

LBT PROJECT 2x8,4m TELESCOPE

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Author : Joar Brynnel

LBT PROJECT 2 X 8,4m OPTICAL TELESCOPE

Scope of work

Telescope cooling system installation

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1. Revision History

Issue	Date	Changes	Responsible
Draft	23-Mar-04	First draft	Joar Brynnel
A	25-Mar-04	First issue. Comments from JHS and JMH 4.1.3 added clarification 4.2.2 added sentence Figure 1 Edited for clarification Figure 3 Deleted (redundant) 5.2 Section renamed and edited Figure 3 Added photo of treehouses 6 Added clarification note	Joar Brynnel
B	26-Mar-04	5.8.2 Removed words "Absolute pressure" 4.2.2 Added words "and contract"	

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3. About this document

3.1. Introduction

This document describes scope of work for design and installation of Cooling Water distribution on the Large Binocular Telescope located on Mt. Graham, AZ.

The purpose of the Telescope cooling system is to cool equipment located on the telescope to avoid any external surface to be significantly warmer than ambient air. Any equipment with a surface temperature significantly warmer than ambient (defined as more than one degree C above ambient) would cause local air turbulence, which could degrade telescope image quality.

Parts of the system, such as coolant pumps and heat exchangers, are already installed in the telescope building. Performance of those shall be verified against requirements as documented. If, based on thermal calculations, existing installation is deemed inadequate, remedial action shall be proposed.

It shall be noted that the telescope is symmetrical left to right. Two independent cooling circuits shall be implemented, one for telescope left side and one for the right side. Requirements in this document are for one telescope side only. Equipment and installation materials required shall be procured and installed for both sides.

Note: All temperatures in this document are expressed in degrees C.

3.2. Reference Documents

- [RD1] LBT drawing 404e006 Cabling and piping path
- [RD2] LBT drawing 303x001 Mechanical plan fourth level
- [RD3] LBT drawing 306m002 Chilled water control diagram
- [RD4] LBT drawing 226m011 Hydronic schematic fixed building
- [RD5] LBT drawing 303m005 Hydronic schematic rotating building
- [RD6] LBT drawing 562e001 Elevation cooling utilities cooling schematic

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4. Scope of Work

4.1. Phase 1 - System design

4.1.1. Flow requirement calculation

Based on heat load specifications in section 6 of this document, and general requirements in section 5, the required coolant flow shall be calculated. Cooling capacity headroom of 10% shall be included for possible future expansions.

No adjustment for instrument duty cycle is made. This might become necessary in order to optimize cooling system requirements.

4.1.2. Pumping system review

Based on the outcome of calculations on section 4.1.1, the (existing) coolant pumping and heat exchanger system performance shall be reviewed and verified.

4.1.3. Distribution system design

Telescope coolant distribution system shall be designed. Pipes and connections shall be properly dimensioned. Design shall be based on drawing [RD6] with updated information as specified in this documentation. Air handling units for the four “treehouses” (elevation electronics room) shall be dimensioned.

4.1.4. Parts definition

A parts list with parts required for complete installation as designed in sections 4.1.3 and 5.8 shall be compiled, with vendor and parts number information.

4.1.5. Phase 1 deliverables

- Parts list with vendor and parts number information
- Updated LBT drawing 562e001
- Document describing thermal calculations and system design

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4.2. Phase 2 – Installation

4.2.1. Parts

Supply of all required parts and installation material as defined in section 4.1.4 of this document. Spare parts shall be supplied for critical long lead-time components.

4.2.2. Site installation

Installation activity on site at Mt. Graham shall be supervised and coordinated by the contractor. Installation work may be contracted to third party after consultation with LBT Project Office. LBTPPO reserves the right to choose and contract the third party contractor. Installation activities must be scheduled in cooperation with the LBT Project Office.

Installation must be performed in a way that safety of telescope optical components (in particular the primary mirror) is guaranteed. Coolant spillage shall be avoided as far as possible to reduce risk of contamination of telescope critical opto-mechanical components. Installation activities must be approved by the site manager.

Although only telescope left side will be operated in the near future, it is planned to install cooling distribution system for both telescope sides as soon as possible.

4.2.3. System test

After installation completion, LBTO and the contractor will jointly test system performance. Tests to be performed are listed below:

- Connection point inspection [5.3]
- Connection point flow test (measure flow with a bypass hose)
- Connection point shutoff valves function [5.3]
- Flow balancing function test (regulate flow with flow valve) [5.7]
- Instrumentation test (read pressure, temp and flow) [5.8]
- Pressure test (measure differential pressure at top of telescope [5.6]
- Installation inspection [4.1.3]
- Spare parts inspection [4.2.1]

5. General requirements

5.1. Cooling performance requirements

Coolant supply temperature is regulated by adjusting flow in the heat exchangers primary circuit, supplied by the telescope main cooling circuit (see Figure 1). Main cooling circuit flow adjustment and control algorithm is part of existing installation and is not scope of this work. Main circuit flow will be regulated to reach a temperature of Ambient minus 1.5 degrees, measured at the output of the heat exchanger secondary connection.

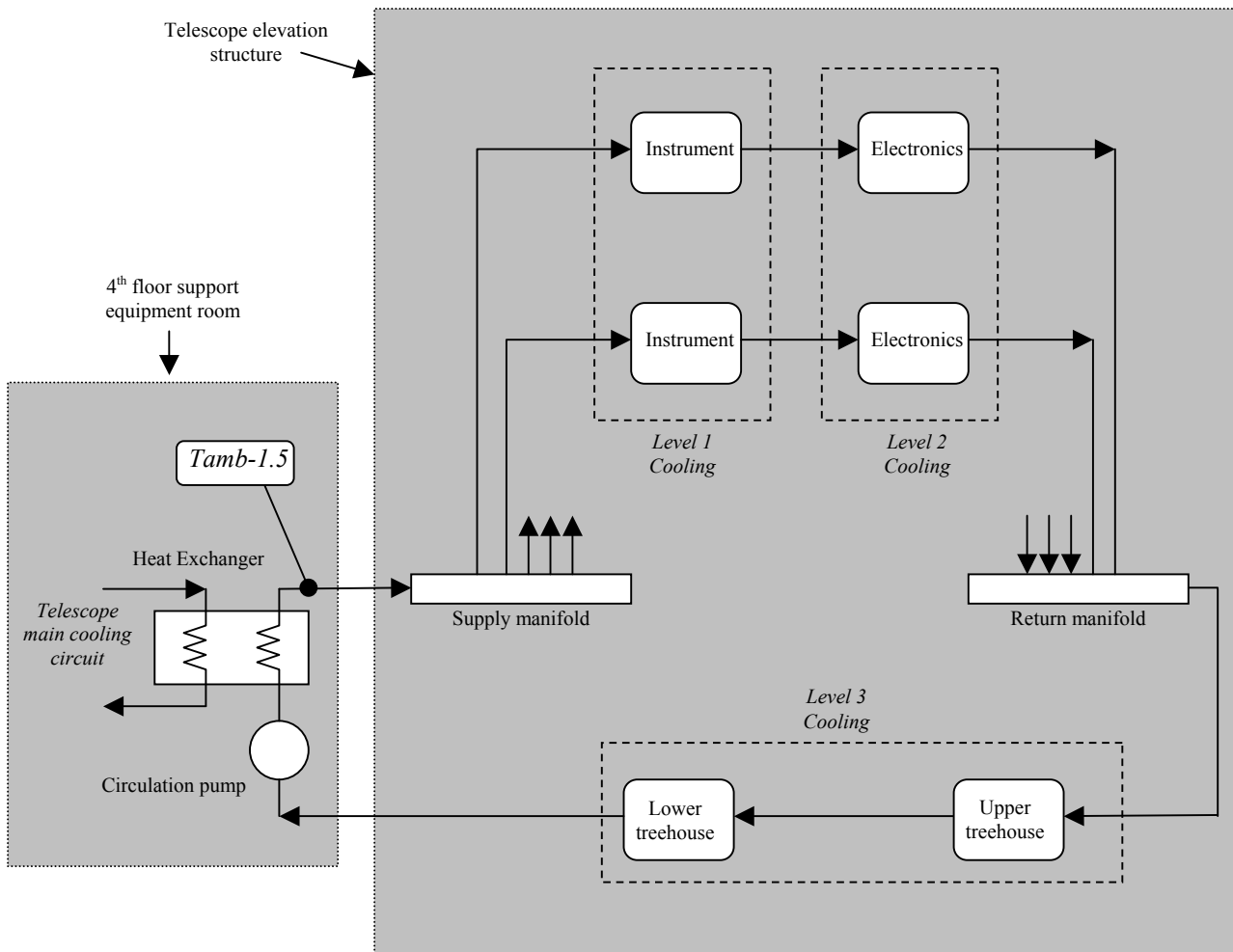


Figure 1 Cooling system overview

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Surface temperature of telescope instruments or other equipment located in the optical path (Level 1 cooling) must not exceed 1 degree above ambient air. All equipment in the Level 1 cooling category must remove dissipated heat using cooling liquid with a coolant supply temperature of 1.5 degrees below ambient and a coolant return temperature of 1 degree above ambient, or a delta T of 2.5 degrees (see Figure 2).

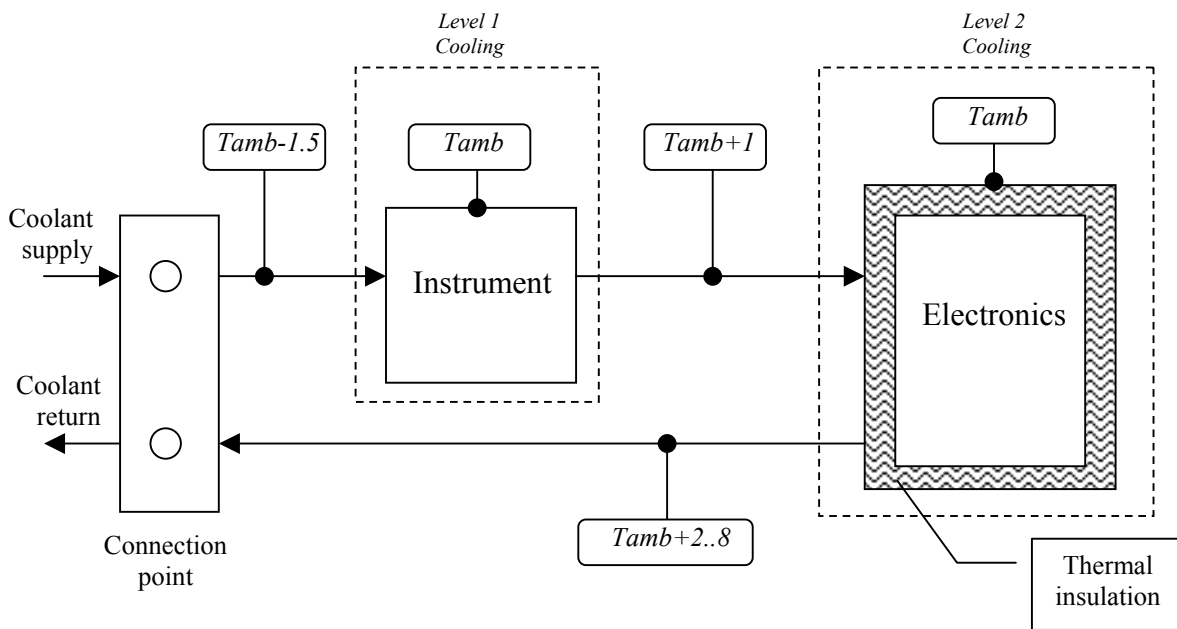


Figure 2 Instrument cooling example

The return flow from Instruments (Level 1 cooling) will be used to cool other equipment such as electronics racks (Level 2 cooling). Cabinets will be thermally insulated, and this will allow for a somewhat higher internal temperature without increasing surface temperature significantly above ambient. Coolant return temperature after Level 2 cooling circuit is expected to be in the range of 2 to 8 degrees C above ambient, depending on power dissipation inside electronics cabinet.

It should be noted that not all instruments require both Level 1 and Level 2 cooling (refer to Table 1).

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5.2. Treehouse cooling

In addition to Instruments (Level 1 cooling) and Electronic racks (Level 2 cooling) there are two (per telescope side) thermally insulated enclosed rooms on the telescope. Those rooms are referred to as Lower and Upper Treehouse. The Treehouses provide mounting space for electronic equipment. For treehouse cooling there is a requirement for water to air heat exchangers (air handlers) to cool the air inside the treehouses. The treehouses shall be cooled by telescope return manifold coolant flow.

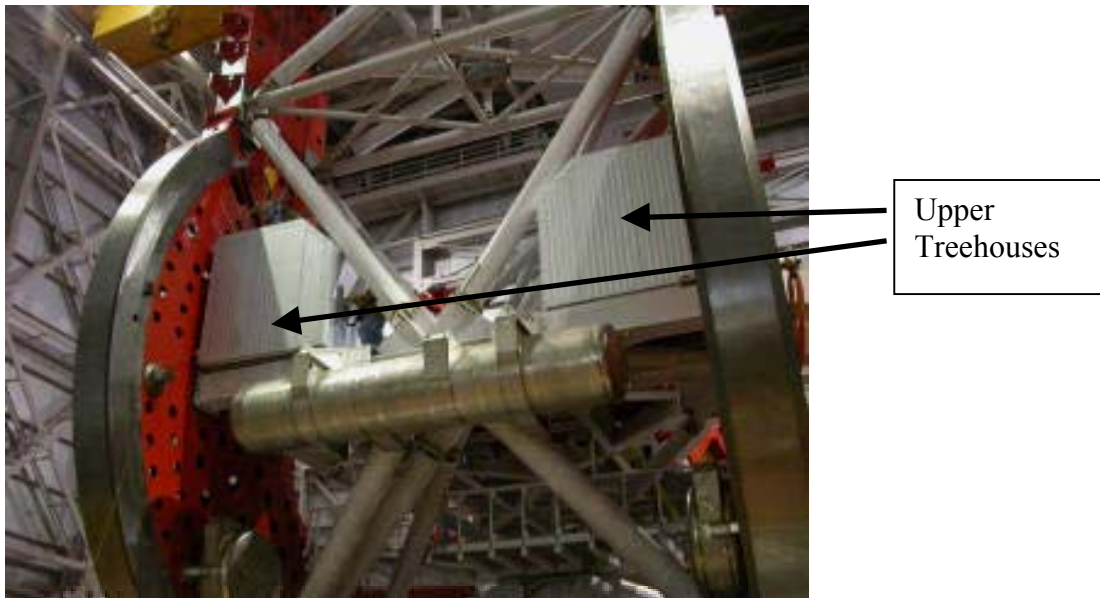


Figure 3 Treehouses

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5.3. Cooling connection points

For easy connection and disconnection of equipment on the telescope, a number of connection points shall be installed. One connection point per line item in Table 1 is required. Each connection point shall have a separate feed/return to the manifolds (see Figure 1).

Each connection point shall be easily accessible and clearly identified with a label (Connection point name and supply/return identification). All connection points (supply and return) shall be equipped with a shut-off valve and quick couplings for easy connection and disconnection of equipment.

5.4. Ambient temperature range

Ambient temperature range is -20 to +25 degrees C.

5.5. Cooling medium

The coolant used is a mixture of 50% water and 50% ethylene glycol.

5.6. System pressure

The maximum specified pressure of the coolant for instruments and LBT672 on the telescope is 6.9 bar (100 psi). Differential pressure shall be at least 2 bar, measured at the top of the telescope at zenith pointing.

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5.7. Distribution system

Thermal insulation for coolant distribution pipes is required to reduce risk of condensation and to reduce thermal losses. Each connection point shall be easily accessible and clearly identified with a label (Connection point name and supply/return identification). Every connection point (supply and return shall be equipped with a shut-off valve and quick couplings for easy connection and disconnection of equipment.

Flow regulation valves for flow balancing shall be provided at the manifold for each individual branch.

5.8. Instrumentation

Each manifold (supply and return manifold) shall be equipped with local (manual gauges) and electronic transmitters as follows. All electronic transmitters shall operate with 24V DC supply, and deliver a 4-20mA process signal.

5.8.1. Flow meter

Unit: Liters per minute
Measuring range: TBD
Accuracy: Within 5% of output signal
Resolution: Better than 1% of measuring range

5.8.2. Pressure gauge

Unit: Bar
Measuring range: 0-10 Bar
Accuracy: Within 5% of output signal
Resolution: Better than 0.1 Bar

5.8.3. Temperature sensors

Unit: Degrees C
Measuring range: -25 to +50 degrees C
Accuracy: +/- 0.5 degrees C
Resolution: 0.1 degrees C

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6. Cooling requirements

Distribution point	Level 1 cooling	Level 2 cooling	Level 3 cooling
Adaptive secondary	1800W	700W	-
BGF (Lucifer)	0	1750W	-
BGF AGW	1500W	0	-
BGC (LBTI)	2000W	1000W	-
BGC AGW	0	0	-
BGR (LINC)	2000W	1000W	-
BGR AGW	0	0	-
DG (MODS)	1000W	1500W	-
DG AGW	1500W	0	-
PEPSI	500W	0	-
LBC	0	300W	-
M3	100W	0	-
Upper treehouse	-	-	10kW
Lower treehouse	-	-	10kW

Table 1 Distribution points

Note: Some entries in Table 1 are 0. This means that there is no equipment connected to this connection point at this time. Most likely equipment will be added to the telescope in the future, and connection points shall be provided for all locations in Table 1 above.

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