

## Appendix C:

### MI LCW System Description



## **Main Injector LCW Repairs**

# **Magnet LCW System Description**

(4-7-98)

The Main Injector Magnet Low Conductivity Water System consists of 6 above ground pumping stations distributed around the circular magnet ring supplying cooling water to the hollow conductor bus of all Main Injector magnets in the tunnel (344 dipoles, 208 quadrupoles, and 100+ smaller magnets) and their power supplies located above ground. The following pages describe in further detail the design of the system from a flow and cooling capacity perspective. Note that schematics are generalized and do not include all existing valves and fittings nor do they accurately describe pipe geometry and valve locations.

All of the piping components are 304L stainless steel welded with 308L filler metal. The vast majority of piping is seam welded 6 inch nominal pipe size, schedule 10 pipe. The magnet bus (not yet connected to the stainless steel piping) is constructed from OFHC copper. The stainless steel piping system has approximately 5,412 welded connections, most of these are girth butt welds and some 5% are on smaller 2" pipe size extruded tee connections (called goosenecks by Fermi personnel). Larger pipe (up to 14 inch nominal pipe size) exists in the pumping stations to accommodate the higher flow rates.

One of the six pumping stations (called MI-60) includes a filling station (presently limited to 30 gpm) and a 3,000 gallon reservoir tank. Each station includes a large tube and shell heat exchanger (also 304L stainless steel) and a de-ionizing (DI) and filtering circuit. About 10% of the system flow is diverted into the DI circuits. All 6 pumping stations are connected through the tunnel via the return and supply headers, although a net flow of only about 110 gpm is predicted between adjacent pumping stations.

The system has a design operating pressure of 150 psi and a design operating temperature of 120° F maximum. Instrumentation includes pressure, temperature, flow, and resistivity. Additional instrumentation for corrosion control is discussed in the System Start-Up, Prevention and Maintenance Section.

# FERMILAB MAIN INJECTOR

## MECHANICAL UTILITIES, & ABORT

John A. Satti

DOE Review

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WBS 1.1.12

LCW SYSTEMS  
COPPER BUS



*Fermilab*

## Review of Design

The proposed system for connecting the power and water to the MIR is similar to the Main Ring.

The Low Conductivity Water (LCW) is a closed loop system and will receive makeup water from the Central Utility Building (CUB).

There will be six utility buildings uniformly spaced along the perimeter of the MIR. In each service building, three pumps in parallel will deliver LCW to the ring. Approximately 9900 Gpm will be available for cooling. The required water for cooling the magnets, Bus, and power supplies is 8000 Gpm.

The hydraulic cell is designed to give the correct flow to allow an average temperature rise of 8°C across each individual magnet.

The normal heat removal capacity per service building in the MIR will be about 2.7 MW.

In each service building, portable, mixed-bed deionizer bottles will be installed. A continuous polishing flow will maintain low conductivity in the water to about 9 MΩ-cm in the enclosure.

Reference: J. A. Satti, "The Fermilab Main Injector Dipole and Quadrupole Cooling Design and Bus Connections", IEEE Trans. May 1995, Particle Accelerator Conference



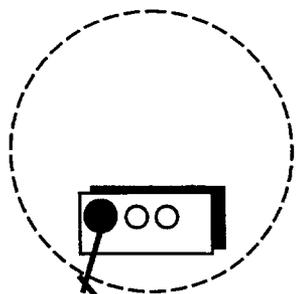
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Existing in CUB

3000 Gal. Stor.

1-DI Column for Main Ring  
1-DI Column for MI Ring

Effluent Disposal



8 GEV LINE

MAIN RING

Use the existing DI columns in CUB to fill the 95° F LCW systems including the storage tanks. Use DI bottles, distributed at service buildings, for polishing action.

1650 GPM

6 DI Bottles

1650 GPM

6 DI Bottles



1650 GPM

6 DI Bottles



MI-30

MI-20

MI-10

MI-8



MIR

3000 Gal. Stor.

1650 GPM

6 DI Bottles

RF

2150 GPM

8 DI Bottles

500 Gal Stor.

MI-40



1650 GPM

6 DI Bottles

MI-50

For P-150

720 GPM

4 DI Bottles

500 Gal Stor.

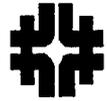
MI-60

MI-52



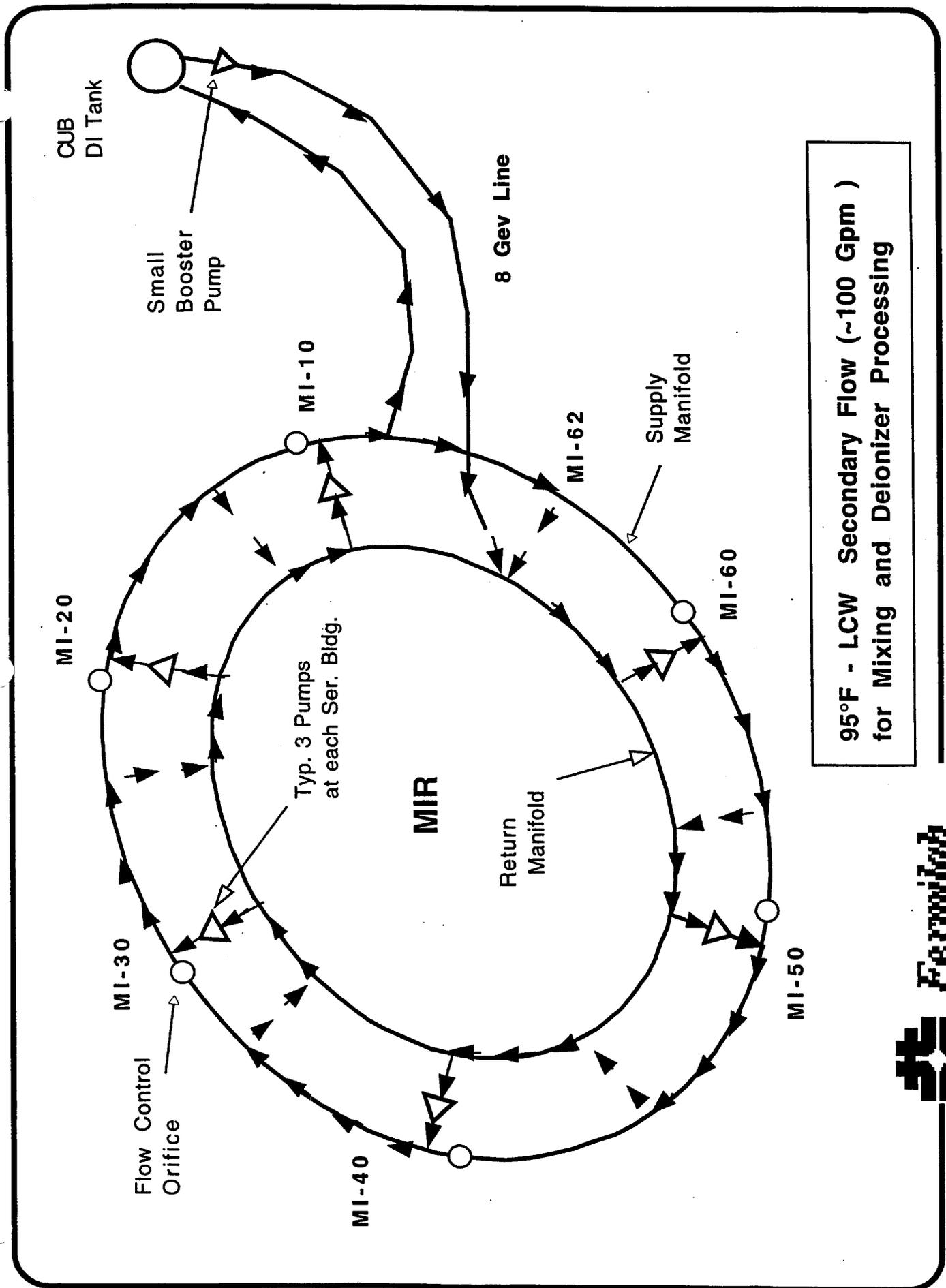
1650 GPM

6 DI Bottles



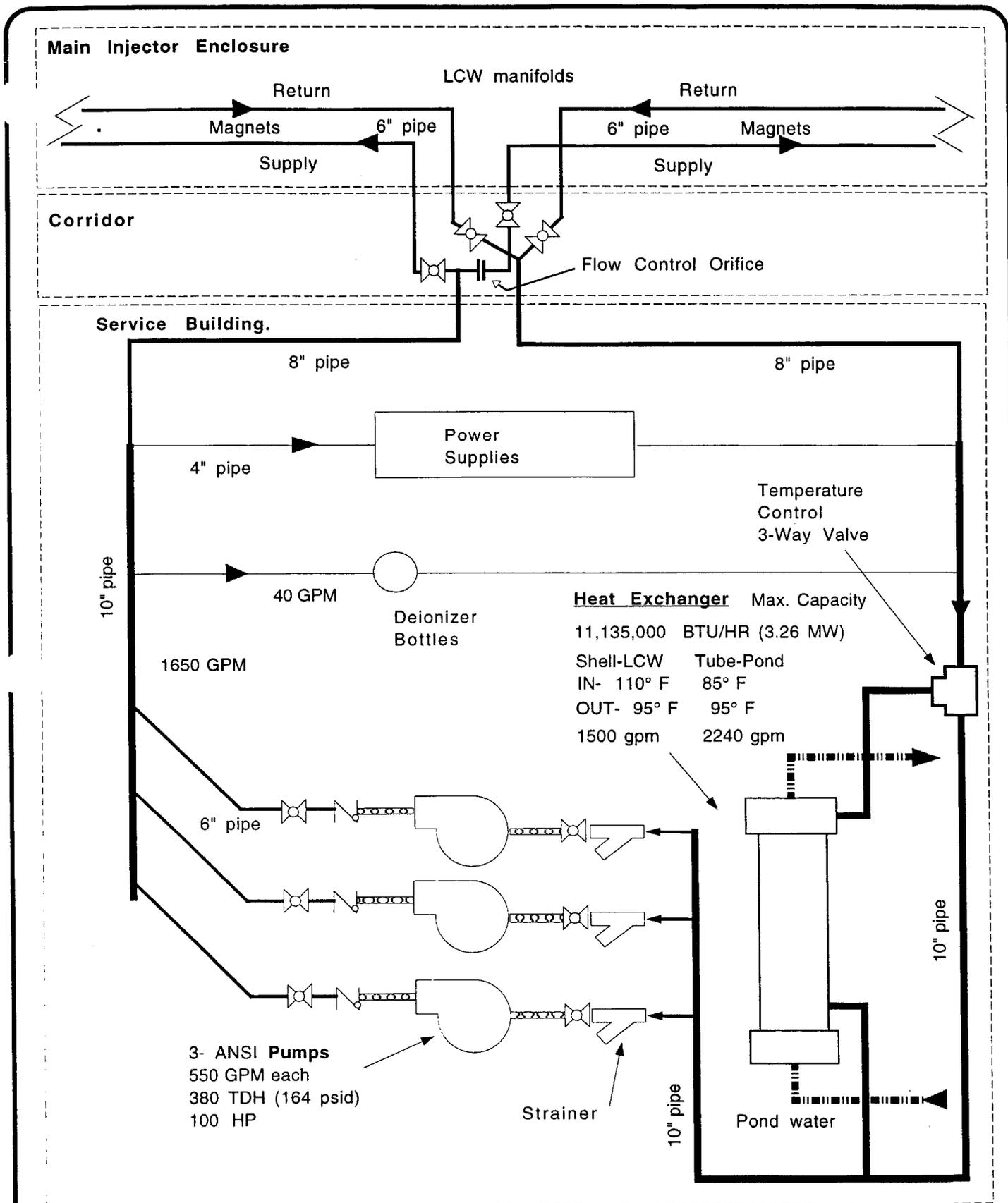
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# Main Injector and Beam Lines 95° F LCW System



95°F - LCW Secondary Flow (~100 Gpm )  
for Mixing and Deionizer Processing

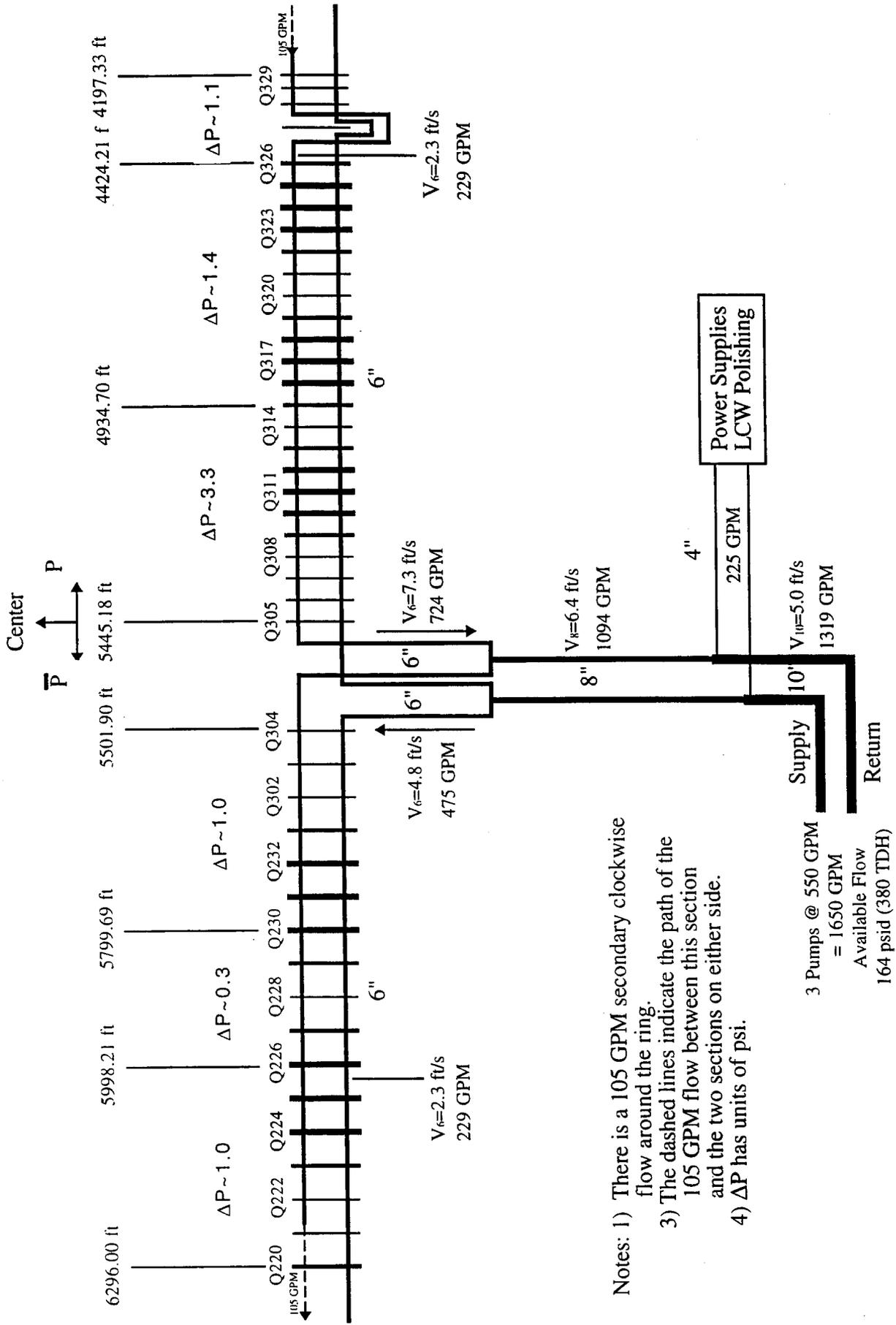




**Typical M.I. Service Building LCW Schematic**



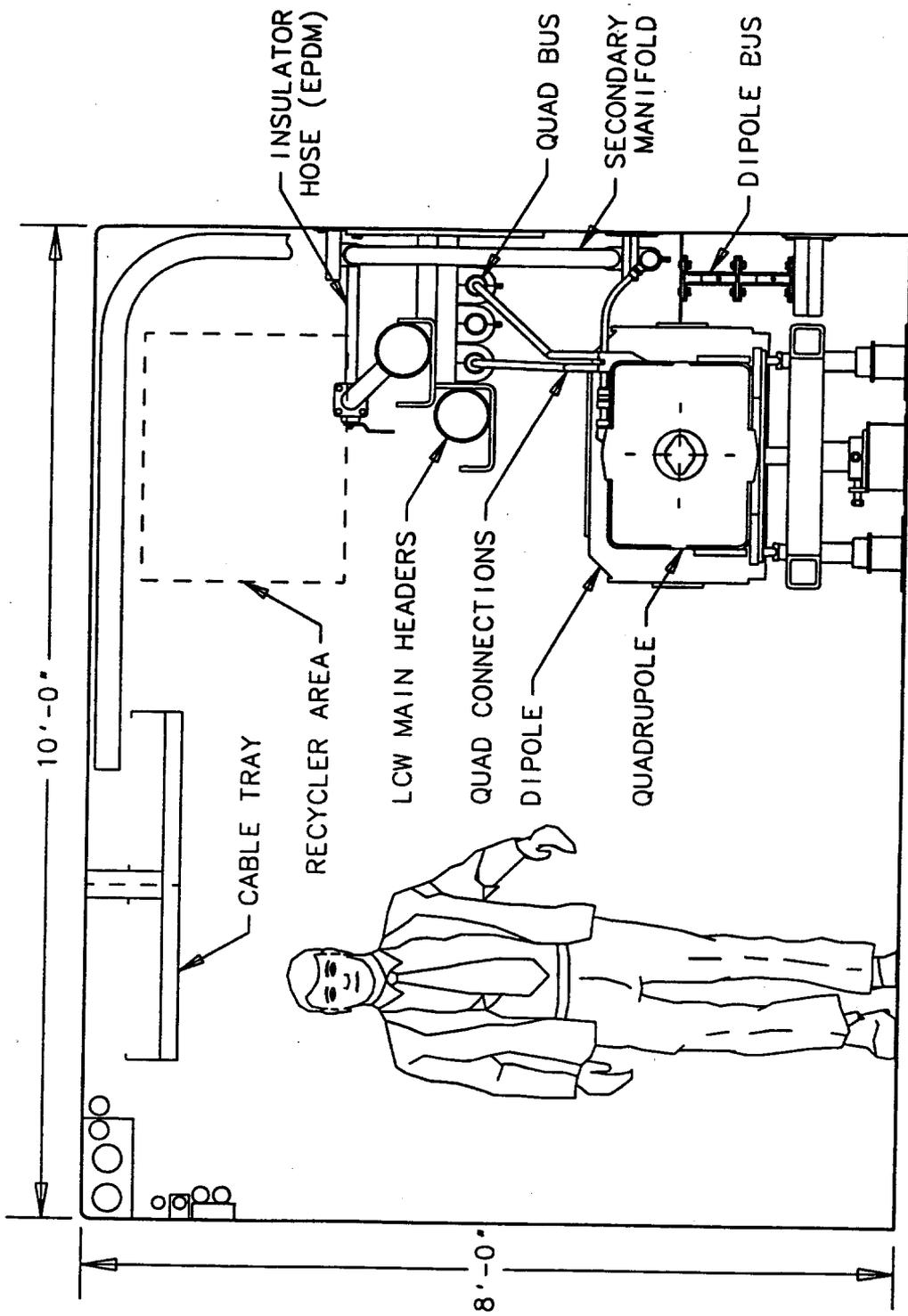




## MI-30 LCW Velocity and Pressure Drop Schematic

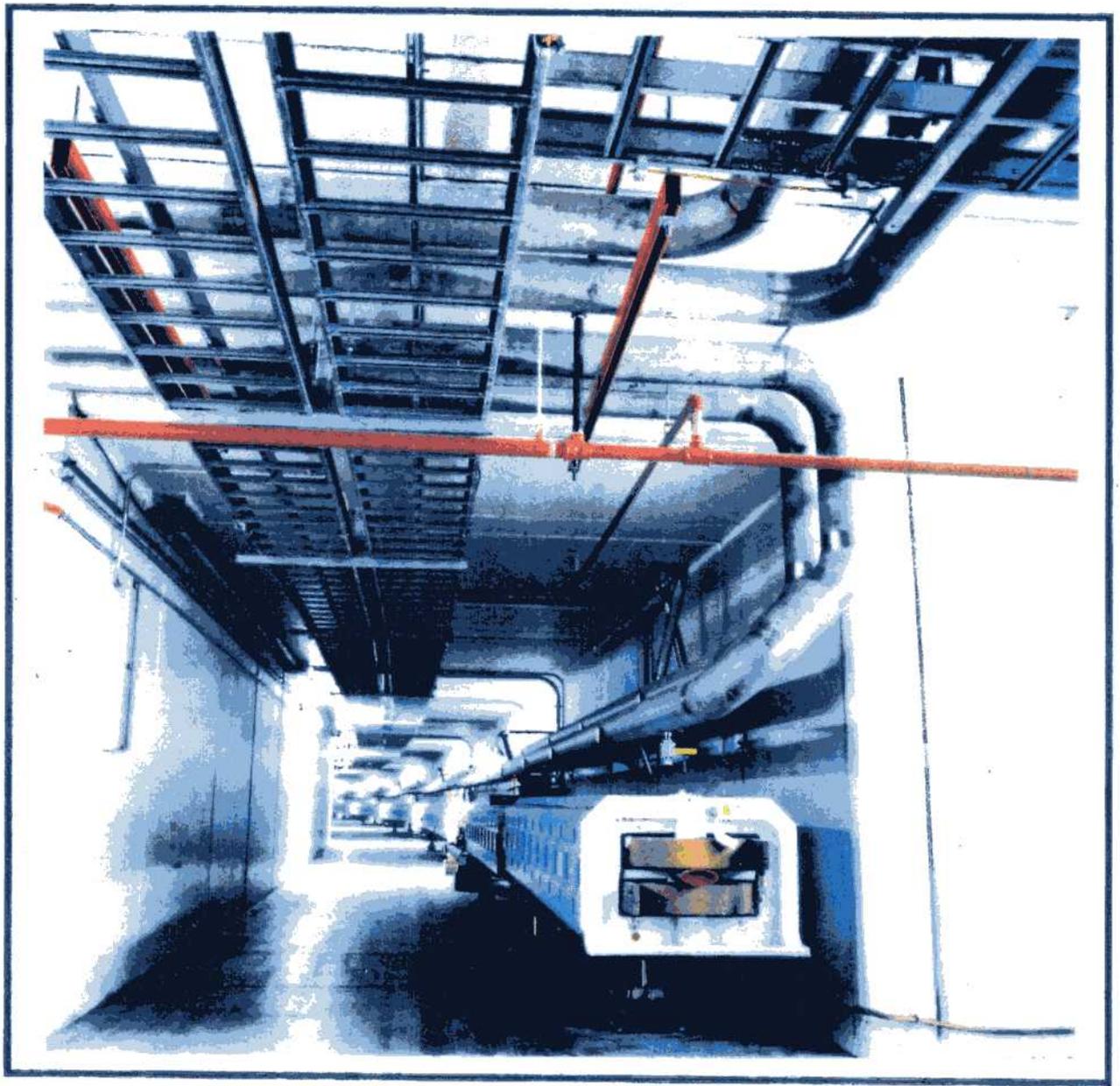


- Notes:
- 1) There is a 105 GPM secondary clockwise flow around the ring.
  - 3) The dashed lines indicate the path of the 105 GPM flow between this section and the two sections on either side.
  - 4) ΔP has units of psi.



CROSS SECTION OF MAIN INJECTOR ENCLOSURE





**Q-624 MIR**

**Typical 6" Headers Expansion Loop**



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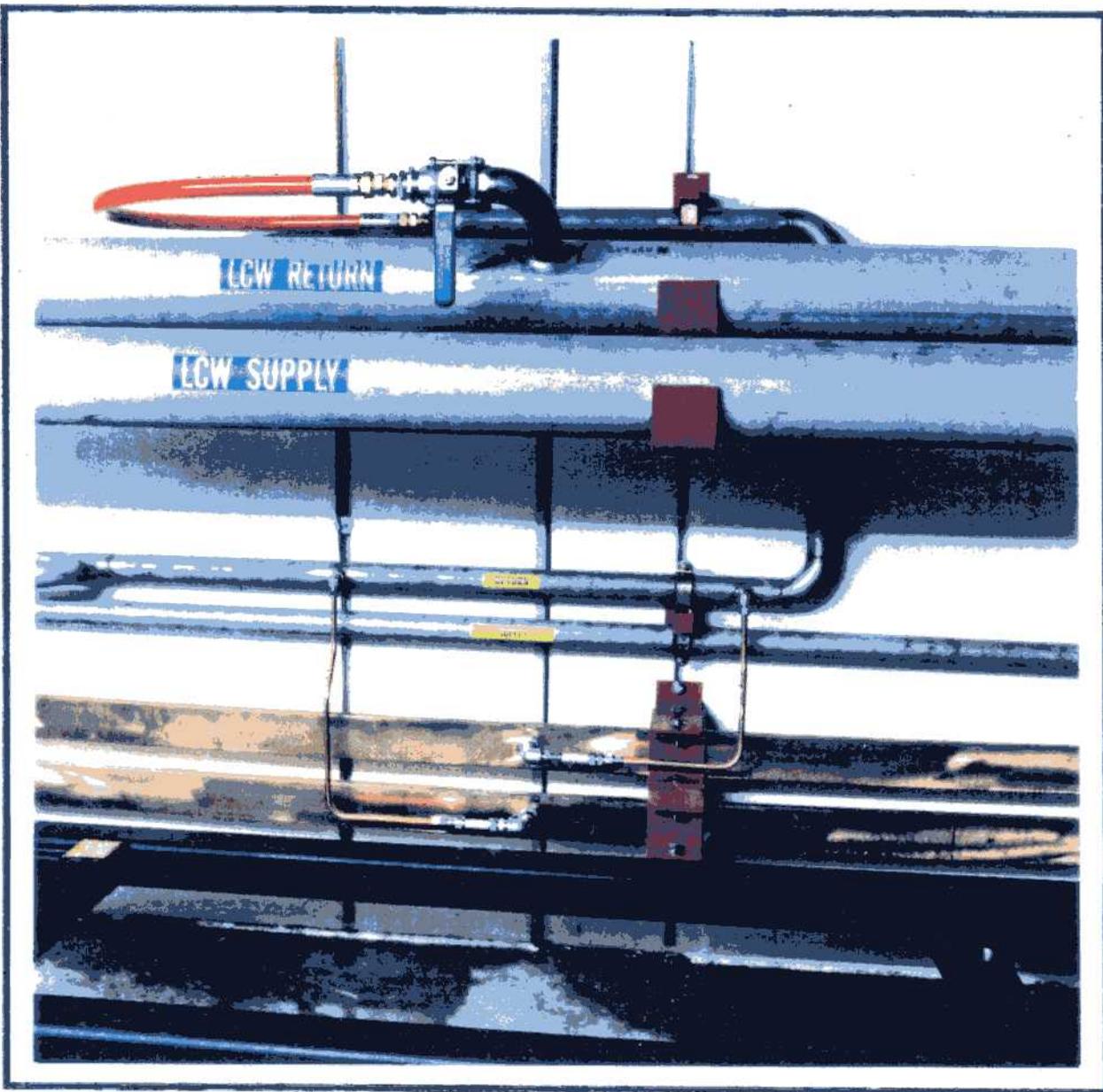


# Q-625 MIR LCW & Power Connections Prototype



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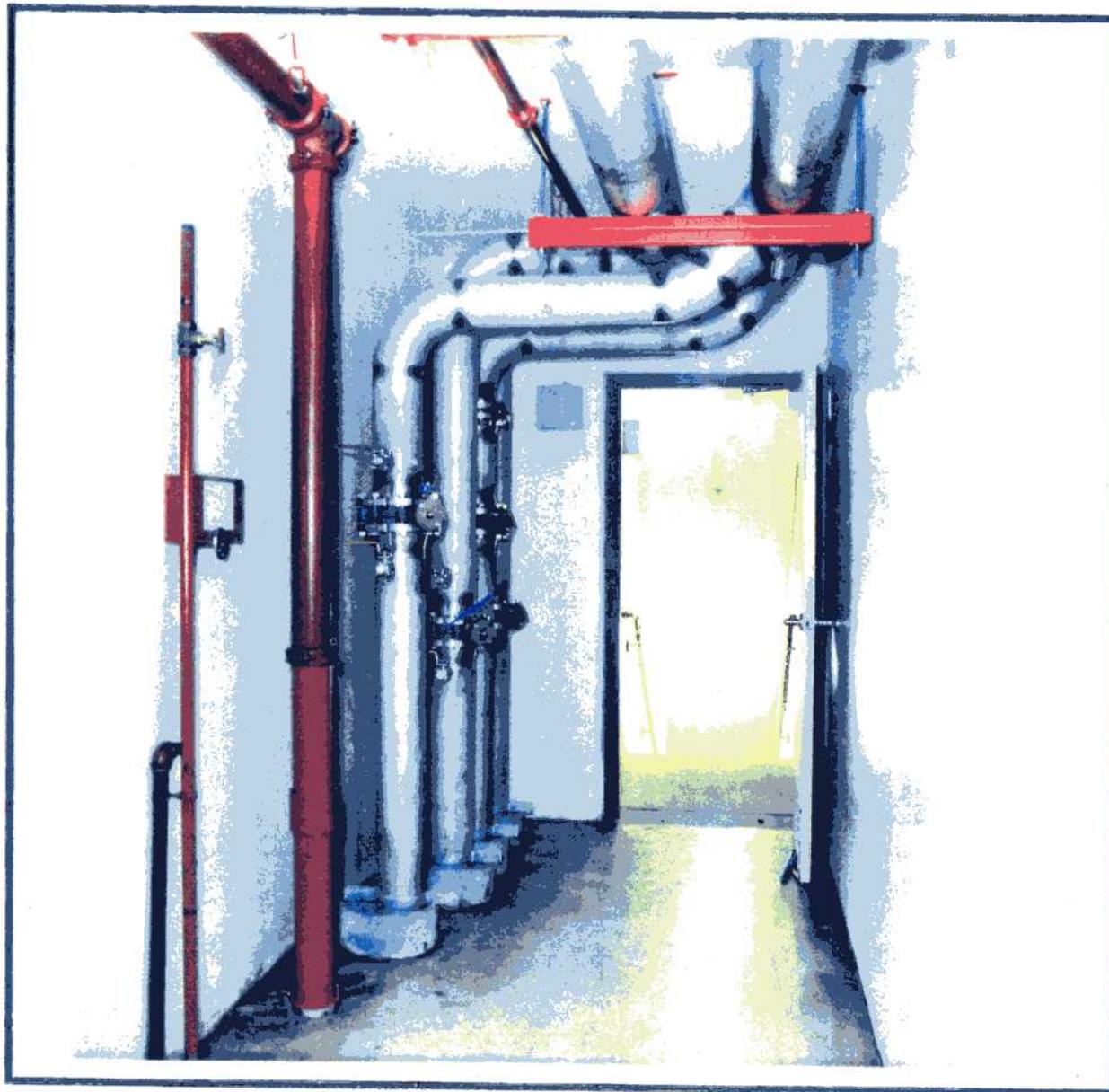


## Q-625 MIR

### Typical LCW Hose & Insulator Connections



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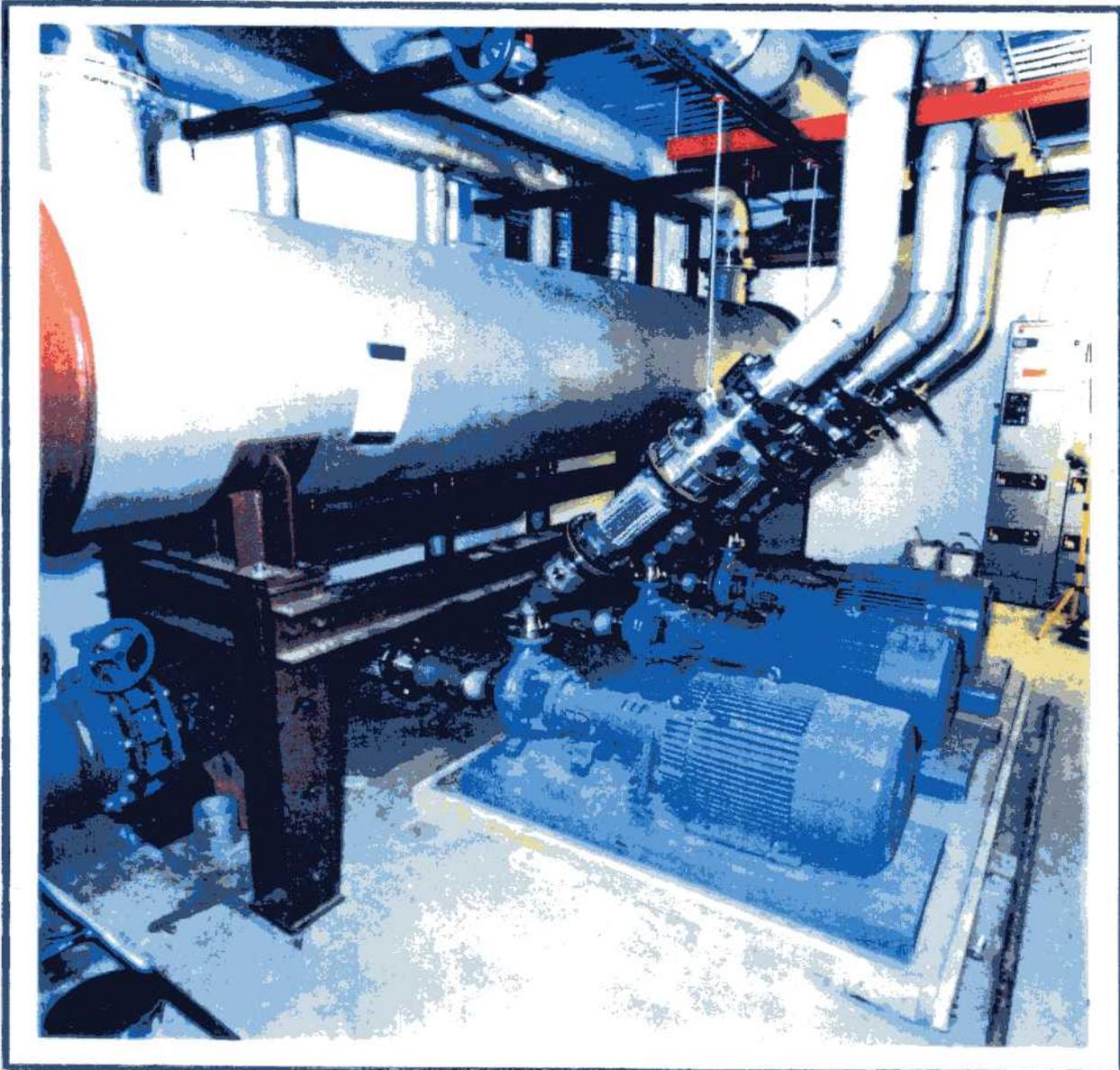


# MI-10 Corridor LCW Piping Penetrations



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## MI-20 Pump Room



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