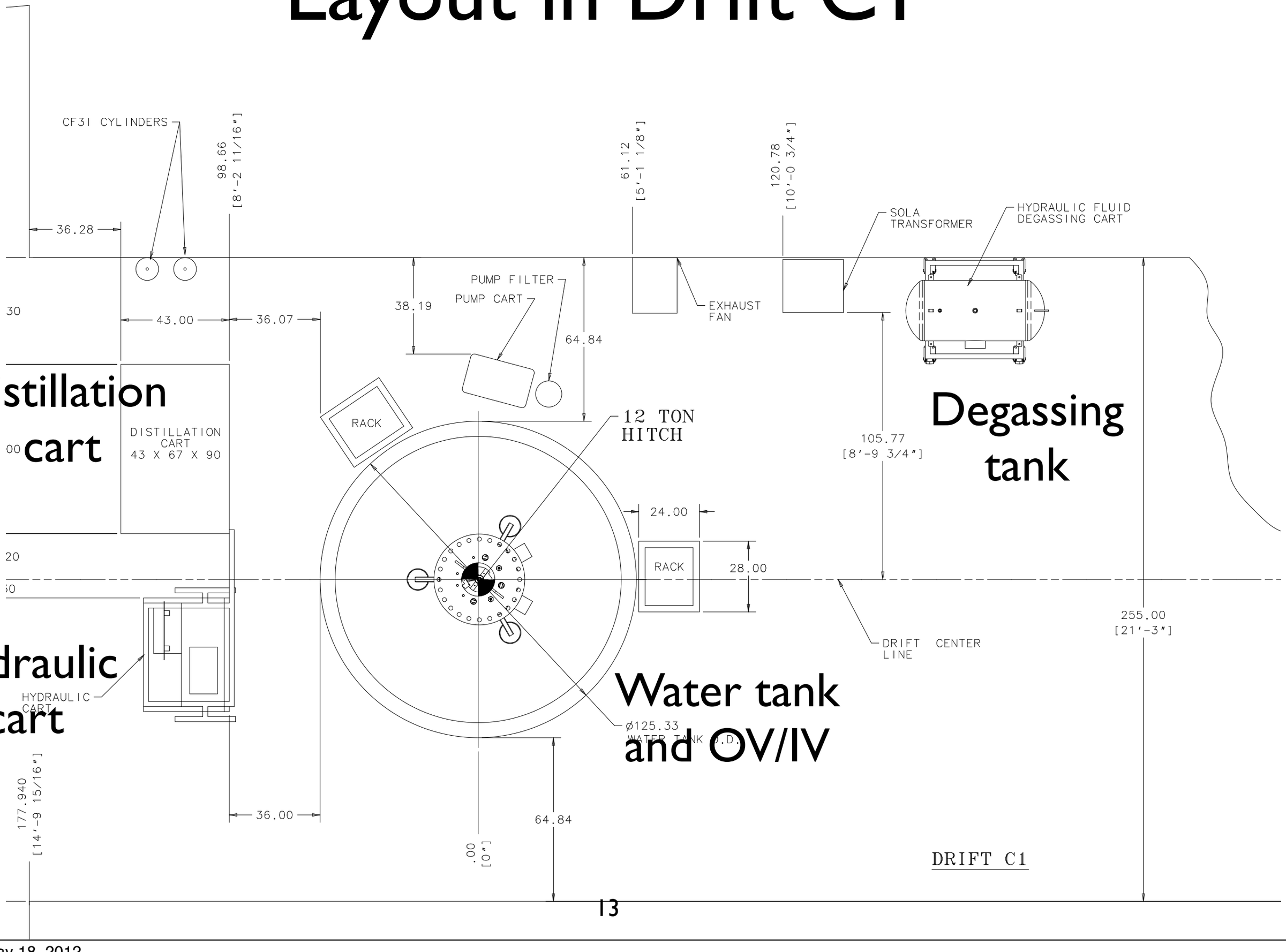
Installation

- Get each piece of equipment underground, placed and connected
- General manpower guidelines
  - Fermilab scientist(s) present for majority of activities outside of water tank construction, including all sensitive operations
  - Requests/Expectations for SNOLAB contribution
    - Bringing equipment underground and into lab (~10 large items, of which 2 require considerable care)
    - Anything involving water tank panels and perimeter plates will be performed by SNOLAB techs (at least 1 cycle of assembly/disassembly/assembly for the water tank panels)
    - Additional heavy lifting (e.g. RBK boom crane) also performed by SNOLAB techs (~6 operations involving the boom crane)
  - 4 weeks (3+1 training) for 2 Fermilab technicians
    - Majority of prefab piping put together by those who built it
    - Inner vessel installation supervised by Fermilab technicians responsible for previous inner vessel operations

Installation



Layout in Drift C1



Schedule for installation

- From now until June 6 – SNOLAB technicians continue water tank installation
  - Finalize exact placement in the drift
  - Lay down bottom layer of foam (currently 4”)
  - Finish inner and outer tank walls
  - Install insulation
  - Remove access section
  - Tank liner installed
  - Initial proposal for protecting the liner during work
  - Proposal for easy access to tank also finalized (stairs over the bottom section of tank is current plan)

Schedule for installation

Schedule for installation

- June 6-15 (8 shifts) - Andrew Sonnenschein on site (training)
- In the meantime, water tank construction continues with SNOLAB technicians, with Eric Vazquez Jauregui and Andrew S. when not being trained
  - Installation of the perimeter plates, except for plate C above the access hole (3-5 shifts)
    - 1" Polypropylene sheets arrive at SNOLAB and are brought underground (2 days)
    - 1" steel plate arrives at SNOLAB and is brought underground (2 days)
    - Pressure vessel arrives is brought underground (2 days)
- From June 18-22 (5 shifts) - Andrew Sonnenschein, Eric Vazquez Jauregui + SNOLAB technicians
  - Both poly sheets and steel plate are placed on the bottom of the water tank on the liner (1-2 shifts)
  - Pressure vessel is placed on stand on steel plate inside water tank (2-3 shifts)

Schedule for installation

- June 25-July 9 (9 work days) - No Fermilab presence at SNOLAB
  - Hydraulic cart arrives and is brought underground (1-2 days)
  - Degassing tank arrives and is brought underground (1-2 days)
  - All prefab piping materials are brought underground (1-2 days)
  - Pressure vessel top flange is brought underground (1-2 days)
  - Water pump and heater (Spaguts) brought underground (1-2 days)

Schedule for installation

- July 9–July 20 (10 work days) – Hugh Lippincott on site (one day of training necessary).
- July 9–July 13 (HL, Eric Vazquez Jauregui, 2 SNOLAB techs)
  - Connect water piping to water tank (1 shift)
  - Install water tank temperature sensors (1 shift)
  - Pressure vessel viewport tubes (1 shift)
  - Hookup water, electricity, air to hydraulic cart and water pump
- July 16–July 20
  - No planned activity

Schedule for installation

- July 23-July 27 - No planned COUPP physicist presence on site - 2 Fermilab technicians arrive for training
  - No planned activity underground
- July 30-August 3 (Eric Dahl, Andrew Sonnenschein, Eric Vazquez Jauregui, 2 Fermilab techs)
  - Install valve box on water tank (1/2 shift)
  - Connect hydraulic lines from cart to valve box to perimeter plate (1 shift)
  - Install temperature sensors in OV (1/2 shift)
  - Attach top flange to pressure vessel (1 shift)
  - DAQ work to prepare for glycol filling

Schedule for installation

- August 6-August 17 (Hugh Lippincott on site)
  - Begin propylene glycol operations (see procedures later in this talk)
    - Leak checks, fill degassing tank, hydraulic cart, pressure vessel with glycol, leak checks, perform first manual expansions (5 shifts)
  - Begin DAQ cycling of chamber (1 shift)
  - Complete water tank and perform water fill of water tank (2 shifts, with help from SNOLAB technicians)

Schedule for installation

- August 6-September 10 in parallel with pressure cycling (HL, Erik Ramberg, Del Allspach?, SNOLAB technicians)
  - Bring high purity fluid cart underground (3 days)
  - Inner vessel is brought underground (3 days)
    - See COUPP-docdb-690 for preliminary shipping plan of inner vessel, in addition to basic handling procedure
  - CF3I alarm system installed (2 shifts)
  - Venting and ductwork (15 shifts?)
  - Alarm system tests (1 shift)

Schedule for installation

- Sept. 10-14 – Hugh Lippincott or Andrew Sonnenschein on site, 2 SNOLAB techs required for water tank panel removal
  - Drain water tank (1 shift)
  - Drain glycol back into degassing tank (1 shift)
  - Disconnect piping from pressure vessel to perimeter plates (1 shift)
  - Remove access panels of water tank (2 shifts)

Schedule for installation

- Sept. 17-28 - Hugh Lippincott, Andrew Sonnenschein, 2 Fermilab technicians on site, with 2 SNOLAB techs
  - Attach acoustic sensors to inner vessel (2 shifts)
  - Connect fill line from high purity fluid cart to perimeter plates (1 shift)
  - Attach camera package to pressure vessel (2 shifts)
  - Insert reflector into pressure vessel (1 shift)
  - Attach inner vessel to top flange and nest into pressure vessel (2 shifts)
    - Follow procedure in COUPP-doc-194
  - Re-connect piping from OV to perimeter plates (1 shift)
  - Leak checking of fill line (1 shift)
  - Connect heating tape and insulation to fill line (1 shift)

Schedule for installation

- Oct. 1–Oct. 5 (Fermilab personnel not yet assigned)
  - Water fill of high purity fluid cart (2 shifts)
  - CF3I storage cylinders brought underground (2 days)
  - Begin commissioning operations

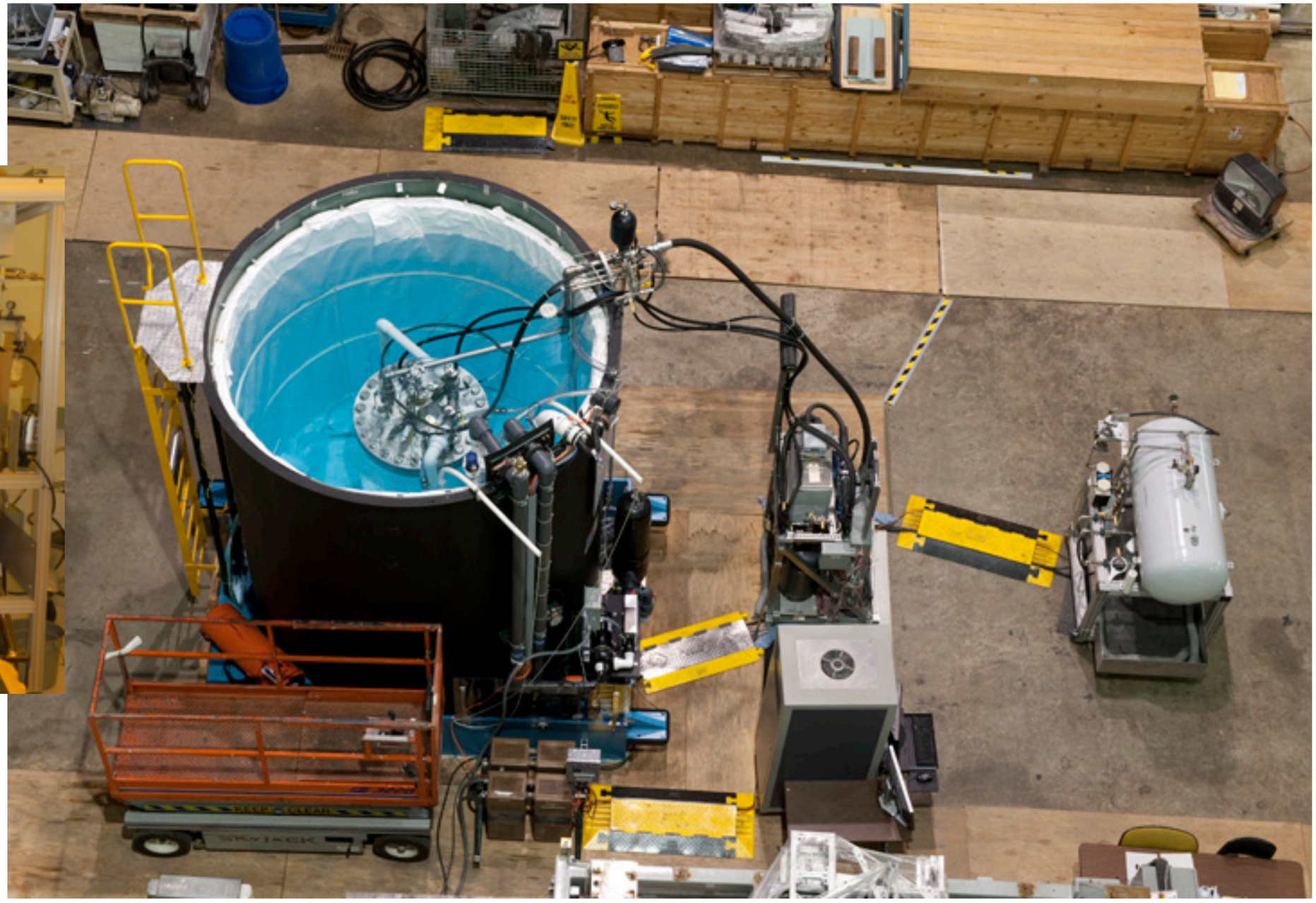
Safety notes on Installation

- Operations include:
  - General construction sequences (water tank, pipe connections) that do not need special safety considerations
  - Use of RBK boom crane by trained SNOLAB personnel only
  - Work performed on top of water tank
    - Harness, fall protection
- For sensitive work involving safety hazards or hazards to the experiment, full written procedure will be approved and followed
  - E.g. Operations involving the inner vessel will follow procedure in COUPP-doc-194 (currently describes removal of inner vessel, but will be updated and inverted to describe re-installation)

Bubble chamber operations

- General propylene glycol handling
  - Fill degassing tank with glycol
  - Evacuate and fill diaphragm tank
  - Evacuate hydraulic cart, lines, pressure vessel
  - Test interlocks
  - Fill pressure vessel and hydraulic lines
- Pressurize system
- Distill water into IV
- Transfer CF3I from transport vessel into high purity fluid cart
- Distill CF3I into IV
- Fill water tank and ramp to operating temperature
- Regular operation
- Emergency procedures

Bubble chamber operations



Operations Manual COUPP-doc-693

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[1] A written procedure must be followed explicitly.
[2] This class is for documents that are crucial to the procedure package.
[3] The hydraulic fluid is polypropylene glycol (see MSDS)

COUPP-60 Bubble Chamber: v. 10 May 18, 2012, H. Lippincott

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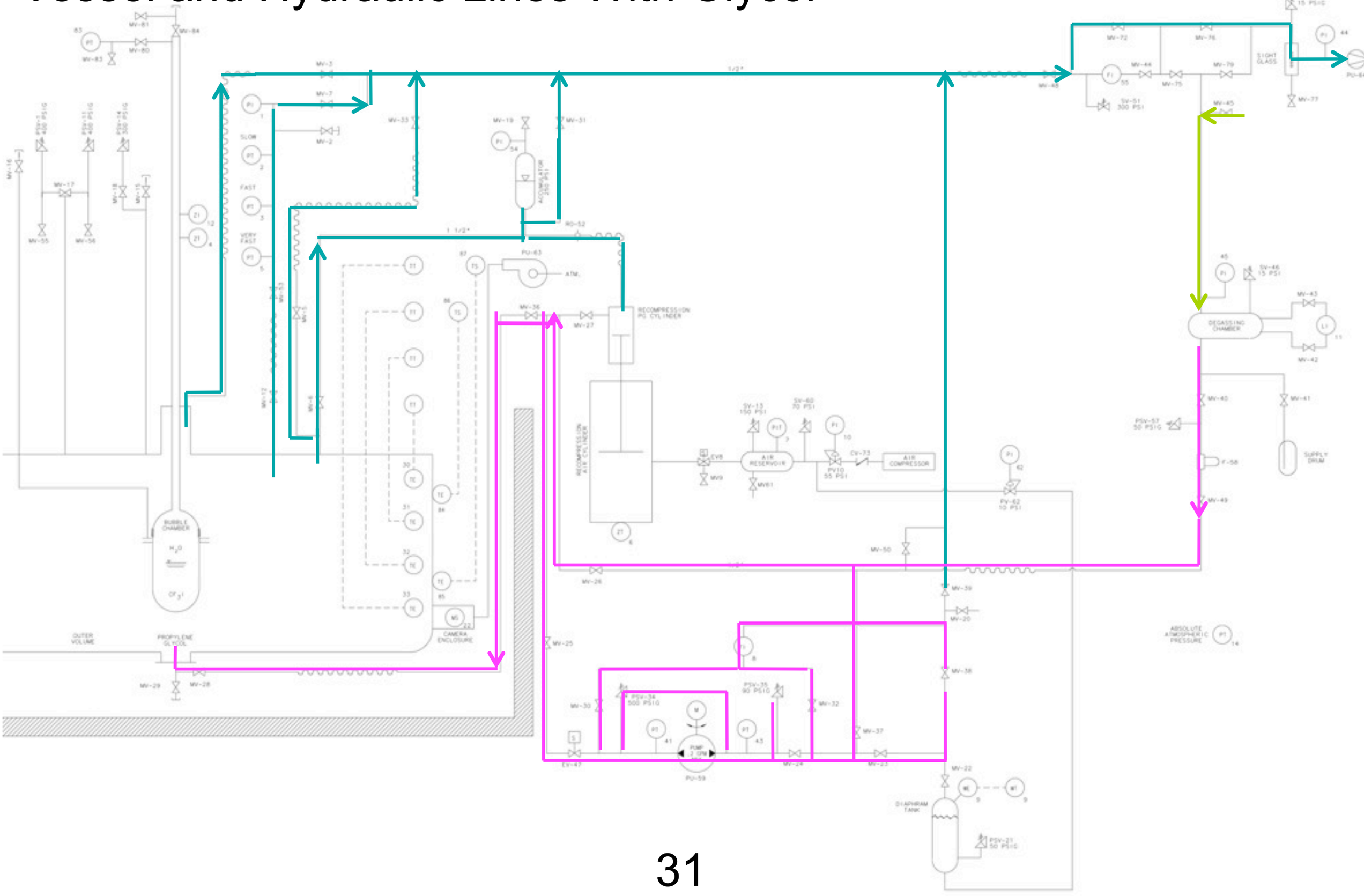
General notes

- All operations have or will have an updated written procedure before any work is done
    - Where necessary a Job Hazard Analysis or SNOLAB equivalent will be performed
- Procedures will include qualifications required to perform operation
- Procedures will contain instructions in case of accident or system failure

Glycol handling (no IV)

- Operations include:
  - Fill degassing tank with glycol
  - Evacuate and fill diaphragm tank
  - Evacuate hydraulic cart, lines, pressure vessel
  - Test interlocks
  - Fill pressure vessel and hydraulic lines
- Procedures described in "3.1 General Glycol Handling Procedures", COUPP-doc-194 with associated flow diagrams
  - Procedure up to date. Flow diagrams and valve lineups need minor updates to reflect valve additions
- Operations performed only by COUPP collaborators

Example Flow Diagram for Glycol Procedure No. 6. “Fill Pressure Vessel and Hydraulic Lines With Glycol”



Glycol handling (no IV)

Hazards	Mitigation
Glycol leak or spill	Glycol is not significantly more hazardous than water System leak check before filling with glycol Secondary containment for degassing tank, hydraulic cart and pressure vessel (water tank) Primary concern is slip hazard. Any spills outside of secondary containment will be cleaned following "1.1 Glycol Spill Cleanup Procedure", http://coupp-docdb.fnal.gov/cgi-bin/ShowDocument?docid=293
In case of fire alarm	If using the vacuum pump, operator will turn off pump and walk away. If using the glycol pump, operator will disable pump and walk away
Unplanned power outage	Pumps will shut off automatically. Operator can walk away.

Pressurize system with glycol (no IV)

- Operations include:
  - pressurizing pressure vessel
  - pressure testing of entire system with no inner vessel
- Procedure described in “3.2 Pressure Test Procedure” - COUPP-doc-194 (Revised May 14, 2012)
- Operations initiated by COUPP collaborators, system left in remote operations for several weeks

Pressurize system with glycol (no IV)

Hazards	Mitigation
Glycol leak or spill	Glycol is not significantly more hazardous than water System leak check before filling with glycol. All connections will be visually inspected during initial stage to look for leaks. Pressure and weight of diaphragm tank can be monitored remotely for evidence of leaks. Secondary containment for degassing tank, hydraulic cart and pressure vessel (water tank) Primary concern is slip hazard. Any spills outside of secondary containment will be cleaned following "1.1 Glycol Spill Cleanup Procedure", http://coupp-docdb.fnal.gov/cgi-bin/ShowDocument?docid=293
In case of fire alarm	No operations needed, system can be unattended
Unplanned power outage	Normal fail safe state will occur (compressed state). If the system is warm, it will equilibrate to room temperature. If this is significantly warmer than the temperature at power outage, relief valves will open, relieving the pressure.

Distill water into IV

- Operations include:
  - heating of high purity fluid cart and line to IV for distillation
  - operation of hand valve above pressure vessel
  - several days required
- Procedure "4.1 Distill Water into IV" in COUPP-doc-194 (Revised May 14, 2012)
- Operations initiated and monitored by COUPP collaborators, but can be left unattended for up to 48 hours at discretion of primary operator

Distill water into IV

Hazards	Mitigation
Operation of valves inside water tank	Follow safety procedures defined for such work, including fall protection, confined space procedures (if water tank is closed up)
Use of line heater provides fire hazard	All fuel sources kept away from line. Heater will be wrapped in flame retarding insulation. Line protection to prevent drawing too much current
In case of fire alarm	No operations needed, system can be left unattended. If possible, manual valve from fluid cart to inner vessel will be closed.
Unplanned power outage	System can be left unattended. If possible, manual valve from fluid cart to inner vessel will be closed.

Transfer CF3I from transport vessel to fluid cart

- Operations include:
  - Connection of line from vessel to cart
  - Mild heating of the transport vessel (can be obtained with a heat gun or heating tape
- Procedure - “4.2 Transfer CF3I from transport vessel” in COUPP-doc-194 (Dated May 15, 2012)
- Operations initiated and monitored by COUPP collaborators. Heat applied only in presence of COUPP collaborators, otherwise can be left unattended

Transfer CF31 from transport vessel to fluid cart

Hazards	Mitigation
CF31 leak	Use of leak monitor to observe any leaks. Fluid cart contained in secondary enclosure with vent pipe. In case of leak, follow the CF31 leak procedure outlined by Del Allspach in doc...
Use of external heater provides fire hazard	All fuel sources kept away from heater. Line protection to prevent drawing too much current
In case of fire alarm	Turn off any heat source if in use. Close valve from vessel to fluid cart and walk away. In emergency, can just walk away.
Unplanned power outage	If possible, close valve from vessel to fluid cart. Walk away.

Distill CF31 into inner vessel

- Operations include:
  - Operation of valves in water tank
  - Heating of high purity cart tanks
  - Chilling of pressure vessel glycol
- Procedure - “4.3 CF31 fill procedure”, in COUPP-doc-194
  - Last performed Oct. 2011, last revised July 10, 2010. Requires updating to reflect new valves, some procedural changes
- Operations initiated and monitored by COUPP collaborators, no unattended operation - 1-2 shifts

Distill CF3I into inner vessel

Hazards	Mitigation
CF3I leak	Use of leak monitor to observe any leaks. Fluid cart and valve box contained in secondary enclosure with vent pipe. In case of leak, follow the CF3I leak procedure outlined by Del Allspach in doc...
Operation of valves inside water tank	Follow safety procedures defined for such work, including fall protection, confined space procedures (if water tank is closed up)
In case of fire alarm	Close valve from high purity cart to inner vessel and walk away.
Unplanned power outage	If possible, close valve from vessel to fluid cart and walk away. Distillation will stop. Glycol and IV will warm up and reach equilibrium at the vapor pressure of CF3I. No other danger.

Fill water tank

- Operations include:
  - Filling of water tank
- Procedure does not exist yet, will be written with assistance of SNOLAB personnel
- Operations initiated and monitored with help of SNOLAB personnel
- Minimal safety risks

Fill water tank

Hazards	Mitigation
Drowning	Do not go into water tank while filling
In case of fire alarm	Turn off water
Unplanned power outage	Turn off water

Ramp to operating temperature

- Operations include:
  - Passive temperature change
  - Potentially necessary to burping of water from top of pressure vessel, requiring tank entry
- Procedure - Last component of "4.3 CF3I fill procedure", COUPP-doc-194.
- Main requirement is monitoring.
- Significant experimental risks, possible operation of valves from inside water tank
- COUPP collaborators only

Ramp to operating temperature

Hazards	Mitigation
CF3I leak	Use of leak monitor to observe any leaks. Fluid cart and valve box contained in secondary enclosure with vent pipe. In case of leak, follow the CF3I leak procedure outlined by Del Allspach in CF3I safety document
Operation of valves inside water tank	Follow safety procedures defined for such work, including fall protection, confined space procedures (if water tank is closed up) If water tank is mostly full of water, additional precautions against fall into water
In case of fire alarm	If no power outage, system is safe on its own. Walk away.
Unplanned power outage	Loss of temperature control. If temperature is below room temperature, system will remain compressed. Relief valves may open, but no danger to experiment. If temperature is above room temperature, glycol and CF3I volumes will compress, and eventually reach equilibrium at vapor pressure of CF3I. System is safe in absence of large glycol leaks.

General operation

- Operations include:
  - Pressure cycling
- Procedure - “5.2 COUPP-60 normal operations”, COUPP-doc-194
- Operations initiated by COUPP collaborators, but remote operations will require SNOLAB monitoring to be outlined in “SNOLAB Checklist”
- See “What if” analysis, COUPP Manual 2.6, COUPP-doc-192 (needs updating for SNOLAB)

General operation

Hazards	Mitigation
CF3I leak	Use of leak monitors and alarms to observe any leaks. Fluid cart and valve box contained in secondary enclosure with vent pipe. In case of leak, follow the CF3I leak procedure outlined by Del Allspach in CF3I safety document
Glycol leak	Same issues as previously, except now with potential experimental damage. New isolation valve can isolate hydraulic cart and tank from the pressure vessel. If the leak is in the pressure vessel itself, potential for damage to the bellows. A fast draining of the water tank is a likely necessity for temperature control and to try to fix any leak as it develops (see "WHAT IF" scenarios, coupp-doc-192).
In case of fire alarm	If no power outage, system is safe on its own. Walk away.
Unplanned power outage	Loss of temperature control. Glycol and CF3I volumes will contract as temperature drops and system may end up in equilibrium at vapor pressure of CF3I. System is safe in absence of glycol leaks.

Other considerations

- Planned power outage requires no action except to halt active cycling
- In unplanned power outage, system will revert to safe "compressed" state.
- Barring leaks in the pressure vessel, hydraulic cart or inner vessel, system can stay isolated with no power indefinitely.
    - Hydraulic cart leaks can be isolated, but requires either power or manual operation of a valve inside the water tank
    - If pressure vessel leaks, likely damage to bellows, leak of CF3I into water tank
    - If inner vessel leaks, release of CF3I into water tank
- Alarm responses have not been fully worked out
    - First draft of CF3I alarm response described in CF3I Safety Document