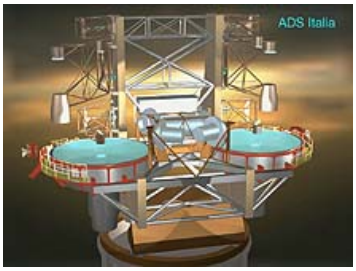

LBT PROJECT
2x8,4m TELESCOPE

Doc.No. : 440s400
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LBT PROJECT

2 X 8,4m OPTICAL TELESCOPE

HBS

Safety Review

	Signature	Date
Prepared	J. Howard	2009-Sep-3
Reviewed	D. Ashby, R. Meeks, J. Little	2009-Sep-15
Approved		

1. Revision History

Issue	Date	Changes	Responsible
a	03-Sep-09	First draft	J. Howard
b	15-Sep-09	Revised after meeting	J. Howard

2. Table Of Contents

3. List Of Abbreviations

HBS Hydrostatic Bearing System
gpm U.S. Gallons Per Minute
OCU Oil Control Unit
PLC Programmable Logic Controller
NFPA National Fire Protection Association
MSDS Material Safety Data Sheet

4. About this document

4.1. Review of HBS Safety

There are three safety issues with HBS. Protection against burst hoses, providing adequate Azimuth Pressure OK for building rotation, and providing graceful shutdown in the event of an E-stop.

The HBS uses nearly 4000 liters of oil, and some of this oil is under high pressure and is piped from the 4th floor to the 5th floor. LBT needs to ensure there are adequate safeguards in place to protect personnel and the telescope from this oil. This is done by prevention, and, if a major leak does occur, the PLC should detect that and shut down.

Azimuth Pressure OK is a signal which enables building rotation to occur. For this to be active, adequate pressure must exist in the azimuth pockets to lift the telescope.

E-stop needs to shut off oil to the elevation bearings, which would set the telescope back down onto the pads and stop it quickly. The oil pressure needs to bleed off slowly enough that the telescope will not exceed acceleration limits during an E-stop.

4.2. Reference Documents

RD1	440x004d	Hydrostatic Schematic
RD2	440x890a	Mobil DTE 10M Series Product Data Sheet
RD3	440x925a	Electrical Equipment for Hydrostatic Bearing System
RD4	005x002a	Exxon-Mobil DTE 11M MSDS

5. Burst Hose Prevention and Mitigation

Since system pressure is 120 bar, and the pumps are rated for a maximum of 231 liters/minute (61 gpm)[RD1], a burst hose will be messy at the least, and cause injury at worst. 120 bar is high enough to cut human skin, and an oil leak will quickly make many surfaces slippery, which makes them a walking hazard. In addition, a large oil spill with find its way down through floors and ceilings all the way down to the ground floor, which could damage equipment. The safeguards against a burst hose are maintenance and inspection by the mountain staff, and detection of a pressure drop by the Siemens PLC.

There are three places where high pressure hoses are used. On level 4 on the OCU, on level 4.5, and on level 5.

5.1. Level 4, the OCU

On the 4th floor on the OCU, there are 6 hoses, one from each of the 4 pumps, and 2 from the main filters to the supply line. These hoses have a working pressure of ....

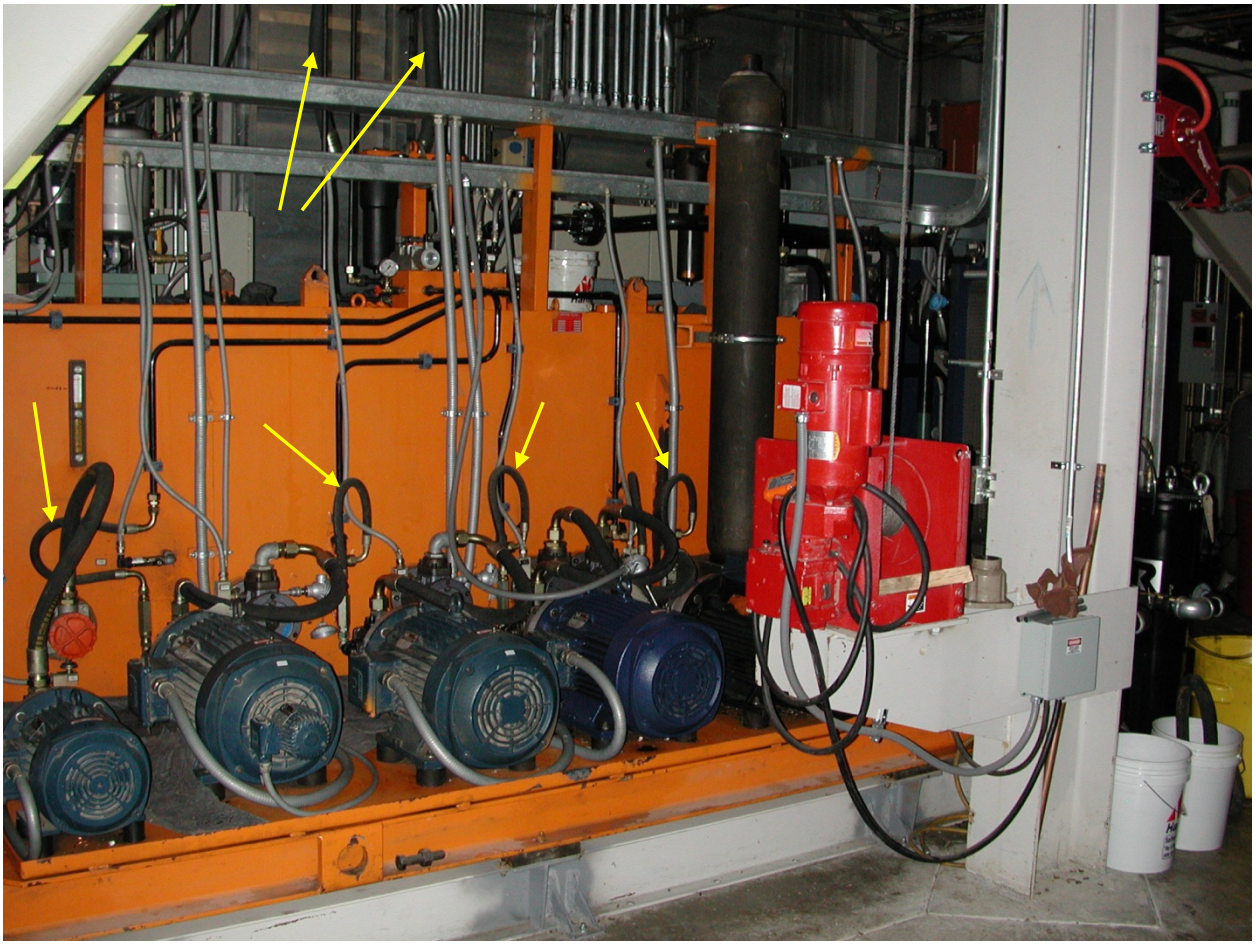

Figure 1: OCU with arrows indicating high pressure hoses

5.2. Level 4.5

On level 4.5, there is a single, large diameter, long hose which is needed to span between the building and telescope. This hose has a working pressure of 350 bar. It is about 4 inches in diameter, and about 20 feet long. It is about 10 feet longer than it needs to be. The installation crew realized this, but shortening it would have been expensive. Because of the confined space, it is very difficult to photograph.

5.3. Level 5

On level 5, there is currently a hose for every pocket (80 in all), each with a working pressure of 180 bar. Many of these hoses extend from manifolds on 5 down to the azimuth pads on 4.5. The number of these hoses will be reduced when the variable capillaries are installed.

5.4. Hose Maintenance

Hoses should be inspected periodically for cracking, splitting, abrasion, and leaks at their swage. Hoses should be replaced every 10 years, and marked with the date on installation.

5.5. Fire Safety

The oil is not a significant fire hazard. The flash point of the Mobil DTE 11M oil is 160C [RD2 & 4]. The NFPA diamond is

[RD4]

5.6. Tubing and Hose Insulation for Pinhole Leak Protection

Closed cell insulation around all the HBS lines will provide a line of defense against oil spray from pinholes damaging anything or anyone nearby.

5.7. PLC Warnings and Alarms for Leak Detection

5.7.1. Normal Operation

The PLC can shut down the HBS if it detects a major pressure drop and alarms. Warnings do not change the operation of the PLC, although there are claims that too many warnings will cause HBS to shut down. Alarms will shut down the HBS pumps.

Currently, the PLC is set up to issue a warning or alarm when any of the following stray outside of a nominal range:

Mean pressure of all the pockets on a single pad, with separate ranges definable for each pad.
Each individual pocket pressure, with separate ranges available for the inner and outer pockets on each pad
The main line pressure measured at the OCU

Azimuth line pressure
Elevation line pressure
Azimuth pad compensation pressure
Elevation pad compensation pressure
Lateral pad compensation pressure

See [RD3] for more details on how the warnings and alarms work. The pocket pressures are nominally 30 to 60 bar, the compensations are 45 bar, and the line pressures are 110 to 120 bar. The ranges are currently set to warn if the pressure drops to 15 bar, and alarm at 10 bar. The upper warning limit should be set to the lowest rated working pressure of any component in the system, and the alarm to the lowest rated peak pressure. There is a high pressure relief valve, but it is not big enough to relieve large flow the pumps can produce.

5.7.2. Startup

Since the pressures need time to stabilize during startup, none of the regular warnings or alarms are in operation. Instead, there are 3 time and pressure points that are checked, with the maximum time allowed for the completion of the 3rd check of 180 seconds after startup. In addition, there is a check of the reservoir level drop during startup. If the level drops more than the value in parameter 34, the system alarms.

6. Azimuth Pressure OK

Azimuth Pressure OK should be two items in series. First, the sum of the 24 azimuth pocket pressures needs to be above a certain threshold, perhaps 90% of nominal. Second, there needs to be a normally open pressure switch in the azimuth supply line downstream of any valves. The switch needs to be set for somewhere between 100 and 120 bar.

7. E-stop

When E-stop is active, the oil pressure must drop gracefully enough to allow the telescope to stop. It needs to stay up for approximately 0.5 seconds, which should give enough time for the brakes to work, but less than 1 second. There is a solenoid valve at the front of the telescope that is normally open when electric power is not applied. It needs to be swapped for a normally closed valve.

A test need to be conducted consisting of measuring the lift with HBS on, then closing the solenoid valve to determine how long it takes for the telescope to fall. If this is in the correct bounds, nothing more needs to be done. If it is less than 0.5 second, a small accumulator must be added to the elevation pocket supply line. If it is more than one second, the compensation volumes must be isolated from the pocket lines.

8. Summary of Open Issues

1. Insulate all lines.
2. Determine warning levels in PLC through trial and error..
3. Do a burst hose test to ensure alarms work.
4. Upgrade pressure relief valve on OCU.
5. Measure pressure vs. time on OCU startup to calibrate startup table.
6. Determine threshold for sum of azimuth pocket pressures for AZ Pressure OK
7. Determine setting of AZ Pressure OK switch

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