LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory

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SITE INSTALLATION
PUMP STATION
Design and Production Proposal

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1 Introduction

This document describes the general site installation PUMP STATION configuration design based on the LASTI and the CIT prototypes. The knowledge and experience working with the pump station and the information from the tests shaped the design layout. The special requirements of the sites include access to service the components and an enclosure for the station assembly to insure any fluid vapor or other contaminates do not enter the clean areas of the site.

2 Major Components List

Reservoir

Drive Motor

Motor Controller

Pump [Screw Type}

System Filters [2]

Accumulator / Resistor Assemblies[2]

Mounting Frame

Granite Motor Damping Base

Containment Cabinet - Ventilated

3 Layout Drawings

PUMP STATION ASSEMBLY SITE VERSION D030127-A

Front view and top view

3.1 Front View

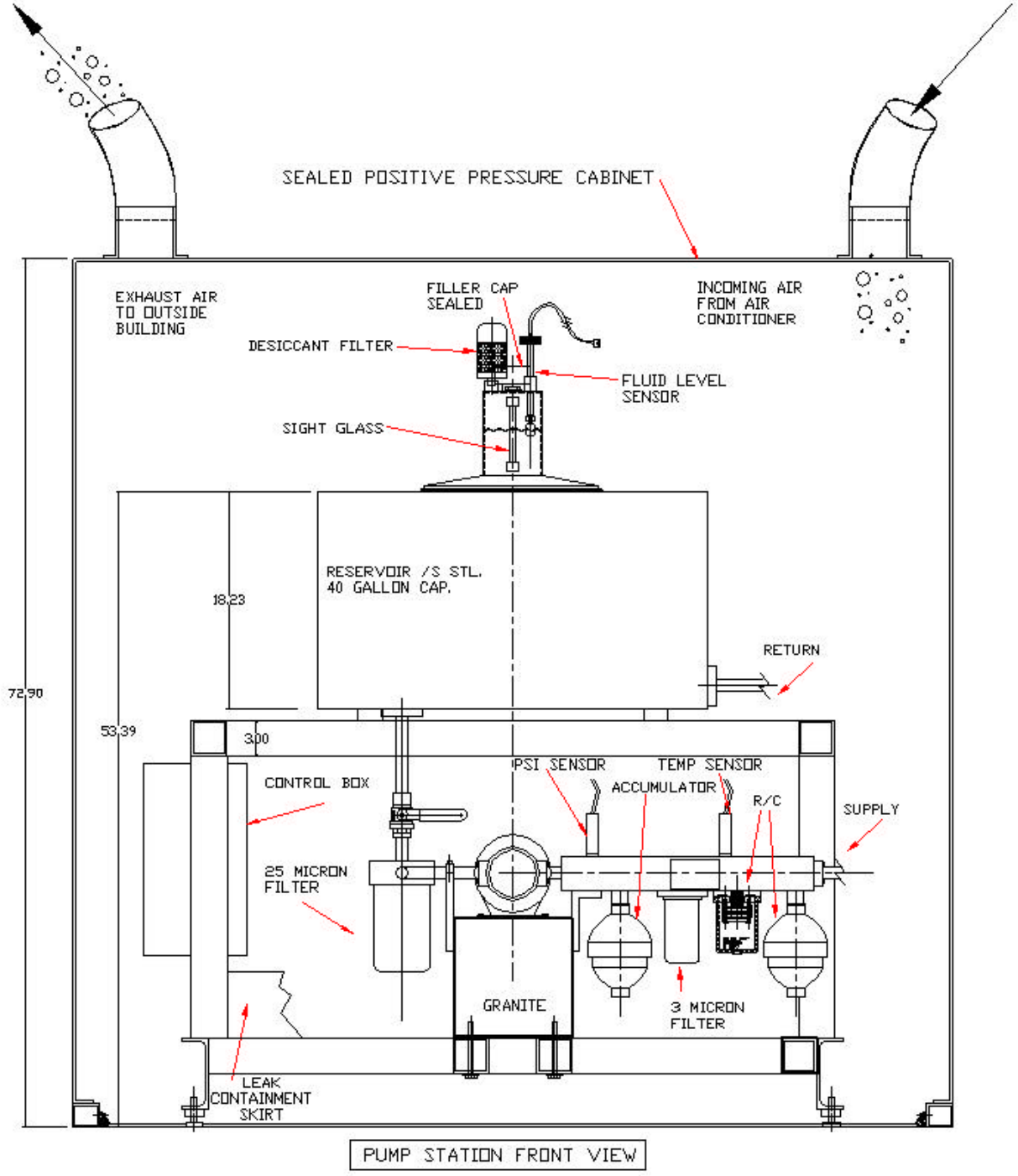

Figure 1 Front View Showing Major Components

3.2 Top View

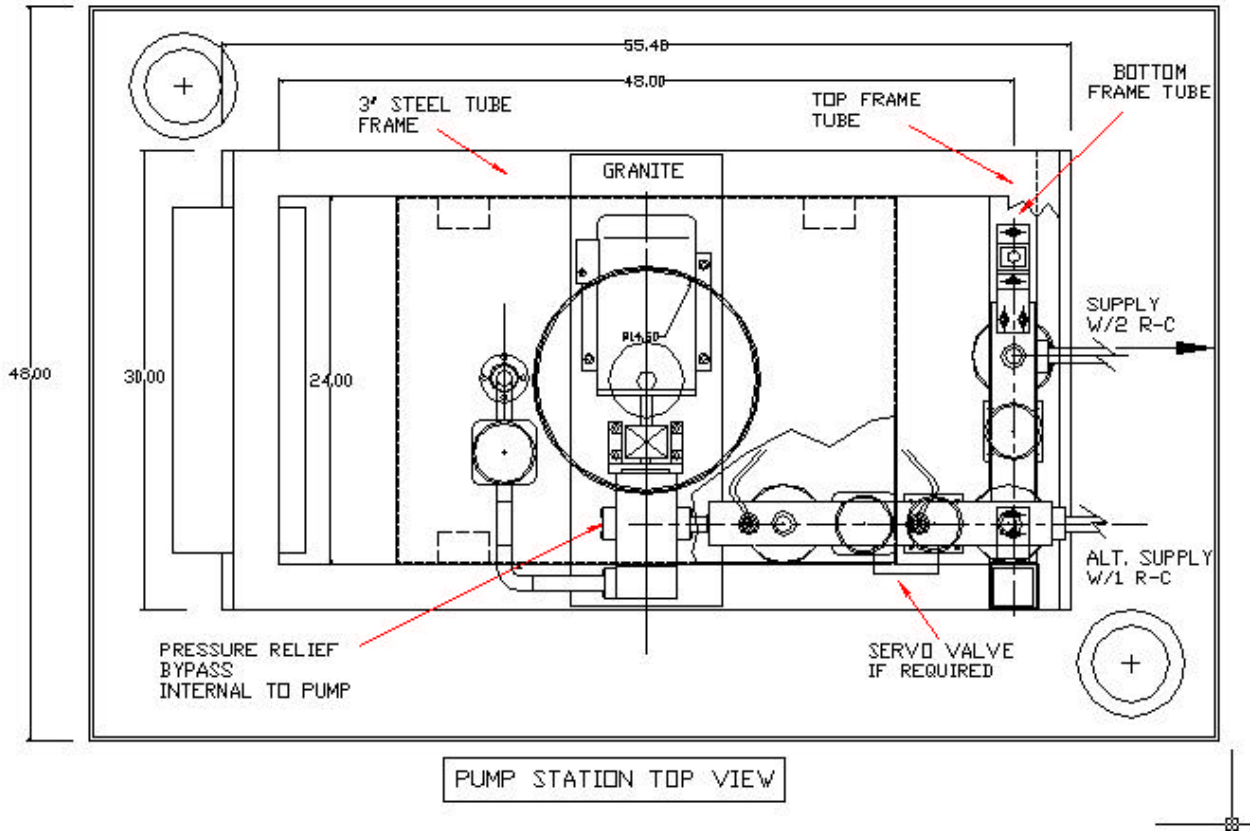

Figure 2 Top View Showing Major Components

4 Major Components of the Pump Station

4.1 Fluid Reservoir

The reservoir is a sealed system there will be a desiccant breather on the reservoir to remove any water from the air before it enters the reservoir. There is a reduced volume area at the fill area of the reservoir to allow only a small fluid to air contact. There will be a visual sight glass to easily see the level of the fluid. Fluid entering or leaving the reservoir will pass thru a fine mesh filter. There will be an adjustable level sensor installed in the reservoir.

4.2 Pump

A screw Pump similar to the LASTI pump but has an internal bypass to prevent and overpressure build up in the system.

4.3 Motor

The motor is an AC heavy cast frame type with a TC shaft style this is shorter than the JM shaft style of the LASTI for a stiffer more stable assembly.

4.4 Mounting Base, Motor

This is now a piece of granite with thread inserts installed to mass dampen the vibrations from the pump and motor rotation masses from influencing the fluid in the form of pressure peaks

4.5 Structural Frame

This is a steel structural shape framework to contain the components of the Pump Station Assembly.

4.6 Containment Cabinet

This is a sealed area surrounding the entire Pump Station Assembly. In the event of a leak, fluid or any other contaminates will be contained within the cabinet. The cabinet is cooled to a constant temperature by the building air conditioning and vented to the outside of the building.

4.7 System [fluid] Filters

A 3 micron absolute filter is near the fluid exit point on the Station Assembly and a 25 micron filter is used prior to the Pump to assure clean fluid supply and a long life to the Pump internal moving parts and seals.

4.8 Changing Filters

The filters are large capacity and will not require changing for at least one year or more of continuous operation.

4.9 Auxiliary Fluid Filtering

A portable Filter Station for cleaning the reservoir fluid to a high level and removing any water or other contaminates while the system is in continuous operation is an option.

5 The Reservoir Level Sensor

There is a built in electro mechanical level sensor system that will shut off the pump if a 'low' fluid level is detected. This will be more sensitive than the LASTI prototype a small loss of fluid will trigger the sensor.

6 R/C Assemblies

The purpose of these assemblies is to smooth out the fluid pressure pulses caused by the rotation of the pump. There will be provision for two R/C assemblies in the Design Plan. The assembly consists of a fluid Resistor and an Accumulator. The resistor construction is a set of specific gaps in an assembly that restrict the flow; and the accumulator is a vessel with a pressurized bladder to cushion the pulses. These two components are placed closely together in the system.

7 General Operation of System

7.1 Start-up

There will be a procedure for filling the system with fluid to eliminate air entrapment that can cause errant operation of the system. Cycling the system on and off and several hours of running will eventually purge the system of air.

7.2 Bleeding the system of Air

There will be 'high' places where there will be bleed valves to allow the entrapped air to escape, after the initial system purge there should not be a need to do this again.

7.3 Controlling the system Fluid Pressure

The Pumping system will control the operating line Fluid pressure with a feed back loop from pressure sensors. The system will use a speed control type motor controller for this.

7.4 Setting the Motor Speed

After initial startup and run-in there will be an RPM speed window set to control the motor speed by regulating the frequency Hz. The controller will respond to demand for a set constant pressure required by the actuator system thru a control box attached to the pressure sensor in the line. This is necessary due the changes in viscosity due to temperature changes.

8 Overall Size and Footprint of the Pump Station

This is a compact assembly and at a height accessible to the average person for service.

Approximately 4 ½ feet wide and 3 feet deep and 5 feet tall as a complete assembly.

The containment cabinet will be approximately 6 feet wide x 4 feet deep x 6 feet tall.

9 Pump Station Safety precautions

There will be several types of safety precautions taken in the operation of the Pump Station system.

9.1 Thermal sensors

There will be a thermal sensor on the motor and possibly the Pump to imediately shut off the system if the temperature rises over a set point

9.2 Pressure sensors

There will be sensors at the pump station and in the lines if a low pressure or high pressure reading occurs the motor will be shut off.

9.3 Containment skirt

There is a containment skirt around the base of the reservoir and motor/pump assembly if a leak occurs this will contain the fluid.

10 Manufacturing and assembly of the Site Pump Station

10.1 First article Pump Station

The structural components for the frame can be fabricated by nearby vendors to our drawings, and assembled at CIT. The remaining Pump Station components can be purchased from vendors and/or fabricated at CIT. The first Pump Station assembly can be completed at CIT and debugged and shipped to the site.

The cabinet will be a custom job similar of some on the market now, the reservoir is custom made to our specifications. The filters and pump / motor are purchase parts.

The manifold parts are fabricated to our design, however the accumulators and pressure sensors are purchased parts.

The structural frame can be painted steel, the reservoir and plumbing from stainless steel.

The manifolds and support hardware aluminum.

10.2 Future Site Pump Station Assemblies

Later Pump Stations could be assembled at the sites.

11 Estimated cost of site Installation System

Assy or Part Name	unit cost	qty	total cost
structural main frame mfg. & assy	$1,550	1	$1,550
granite base	$375	1	$375
control box & hardware	$150	1	$150
motor controller	$775	1	$775
accumulator	$135	3	$405
motor	$350	1	$350
pump	$625	1	$625
reservoir /spcl. /stainless	$1,270	1	$1,270
resistor	$220	3	$660
large filter	$125	1	$125
small filter	$155	1	$155
main manifold /alum	$520	1	$520
secondary manifold/alum	$520	1	$520
level sensor assy	$250	1	$250
filler cap/ assy	$280	1	$280
descant filter & bracket	$75	1	$75
pressure sensor sender	$122	3	$366
coupling	$85	1	$85
motor balancing	$290	1	$290
main assembly feet	$85	4	$340
coupling balance	$75	1	$75
ball valves /stainless	$260	3	$780
filter heads + modification	$285	2	$570
manifold at pump / alum	$340	1	$340
containment cabinet & hardware /custom	$1,600	1	$1,600
air filter and fan / containment cabinet	$580	1	$580
total			$13,111

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