DEPARTMENT OF MECHANICAL ENGINEERING

Name of SOP	EHD Two Phase Loop
Effective Date	22/05/2014
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Reason for SOP	Risk of burn Risk of high pressurized refrigerant being released Risk of electrical shock
Approved by (supervisor)	Dr. Cotton / Dr. Ching
Date reviewed by (JHSC)	June 11, 2014

Definitions

Terms	
Acronyms	EHD - Electrohydrodynamics RMM – Risk Management Manual JHSC – Joint Health and Safety Committee Chair – Chair of Mechanical Engineering EOHSS – Environmental Occupational Health & Safety Service

Requirements

Applicable OHSA regulations and / or codes of practice

1. OHSA Code
2. McMaster University Risk Management Policies

Training and Competency

1. All users must have a valid Ozone Depletion Prevention Card to charge the loop with R134a
2. All users must have gas cylinder training
3. All users must have training provided by Thermal Management Research Laboratory Staff
4. All users must display competency after training

Description of the Task

Location and time of work	JHE 106B during normal working hours
Individuals and skills required	Graduate Students, see requirements
Equipment and supplied required	120 VAC Variac Trek High Voltage power supply (model 20/20C) Miller Welder (CST 250) LTM Luxarc 200W Lamp Yellow Jacket refrigerant recovery pump Vacuum pump
Personal protective equipment required	Goggles when charging

Sequential steps to complete the work safely

General Safety Instructions

1. All users must obey the safety instructions and warnings posted on the loop.
2. The operator should only access the test facility work area.
3. All users must *not* disconnect any refrigerant lines, fittings or mechanical supports from the loop while the loop is charged/pressurised (see loop pressure gauges)

4. Make sure the test section is grounded before turning on the high voltage power supply
5. Turn off the high voltage power supply in case any sudden increase in the output current
6. If the refrigerant alarm goes off
7. Minor leak (within test rig)
   Isolate leak with valves, open the windows, shut off heater, leave the room and report fault to the technicians in JHE205
8. Major leak (from refrigerant cylinder or recovery pump)
   Leave the room immediately and call security (dial 88)

Specific Instructions for charging the loop

1. Open all the valves, taking care on the pressure transducer loop (See schematic 1)
2. The loop must be leak tested before the loop can be charged. It must hold 100 psi of nitrogen gas for three days.
3. Set up the refrigerant manifold with the refrigerant cylinder and vacuum pump according to the Yellow Jacket charging procedure
4. Vacuum the rig
5. Slowly charge the rig with R134a to 80 psi
6. Close the required valves for convective boiling operation (schematic 2)

Specific Instructions for running the loop

1. Turn on the computer with the National Instruments data acquisition programs and run the program “main_program.vi” to monitor liquid and vapour line temperatures throughout the loop.
2. Set-up ice bath in thermocouple cold junction for accurate thermocouple readings
3. Turn on water supply to the condenser
4. Turn on Variac and adjust to desired refrigerant mass flow rate.
5. Make sure that the knob for adjusting the welder current is at the zero current.
6. Turn on the welder and adjust the output current to desired inlet quality. Do not exceed the maximum allowable current and voltage levels for the given mass flow rate (check allowable in dry-out tables)
7. Make sure the test section water heater is set to room temperature
8. Turn on the test section water heater and set to desired water temperature
9. Make sure that the controller of the high voltage power supply is at the zero volts.
10. Turn on the high voltage power supply, closely monitor the current (turn off the power supply for any sudden increase) and adjust slowly to the desired voltage
11. Turn on the LTM Luxarc lamp only during image capturing periods to avoid overheating. Do not continuously operate the light for long periods of time (> 5 min)

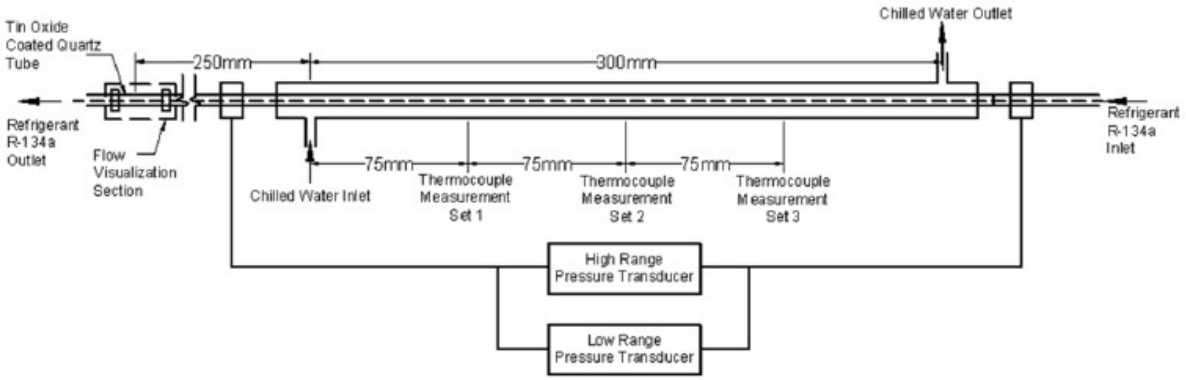
Specific Instructions for shutting down the loop

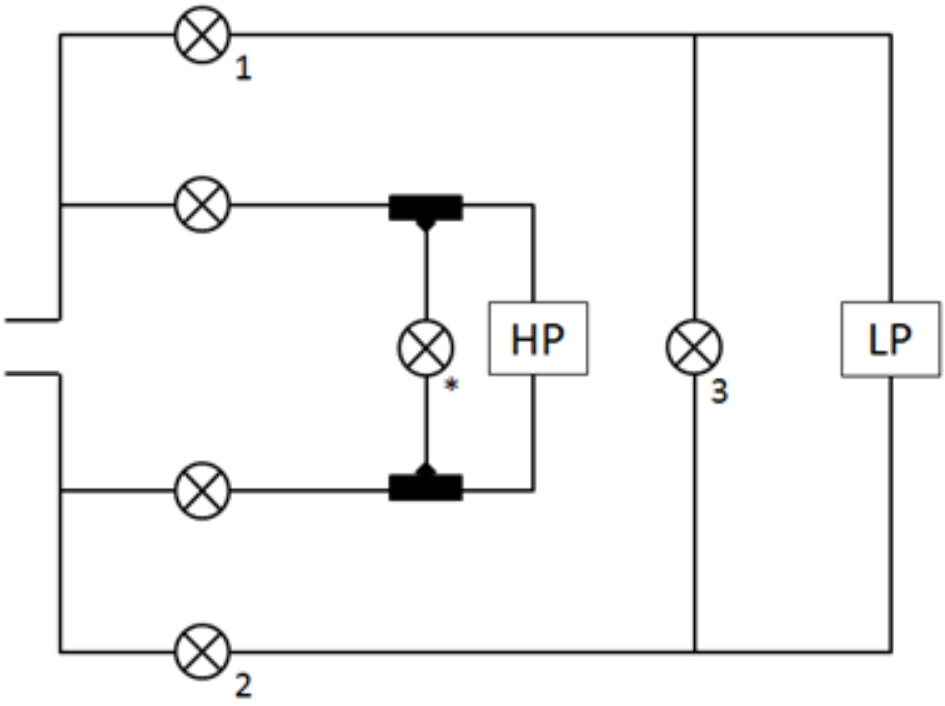
1. Turn off the lamp and high voltage sources
2. Slowly reduce the welder output current until it reaches zero
3. When the temperatures of the rig reach room temperature, turn off the

variac and the water supply to the condenser
4. Turn off the computer
5. Make sure that the high voltage power supply and welder are turned off after the experiment.

Specific Instructions for discharging the loop

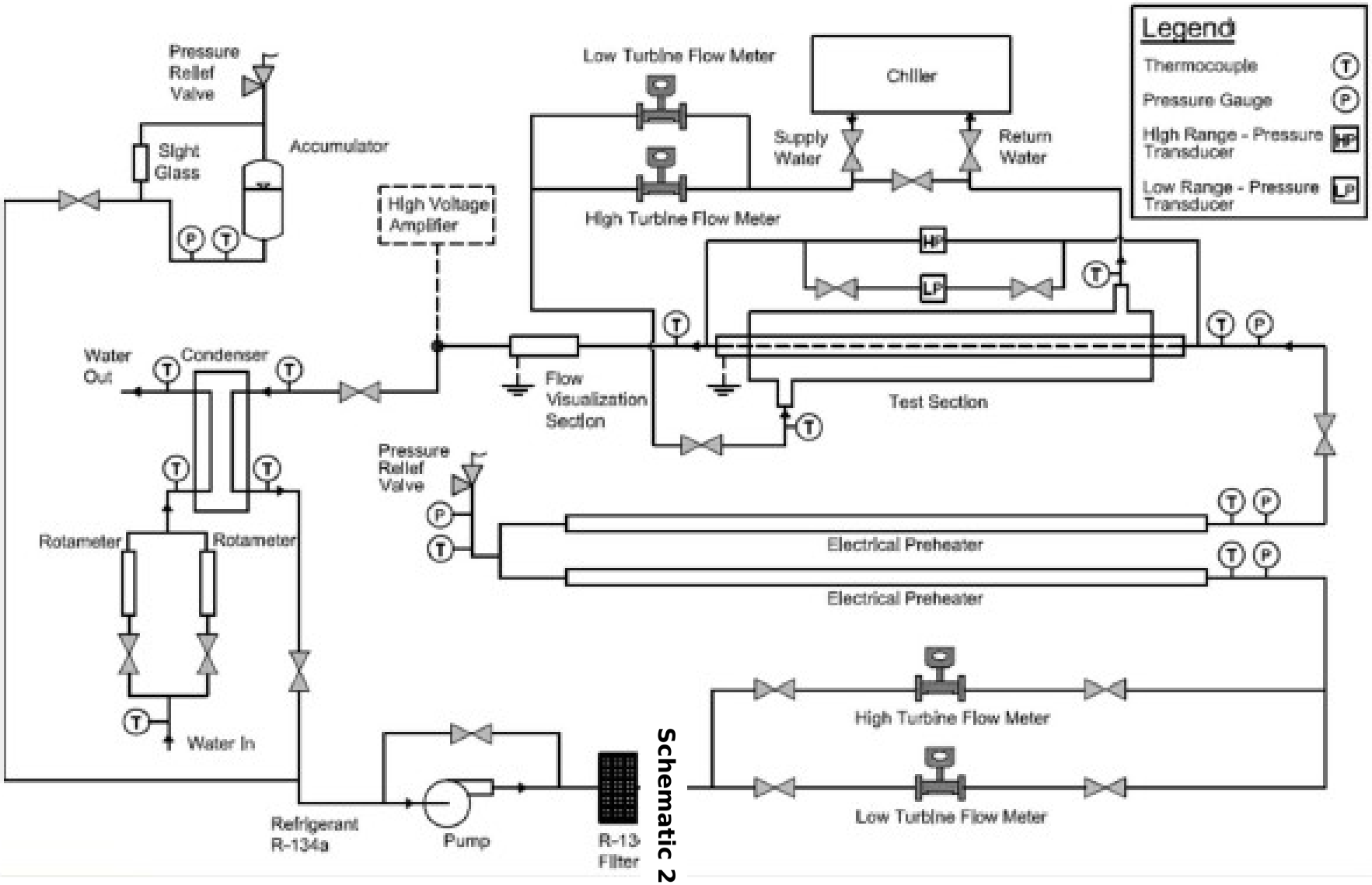
1. Ensure that there is no power or heat going to the rig
2. Set up the refrigerant manifold with the recovery pump according to the Yellow Jacket discharging procedure
3. Open all of the valves, taking care with the pressure transducer loop (See schematic 1)
4. Discharge the rig





* Always closed
High -> Low: Open 1 & 2, then close 3
Low -> High: Open 3, close 1 then 2

Schematic 1: Pressure Transducer Loop



Schematic 2: EHD Loop

Contingency Plan & Reporting

Accident / Injury response

1. Apply first aid as required
2. Notify mechanical engineering technical staff immediately
3. For all injuries complete a “Injury/Incident Report” and provide a copy to the Chair and EOHSS
4. In case of critical injury call security (dial 88)
5. In case of critical injury notify EOHSS immediately, ext 24352

Spill Response

1. Isolate the area leaking using the appropriate valves if safe to do so. Avoid any skin contact with leaked refrigerant. Ensure adequate safety protection when operating valves (gloves, eye protection)
2. Reclaim remaining refrigerant from loop using Yellow Jacket XLT Recovery System into a recovery cylinder

Environmental Responsibility

Waste disposal procedures

1. Follow operating procedure of Yellow Jacket XLT Recovery System for refrigerant recovery. Only recover refrigerant to a recovery cylinder.
2. Return full recovery cylinders and empty refrigerant cylinders to the designated distributor

Building Air Quality

Leaks will be detected by the refrigerant sniffer and can be seen as drops in pressure from 80 psi on the loop pressure gauges. In the case of a leak. See 7 & 8 in General safety instructions

References (OHSA/regulations, EPA & municipal environmental regulations, McMaster university program/policy, Material Data Sheets)

1. RMM #301 Standard Operating Procedure
2. RMM #300 Safety Orientation and Training Program
3. RMM #310 Eye Protection
4. RMM #309 Laboratory Safety Manual
5. RMM #1000 Reporting & Investigating Injury, Incidents and Occupational Disease

Distribution

1. Trained operator
2. Technical Staff of mechanical engineering
3. Lab supervisor
4. JHSC