LNRS

General Specifications,

Deficiencies and Components

The LNRS (Liquid Nitrogen Recirculation System) is an integral component of the David Florida Laboratory's TV5 Thermal Qualification Space Simulation Chamber.

This system is utilized for both client and DFL's spacecraft test requirements as specified by the clients approved test plan.

It is used to specifically perform a closed loop configuration; pressure stabilized and uniformed cold temperature operation of any item contained within the confines of the TV5 Chamber.

The LNRS cooling capabilities far surpasses the potential of the TV5 Chamber's twelve LN_2 boiling shrouds capacity to maintain a uniformed cold environment, within the TV5 Chamber.

Typically the TV5 Chamber boiling shrouds system and the LNRS are operated in parallel for most client test plans.

The LNRS consists of four primary subsystems

1) Bulk Storage Tanks (located exterior to the building)

2) Skid Subsystem

3) Supply Manifold

4) TV5 Chamber Internal Connections

5) Return Manifold.

Bulk Storage Tanks System

This system is the main source of LN_2 to the LNRS Skid Subsystem and it also contains a tieback connection for proper operation of the LNRS.

The tieback line is connected to one of the bulk storage LN_2 tanks through an electrical controlled valve.

This bulk storage tank system is connected to a junction above the Skid Subsystem. This junction is used to feed makeup LN_2 to the input of the LN_2 centrifugal pumps and connects to the discharge from the automated 50 Kilowatt sub cooler.

Skid Subsystem

The Skid Subsystem consists of two LN_2 centrifugal pumps, connected through an automated controlled 50 Kilowatt sub cooler leading to the Supply Manifold.

One LN_2 pump on the Skid Subsystem is used as the primary pump for our system with the secondary pump in standby (isolated) mode.

Electrical and manual valves along with temperature indicators, PRV's and a flow measurement device are also contained on the Skid Subsystem.

It should be noted that this subsystem also contains the electrical Main Skid Vent Valve and the electrical Skid Bypass Valve.

Supply Manifold

This manifold contains the primary electrical control supply valve, PRV's, rupture disk and the manual zone isolation valve for each of the six supply zone.

The six manual zone isolation valves are connected through flex lines to each of the six zones penetrations feedthroughs. These feedthroughs on the supply port are used to penetrate to the interior of the TV5 Chamber for LN_2 connection purposes.

TV5 Chamber Internal Connections

Any supply feedthrough can be configured as per customer test plan or DFL requirements for LN_2 usage using flexible LN_2 hoses or rigid plumbing.

Return side connections from customer or DFL LN_2 requirements, are then connected to the return port six zones return penetration feedthroughs, by means of either flexible LN_2 hoses or rigid plumbing.

These six return penetration feedthroughs are used to exit the interior of the TV5 Chamber for connection to the return manifold by flexible LN_2 hoses.

Return Manifold

This manifold contains the electrical zone vent valves, electrical zone return valves for each of the LN_2 zones, PRV's, primary electrical control return valve and the primary electrical control return manifold vent valve.

It connects back to the input side of the automated 50 kilowatt sub cooler and the skid bypass lines through to the supply side of the primary LN_2 pump.

Main component list:

A. Cryo-Mach 1x2x6 Model: C-C Pump Electric Motor
B. 2 ¾" Conflats
C. 1" Concentric Union
D. 1" Cashco Ranger Crygenic Valve
E. 50 kW subcooler
F. 209LT Asco valve
G. 300psi 1" Burst disc
H. Vacuum Feed-through for 1" line
I. Shipham 3" Gate Valve
J. 1" Powell globe valve

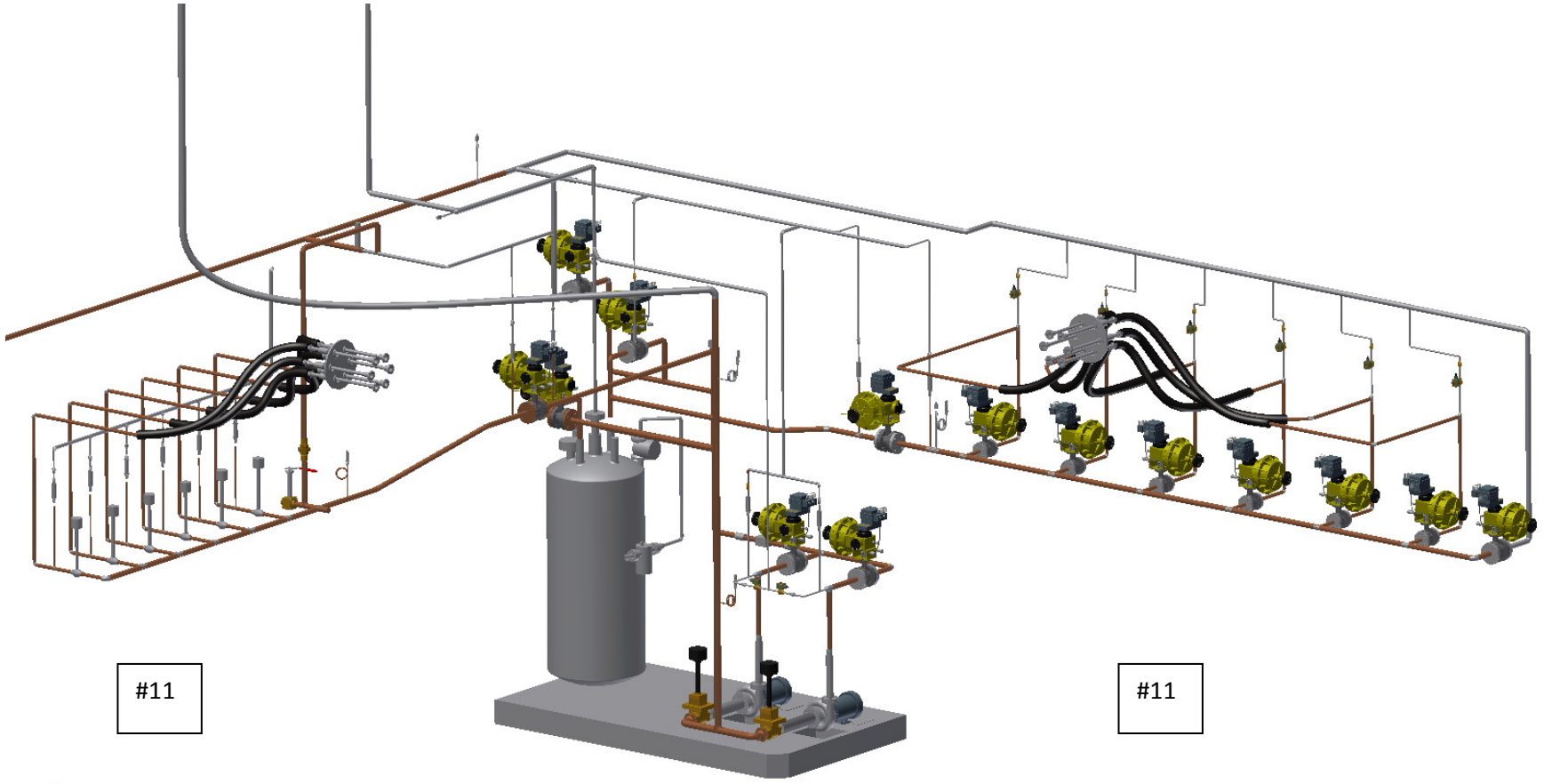
LNRS Corrective Action Lists

Required Corrective Actions:

1. Replace sub cooler 30° seat with 60° seat
   Reason: eliminate starvation during heavy use
2. Change LNRS zone supply valves (manual) to positive sealing valve
   Reason: cannot properly isolate Zones
3. Address vent 1 and vent 4 leak at main floor 270°
   Reason: safety, system stability and vent overflow
4. Replace both LNRS pump supply isolation valves
   Reason: cannot isolate LN_2 pump during operation
5. Replace all 2 ¾ conflats on the supply and return ports, repair missing keyways
   Reason: proactive repair as there are signs of wear
6. Zone 6 ranger valve leak
   Reason: cannot properly isolate Zone 6
7. LNRS zone supply and return rework with bayonet flex lines
   Reason: concentric unions require constant tightening due to wear
8. Asco valve reconfiguration from vertical to horizontal
   Reason: valves leak even though they are operating properly

Suggested Enhancement Actions:

9. LNRS zone vent plumbing and rework vent
   Reason: goal of no LN_2 outside
10. LNRS zone purge (new)
    Reason: to speed Zone recovery
11. Install staging at the supply and return LNRS manifold
    Reason: access for Zone leak detection
12. LN_2 pump type analysis
    Reason: possible options of changing from direct drive to magnetic (thermal conductance issue): centrifugal to axial (cavitation/start-up issue)
13. Recirculation analysis option for new re-liquification system
    Reason: elimination of constant adjustment of LNRS during start-up and recovery operation



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Letter – Component

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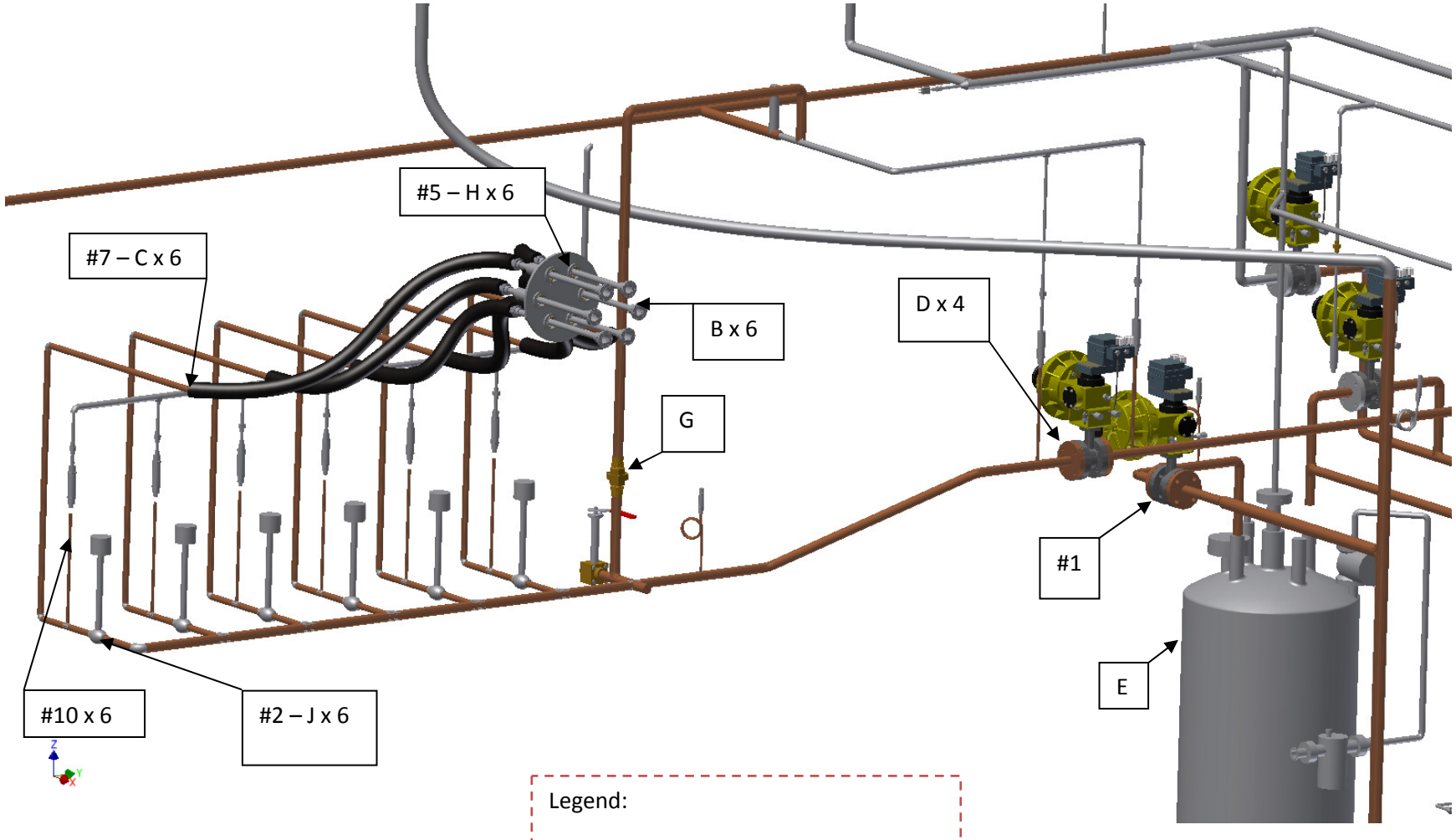

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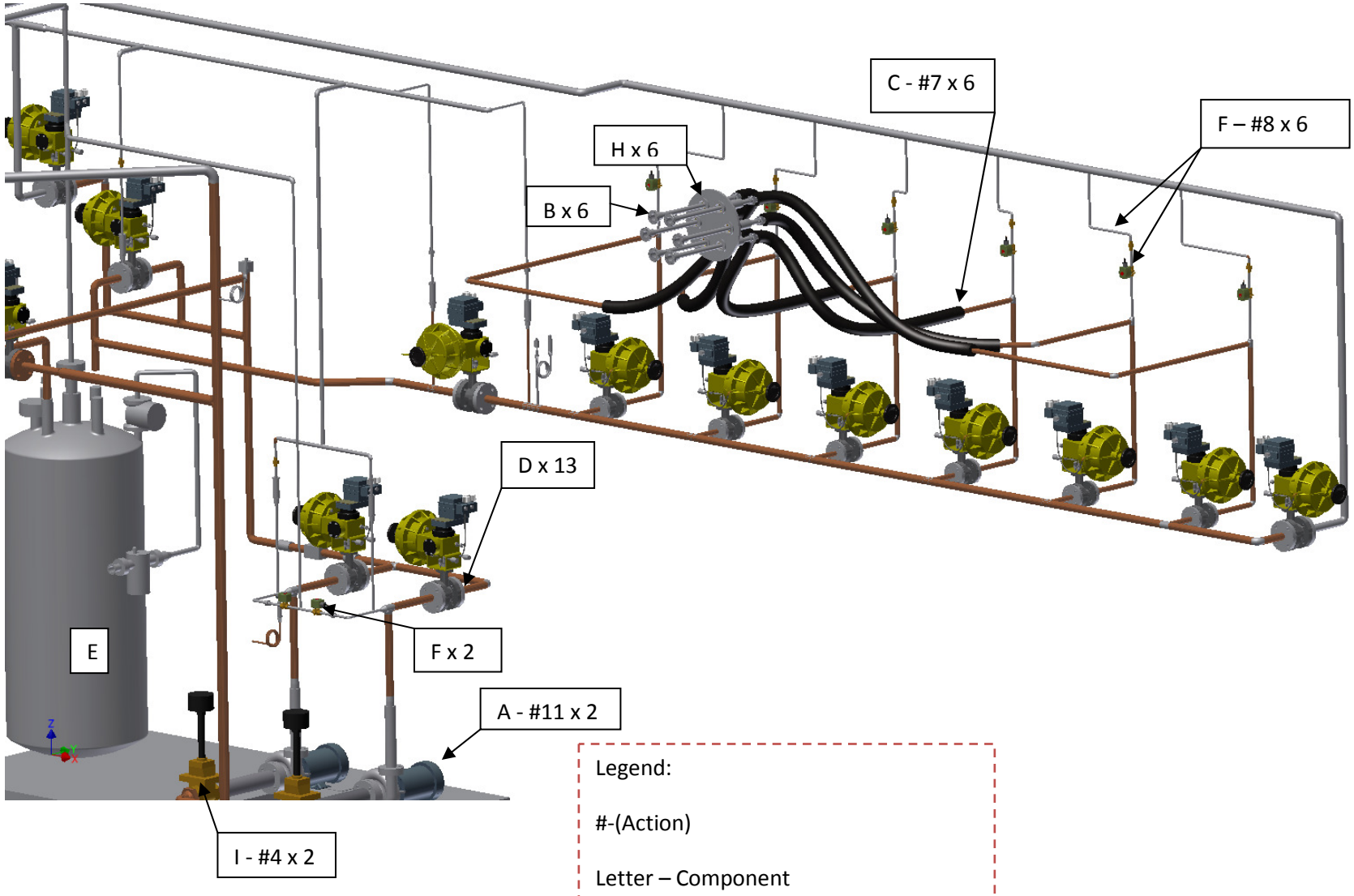
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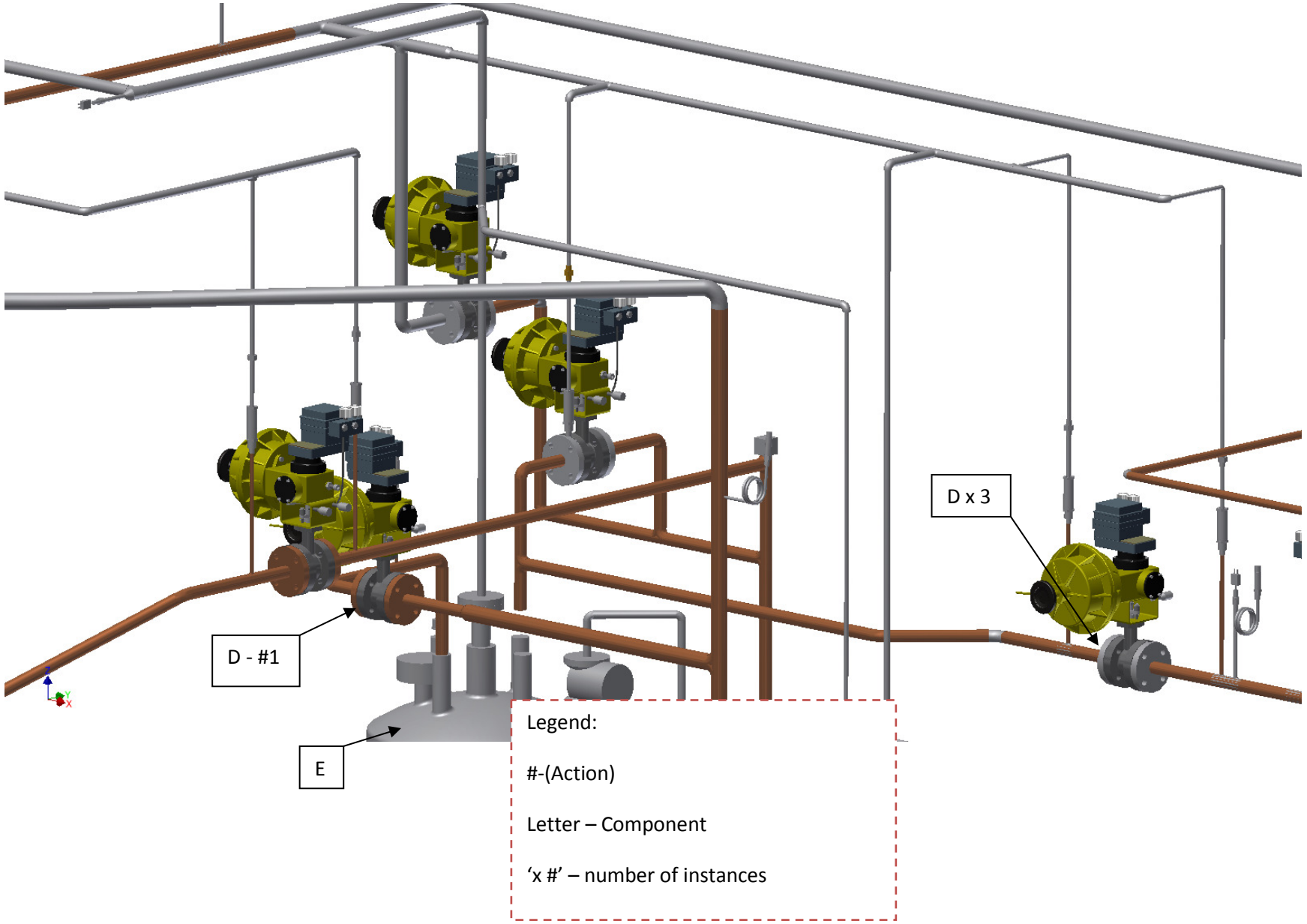
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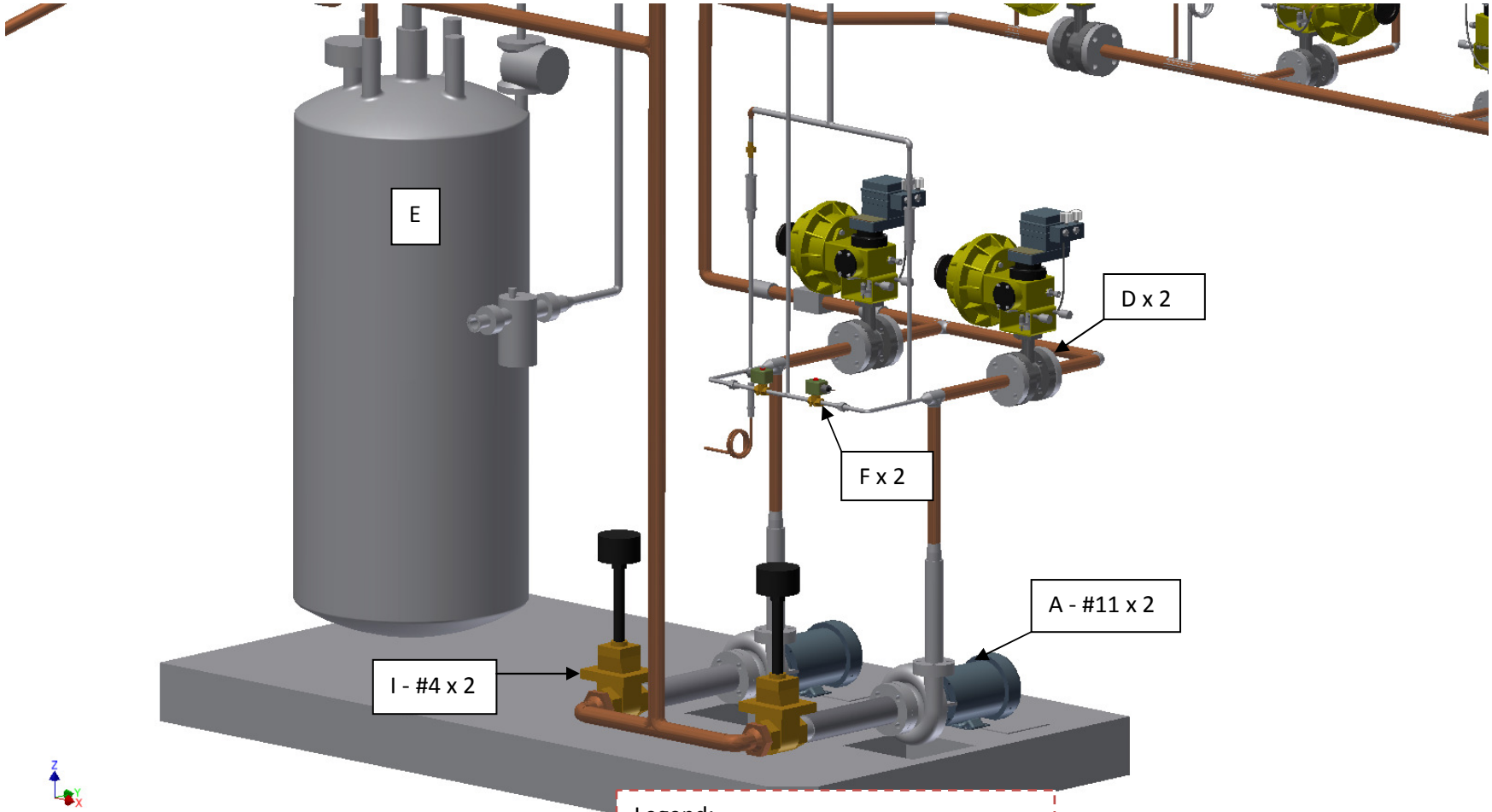

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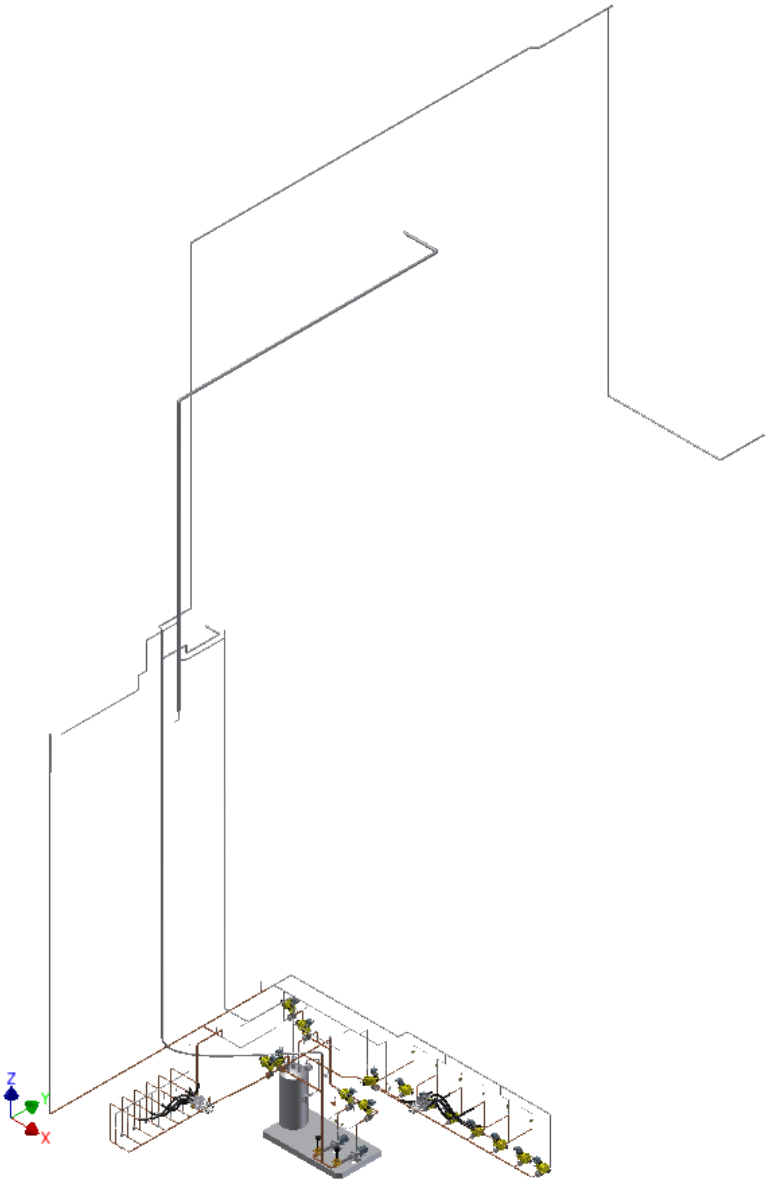

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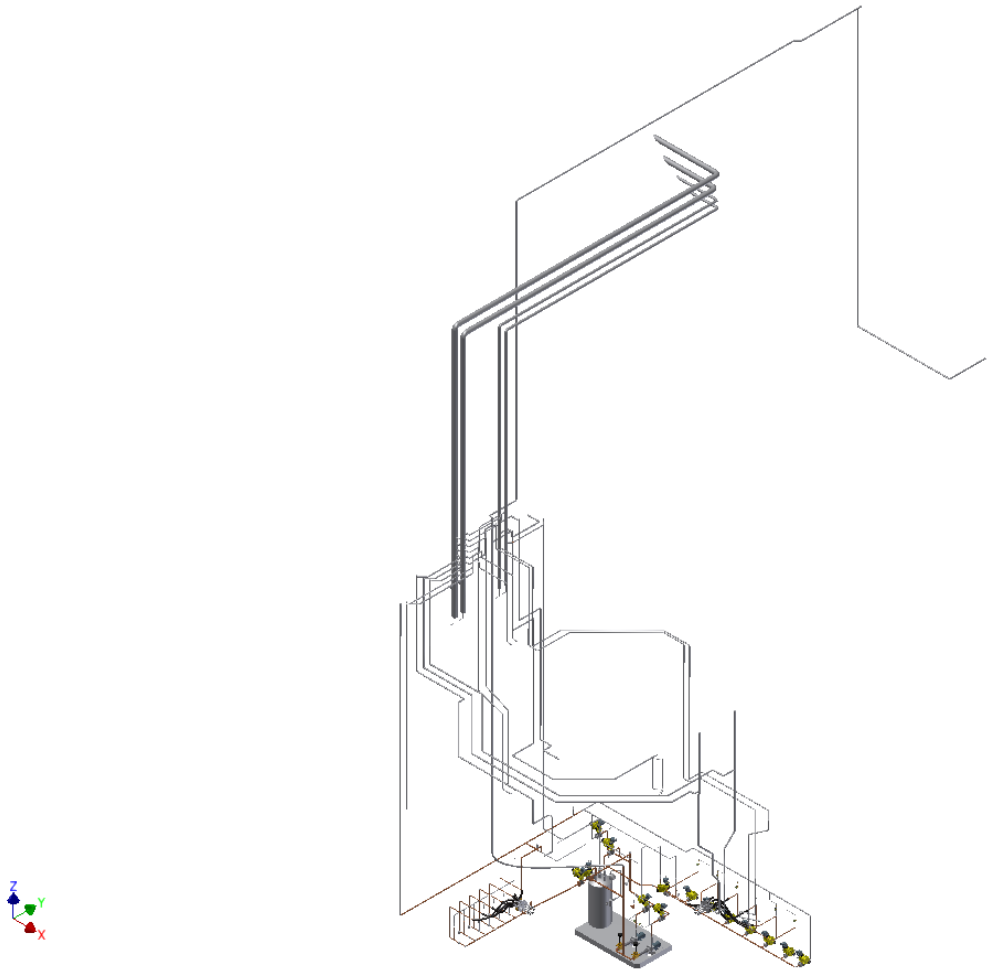

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