CLS Liquid Nitrogen System Specification

8.4.28.2 Rev. 0

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1 INTRODUCTION

1.1 Purpose

This document specifies the requirements for the Canadian Light Source (CLS) Liquid Nitrogen (LN2) system for use with the cryogenic refrigeration system, beamline distribution, and CLS superconducting RF cavity.

The Canadian Light Source requires a LN2 storage and distribution system to supply LN2 to the liquid helium cryogenic plant; beamline distribution points on the CLS storage ring and a dewar fill location. The cryogenic system is to be designed, fabricated, delivered to the CLS site, installed and tested for use with the refrigeration plant. The cryogenic system shall be designed with the flexibility to allow for expansion of its distribution capacity in the future.

1.2 Scope

The LN2 system includes the LN2 storage dewar, cryogenic distribution system with keep fulls, gaseous N2 exhaust system and an LN2 inventory (option), required to deliver the cryogens to the cryogenics room, top of the storage ring for beamline distribution and a fill dewar location. The Proponent shall also supply any other components required to meet the requirements outlined in this specification or required to provide a complete and operating system.

This specification details the requirements for the design, fabrication, supply, installation and testing of the system. This work includes, but is not limited to:

- Materials
- Equipment
- Commercial components
- Detailed drawings
- Fabrication
- Delivery to site
- Assembly
- Installation
- Testing and Inspections
- Quality Assurance /Quality Control documentation
- Commissioning and Owner Training
- Initial Operation

1.3 Background

The Canadian Light Source, CLS, is a national facility under construction on the University of Saskatchewan campus in Saskatoon, Saskatchewan. This facility is a 3rd generation synchrotron light source, which will produce a high intensity source of infrared, visible, ultraviolet and x-ray radiation.

This facility will use a superconducting (SC) RF acceleration module immersed in a bath of L He. The liquid helium transport line requires a supply if liquid nitrogen for thermal shielding. LN2 flow of up to

2,740 litres LN2 per day used to cool the intercepts on all the thermal transition pieces between the LHe system and the room temperature components.

In addition to supplying the LHe refrigeration system, a LN2 distribution system is required on top of the storage ring tunnel to supply beamlines with LN2 to cool optical components within the beamlines. Preliminary requirements indicate that each of nine (9) distribution point on the tunnel shall be capable of supplying up to 700 litres LN2 per day, with a total consumption at all points of 5,400 litres of LN2 per day.

Further to the thermal shielding and beamline distribution systems, LN2 is required at a single fill point for small portable dewars to service various areas of the CLS. This portion of the LN2 system shall be capable of supplying 500 litres of LN2 per day.

More detailed information on the LHe cryogenics specification can be found in the CLS Cryogenics System Specification 8.4.28.1 Rev. A.

2 LIQUID NITROGEN STORAGE & DISTRIBUTION SYSTEM REQUIREMENTS

2.1 Functional Requirements

2.1.1 The Proponent shall supply one complete “turn-key” LN2 cryogenic system used to store and distribute LN2 to the Cryogenics Room (1061), nine (9) locations on the CLS storage ring and one (1) location in the Loading Dock (1069).

2.1.2 Provide an external connection point for tanker filling of the system to replace the storage tank for periods of maintenance or malfunction.

2.1.3 All large components of the cryogenic system shall be equipped with crane attachments for lifting the components. The gravitational centre of all large components shall be marked.

2.1.4 Unless otherwise stated, the Proponent shall supply all monitoring transducers (e.g., temperature, flow, pressure and fluid levels) required for adequate monitoring of the system.

2.1.5 Provisions shall be made for remote control and monitoring by the CLS control system. The Proponent shall allot a minimum of 10% spare space for additional monitoring points that may be required in the future operation of the cryogenic system. The Proponent shall state the spare space allocated for future expansion.

2.1.6 The nitrogen control system shall be designed to interface with the CLS Distributed Control System (DCS). The interface may use EPICS communication protocols, RS-232, RS-485, Modbus Plus, or Profibus. The interface shall be reviewed and accepted by the CLS before being implemented.

2.1.7 If a Programmable logic controller (PLC) is used, it should be based on a Modicon Momentum, Siemens S7/300 or Siemens S7/400 controller. All PLC control software programs shall be provided by the Proponent, in source form as well as installed on the PLC hardware.

2.1.8 Controller hardware and software must be reviewed and accepted by the CLS to verify adherence to the CLS standard control protocols and standards.

2.1.9 The cryogenic system shall be configured to allow for convenient purging and testing of the system.

2.1.10 The cryogenic system shall be designed with the flexibility to allow for future expansion of its capacity and/or distribution.

2.1.11 The cryogenic system shall remain safe for all personnel and equipment under the conditions of a system power failure. The Proponent is strongly encouraged to base its design on the likelihood of more than 3 full system power failures per year. The Proponent shall make specific reference to the CLS as to the limitations/strengths of the proposed system under power failure conditions, and recommend enhancements that may be implemented to minimize problems.

2.1.12 The LN2 tank shall be equipped as to allow for the supply of dry N2 gas to the CLS. The system shall have the capability of drawing either N2 gas from the tank for low gas requirements or LN2 to facilitate larger N2 gas requirements. This system may be developed as a future expansion to the system but is included in the initial installations at this time.

2.1.13 The Proponent shall supply and implement all interlocks required.

2.1.14 All valves shall be low heat loss valves designed for use with LN2.

TRANSFER LINES

2.1.15 All LN2 lines should be high quality stainless steel and be vacuum jacketed. This line shall attach to the external LN2 storage tank and supply a dewar filling point, the cryogenics room, and beamline distribution points located on the roof of the storage ring shielding tunnel. Details of the distribution points can be found in the Drawings.

2.1.16 All transfer lines shall be equipped with adequate “keep-full” devices or “phase separators” to eliminate the flow of slugs of gas in the transfer lines.

2.1.17 The Proponent should use reusable gaskets on the outer vacuum jacket. This will avoid the problem of having to disconnect all inner lines to insert a new gasket for the outer vacuum jacket.

2.1.18 The Proponent shall work together with the CLS to establish the routing of the distribution line used to transfer LN2 within the CLS.

2.1.19 All piping shall be designed so as to eliminate condensed water and the forming of ice along the piping surfaces.

2.1.20 Piping shall be designed to eliminate problems associated with thermal deformation stresses resulting from warming or cooling of pipe runs. The Proponent shall incorporate adequate flex sections or sections of flexible piping so that rigid piping sections are not subject to thermal deformations. The Proponent shall supply flex sections (or other methods of mechanical and vibration isolation) spanning the concrete isolation joint located between the outer building and the main building floor slab.

2.1.21 The Proponent shall do calculations to determine the expected pressure drops within the distribution system. The Proponent shall provide these to the CLS at the time of the bid.

2.1.22 Any connections in the distribution line requiring welded connections shall be clearly indicated by the Proponent. The Proponent shall be responsible for all such welds.

2.1.23 Transfer lines shall be equipped with spare ports with shut-off valves to allow for future gauges and sensors to be installed. This shall include, but not be limited to, the cryogenics room, dewar fill station, and at least 3 locations on the beamline systems. The implementation of these extra ports shall be coordinated between the Proponent and the CLS.

LIQUID NITROGEN STORAGE

2.1.24 The Proponent shall supply a 40,000 litre LN2 storage tank.

2.1.25 The outer vessel of the LN2 tank shall be equipped with a relief valve and a pump-out port for the insulation vacuum.

2.1.26 The Proponent shall supply a pump-out port to the main LN2 vessel. This port shall be equipped with a manual valve.

2.1.27 The LN2 tank shall be equipped for both remote and local measurement of the N_2 vapour pressure.

2.1.28 The LN2 storage tank shall be equipped with one main and one spare port to allow for filling of the tank from a supply tanker.

2.1.29 The Proponent shall supply the facilities required to evacuate N_2 from all vents.

2.1.30 The storage system shall be an all-metal system.

2.1.31 The available space for the LN2 storage can be seen in the figure Liquid Nitrogen Layout and Piping Plan, BLDG/ME/CRYO/0066000 Rev. A. The concrete pad exterior to the building, labelled “Gas Farm” on Cryogenic Layout Proposal shall be used for the gas storage facilities. Approximately half of this pad is available for LN2 gas storage. The remaining pad is designated for a 60,000 litre vertical L He storage tank. Dimensions of the pad are shown on Liquid Nitrogen Layout and Piping Plan, BLDG/ME/CRYO/0066000 Rev. A. Any additional space requirements shall be subject to review and acceptance by the CLS. Preference will be given to designs that can fit into the allotted space.

2.1.32 OTHER COMPONENTS

2.1.33 The Proponent shall provide adequate temperature monitoring. Non-cryogenic temperature monitoring shall be accomplished with 100 ohm platinum resistive temperature detectors (PRTD) with an $\alpha = 0.00385$ (IEC) temperature coefficient. All temperature measurements shall be 3-wire measurements. The sensor elements should have a ¼ inch diameter stainless steel sheath, six inches long, to be compatible with other CLS sensors. The Proponent shall provide all thermal wells required for temperature measurement. Cryogenic temperature monitoring shall be accomplished with cryogenic linear temperature sensors (CLTS). Cryogenic temperature sensors should read out in Kelvin. The method, location, number of temperature monitoring points, and accuracy shall be reviewed and accepted by the CLS. The Proponent shall supply the signal processing for all temperature readings. Provisions shall be made for monitoring by CLS computers. The Proponent shall build in provisions for a minimum of 10 percent additional monitoring points to be added at a later date.

2.1.34 The Proponent shall supply the vent tubes from all burst disks and relief valves to connect up with the CLS venting system. The Proponent shall size these tubes to allow for handling of the vaporized gas without backpressure effects. Any vent tubes that may contain cold gases shall be permanently insulated. The specifics of the venting system shall be worked out as collaboration between the Proponent and the CLS.

2.1.35 The Proponent has the option to supply the Grade A LN2 (99.995% purity) to facilitate all of the required purging and pumping processes as well as the initial charging of the system. The Proponent shall provide the CLS with the expected amount of LN2 required for all purge and pump down processes, normal operational losses during commissioning and acceptance test procedures, and the initial charge of the system.

2.1.36 All tubes, pipes, and vacuum components shall be free of dust, dirt, scale, rust, flux residues, oil residues, solvents, grease, films etc., prior to assembly into the system. The Proponent shall thoroughly clean all components before they are fitted, to adhere to this specification. The Proponent shall outline any additional cleaning procedures that are required after initial assembly. The proposed cleaning procedures shall be made available to the CLS at the time of bid. Cleaning procedures shall be subject to review and acceptance by the CLS.

2.1.37 The Proponent shall provide sufficient piping flexibility to absorb equipment vibration. When piping passes through wall, it must not touch any part of the building and be supported by pipe hangers to prevent transmission of vibrations through the building.

2.2 Performance

2.2.1 The cryogenic system shall be designed to be capable of continuous operation while filling the storage tank or from the alternate tanker fill location.

2.2.2 The cryogenic system shall be capable of continuously delivering a maximum of 2,740 litres of LN2 per day to the Cryogenics Room locations (Room 1061), 500 litres LN2 per day to a dewar fill station in the Loading Dock (Room 1069), and 700 litres LN2 to each of the nine (9) distribution points on the storage ring tunnel for a total of 5,400 litres per day to the nine points. Extra capacity will be required to make up for heat losses in the distribution lines and neck cooling losses of any dewars.

2.2.3 The distribution system shall be designed with “keep fulls” where required.

2.2.4 The cryogenic system shall be equipped with a Nitrogen gas exhaust system.

2.2.5 Unless explicitly stated, all control and monitoring of the cryogenic system shall conform to the “CLS Design Specification Control System Overview“ [2].

2.2.6 The design floor load under any component should not exceed the following values:

1. The floor slab in the Cryogenic room: 4788 Pa (100 lbs/sq.ft.)
2. The main hall floor slab: 28730 Pa (600 lbs/sq.ft.)
3. The perimeter main hall slab: 4788 Pa (100 lbs/sq.ft.)
4. Main hall area over the basement: 3830 Pa (80 lbs/sq.ft.)
5. Roof of the storage ring shielding tunnel: 4788 Pa (100 lbs/sq.ft.)

6. The “Gas Farm” slab external to the building has a varying load capacity due to the pile configurations underneath it. The east half of the slab (nearest the building) has a load capacity of 90 tonnes, while the west half of the slab (furthest away from the building) has a load capacity of 110 tonnes (He storage tank).

Floor loading in excess of these values shall be subject to review and acceptance by the CLS.

2.2.7 All control and interlock signal inputs shall be 24 V DC and shall require less than 50 mA drive. Interfaces with CLS equipment shall be designed to work with external optical isolators.

2.2.8 All control and interlock signal outputs shall be 24 V DC and shall be able to switch a minimum of 50 mA and use optical or some other form of isolation.

TRANSFER LINES

2.2.9 The Proponent shall design the LN2 transfer lines to accommodate LN2 flow rates of 20 to 150 litres per hour to the cryogenics room, in addition to that required for the beamlines.

2.2.10 All vacuum vessel surfaces, and nitrogen transfer lines shall be designed so that the surfaces remain within +/- 5 K of the ambient temperature.

CRYOGENIC LIQUID STORAGE

2.2.11 The cryogenic system shall be capable of storing a minimum of 40,000 litres of LN2. It is expected to have a tanker truck deliver LN2 once a week to top up the tank.

2.2.12 The Proponent shall clearly outline the LN2 storage system at the time of the bid. This shall include, but not be limited to, the type of storage tanks used, the storage pressures, the storage capacity.

2.2.13 The LN2 storage system shall be equipped with adequate dual-redundant pressure relief valves set at the maximum system working pressure.

2.2.14 The LN2 tank shall be equipped with level detectors, to provide LN2 inventory. This information shall be available to the CLS control system.

2.2.15 The LN2 storage and distribution system shall be subject to review and acceptance by the CLS.

3 SAFETY AND ENVIRONMENTAL

3.1.1 The Proponent shall be responsible for providing protection from any potentially dangerous mechanical systems or cryogenic hazards that may be encountered in the normal operation of the cryogenic system.

3.1.2 The Proponent shall be responsible for the labelling of all potentially hazardous systems or components with standard type labels.

3.1.3 All piping and transfer lines shall be clearly labelled with information of the contents and flow direction.

3.1.4 The general layout of the main floor of the CLS is shown on Main Floor Mechanical Piping Plan, BLDG/PPG/WTR/0025427 Rev. 0. Potential space available on the surface of the storage ring tunnel is shown on Piping Sections, BLDG/ME/PPG/WTR/0025428 Rev. 1.

3.1.5 The cryogenic system shall be capable of operation in an ambient temperature range of 10°C to 40°C. The normal ambient temperature of the main floor area at the CLS is 23°C. The expected temperature stability of the main floor will be +/- 1° C during normal operation.

3.1.6 The main CLS building and the cryogenic room are equipped with an overhead sprinkler system. All components of the cryogenic system shall be installed in a “weather-resistant” condition or housed in “weather-resistant” cabinets that are capable of withstanding modest exposure to water or other fluids.

3.1.7 The components shall be able to withstand a relative humidity range of 0 % to 90%. The expected relative humidity limits under operation are from 25% during the winter months and a maximum of 50% during the summer months. The expected relative humidity range for components under storage will be the same as those for operation.

3.1.8 Any equipment located external to the building envelope will be designed for “outside” use. Over the course of one calendar year, the CLS may encounter temperatures ranging from –40°C to 40°C. All equipment that is to be used outside shall be designed to operate in a temperature range of –50°C to 60°C.

3.1.9 No components of the cryogenic system shall induce a vibration source to the floor greater than 0.4 microns at frequencies less than 100 Hz. All equipment/structures shall conform to the BKL report “Vibration Isolation Mechanical Equipment” [3]. The Proponent shall be responsible for the correction of any vibration problems resulting from its equipment for a period of up to 6 months after final acceptance.

3.1.10 All small tubing water connections shall be American standard Swagelok fittings. All large water tubing shall use NPT treads.

3.1.11 The cryogenic system shall be designed such that no component damage or personnel hazard shall result from any combination of a loss of instrument air, or a power failure.

3.1.12 AC input power will be supplied through a CLS-installed, external, manually operated disconnect switch, which is normally closed.

3.1.13 The electrical power supplied by the CLS will be 60 Hz AC. Each load connection shall be one of the voltage levels listed below and not exceed the current limits given in Table 1.

Table1: Load Connections

RMS voltage (V +/- 10 %)	Single or Three Phase	Maximum RMS current (A)
120	Single	15
208	Single	15
208	Three	30
600	Three	1900

Line voltage will exhibit instantaneous (faster than one millisecond) fluctuations of +/- 1.5 % and gradual variations of +/- 10 %. Brownout conditions involving instantaneous drops and restorations of 10 % are also observed.

3.1.14 The Proponent shall describe in detail the electrical power requirements at the time of the bid.

3.1.15 Every effort shall be made through careful design to keep the acoustic noise levels well below 60 dB. Noise levels above 60 dB limits effective communication and warning sounds such as sparking are masked. In instances where these noise specs cannot be reached, the Proponent shall state this to the CLS in the proposal. The Proponent may quote on the cost of additional noise abatement as an option.

3.1.16 In general, the cryogenic system can be set up and operated according to standard industrial practices. However, maintenance and testing in some cases may be expedited by deviating from standard practices provided extra precautions are taken to reduce hazard to an acceptable level before these deviations are permitted.

3.1.17 All volumes that have the ability to be isolated and contain liquid cryogens, or have the potential to result in over-pressures, shall be equipped with suitable relief valves. All such valves shall be easily accessible for inspection and resetting.

3.1.18 All relief valves looking at an area containing super-insulating materials shall be properly screened to protect from possible blockage.

3.1.19 All equipment must be housed in a suitable enclosure to prevent contact by personnel with high voltage or other dangerous components. These enclosures may be one of the following:

1. Permanent completely enclosed cabinets
   Permanent cabinets should be constructed of metal panels with plastic or safety glass for windows when necessary. They should be constructed so that it is impossible to touch high voltage from the outside with a thin conductor of reasonable length. These cabinets must provide protection for uninformed personnel and be suitable for unattended operation. Doors must be fitted with redundant and independent interlocks.
2. Permanent walk-in enclosures
   Walk-in enclosures may be used for equipment that occupies large areas. The walls of such enclosures must be a minimum of 2 m high and should be higher than the equipment. They may be constructed of perforated metal with openings smaller than 1 cm or have solid walls with safety glass or plastic windows to allow for a clear view of the inside. Access doors must be fitted with redundant and independent interlocks. Local control panels are required outside the enclosure but close to it so that the operator can readily check that no one is inside during operation. They must provide protection for uninformed personnel and be suitable for unattended operation.

Where exposed high voltage is present, cabinets or walk-in enclosures shall be equipped with grounding hooks to allow for the safe discharge of high voltage on equipment that may retain a charge. These grounding hooks should be positioned to prevent access without the hooks being moved.

4 APPLICABLE CODES, STANDARDS AND PROCEDURES

4.1.1 The following documents can be considered as part of this specification. All equipment shall be built in strict accordance with the following standards:

1. CSA Canadian Electrical Code 1998 Safety Standards for Electrical Installations [4]
2. B51-97 Boiler, Pressure Vessel, and Pressure Piping Code (CSA) [5]
3. ASME Boiler and Pressure Vessel Code Section VIII divisions 1 2 and 3 [6]
4. B52-99 Mechanical Refrigeration Code [7]
5. IEC 61508 - Functional Safety of Electrical/Electronic/Programmable Electronic Systems – Parts 2 and 3 [8] shall be applied to any computer system performing a personnel safety function.
6. The Saskatchewan Occupational Health and Safety Act and Regulations [9].

4.1.2 Unless otherwise specified, the issue date or revision level shall be that in effect on the date of the Invitation to Quote. Exceptions to these standards shall be reviewed and accepted by the CLS.

5 QUALITY ASSURANCE

5.1.1 The Proponent shall maintain and apply a quality assurance program compliant with ISO-9001 for the design, manufacture and testing of all components.

5.1.2 The guidelines of ISO-9000-Part 3 shall be followed for software.

6 INSPECTION, TESTING AND COMMISSIONING

6.1 The Proponent shall be responsible for the installation of the cryogenic system. The Proponent shall also provide the manpower for the installation. The Proponent should try and incorporate the use of CLS staff in the installation process during tasks that will be related to the long-term maintenance of the system. The Proponent shall supply a list of the CLS personnel (along with their required skills) it feels should be made available to participate in the installation process at the time of the bid.

6.2 The CLS main hall is equipped with a 10 tonne overhead crane. The crane has coverage extending from the loading area to drop areas above the booster ring and storage ring tunnels. The CLS has a pallet jack rated for 2000 kg (4500 lb). The Proponent must advise the CLS if additional handling equipment is required.

6.3 Installation and testing shall conform at all times to the local safety codes, including the Saskatchewan Occupational Health and Safety Act and Regulations and the CLSI Policies and Procedures.

6.4 The CLS reserves the right to have access to the Proponent's facility at any time during the fabrication and testing procedures. The CLS shall have the right to witness any manufacturing or testing procedures upon request. When requested, the Proponent shall provide a minimum of 21 days notice in advance of any test date to allow for the CLS to make the necessary travel arrangements.

6.5 The CLS reserves the right to require additional or more extensive tests to be conducted in the event of marginal design or performance.

6.6 The Proponent shall formulate acceptance test procedures for all components and will provide the facility and instrumentation to perform all relevant tests to ensure compliance with this specification. The acceptance test procedures shall include but not be limited to all of the testing procedures specifically outlined in this document.

6.7 All items purchased or manufactured by a subcontractor used in the work shall be clearly identified to the CLS.

6.8 Review and acceptance of the CLS shall not release the Proponent from its responsibility to correct errors, oversights and omissions to ensure conformance to the specifications in this document.

6.9 Refer to Section 7 for Cryogenic Acceptance Tests

7 ACCEPTANCE TESTS

7.1 Tests Off Site

7.1.1 The system shall undergo initial component testing at the Proponents site prior to shipment to the CLS. This testing shall include but not be limited to the following:

1. Pressure, vacuum and leak testing shall be performed on the distribution piping. All components that function in a vacuum shall be certified as being leak tight at the factory except for the field connections.
2. Leak test shall be performed on the LN2 storage tank. The CLS may require separate test to be performed or accept factory acceptance test depending upon the system proposed.
3. The CLS shall require factory acceptance tests on all major components including spares.

7.2 Final Acceptance Test at the CLS Site

7.2.1 Final acceptance of the cryogenic system shall require a successful test to be performed at the CLS.

7.2.2 Leak Tests:

1. All equipment shall be cleaned and demonstrated leak tight. All field connections shall be demonstrated as He leak tight.
2. All piping and components shall be leak tight to the insulating vacuum at room temperature and at the mean average working temperature. Leak rates shall be demonstrated to less than 1E-5 Pa*l/s He for the sealed vacuum.

3. The vacuum shielding of the transfer lines shall be leak tight at room temperature to a global leak rate of less than 1E-4 Pa*l/s He. Individual connections shall have leak rates less than 1E-6 Pa*l/s He.

7.2.3 All mechanical systems shall be checked for proper operation. All valves and actuators shall be stroked and verified to operate normally.

7.2.4 All sensors shall be checked for normal operation.

7.2.5 All interlock functions shall be checked for proper operation and indications. All fault status indicators shall latch until reset.

7.2.6 Control functions shall be exercised through all states.

7.2.7 The Proponent shall develop test procedures to verify all the major performance criteria of the liquid nitrogen system. This shall include test to verify the following:

1. Delivery of 2,140 litres per day to the Cryogenics Room at the CLS interface point.
2. Delivery of specified capacities to the beamline points.
3. Delivery of specified values to the dewar fill location.
4. Delivery of specified values to the transfer lines.
5. Heat leak measurements of the transfer lines.

The Proponent shall be responsible for any additional equipment that is required to perform these tests. This may include such items as a test dewar equipped with heater and liquid level sensor, additional cryogenic adapters, etc.

8 RELIABILITY AND MAINTAINABILITY

8.1 All elements of the cryogenic system shall be designed and manufactured with strong consideration for both reliability and serviceability. Access to all external connection points must be incorporated into the overall design.

8.2 The Proponent shall supply documentation to the CLS outlining the expected maintenance requirements and schedules for all major subsystems of the cryogenic system. The Proponent shall supply a list of recommended spare parts, along with cost information.

8.3 The cryogenic system shall be designed and constructed to be in continuous use with very limited maintenance periods throughout the year. Major maintenance periods will be scheduled twice a year and have a duration of approximately 10 working days. Weekly maintenance periods will likely be scheduled to last for one 8 hour time period. Weekly maintenance should not be required for the cryogenic system. The total maintenance time annually should not exceed 6 man-days.

8.4 All components shall have a minimum mean time between failure (MTBF) of 40,000 hours in the operational environment at the CLS as outlined in this specification.

8.5 The cryogenic system shall be designed and constructed in such a way as to supply access to any system components that are expected to fail in the normal operating environment. This will facilitate easy and timely replacement of such components upon failure or during scheduled maintenance periods. Any units that need to be removed from cabinets or racks for service shall be mounted on slides. The Proponents drawings shall show the positions of the major components in each subsystem.

8.6 The cryogenic system shall be designed and constructed with an expected operational lifetime of greater than 20 years.

8.7 All threaded mechanical fasteners should be American Standard Thread. The use of metric standards is negotiable with the CLS but not preferred. If metric standards are used, the proponent shall provided additional spare nuts and bolts.

8.8 When assembling any vacuum vessels or the cryogenic transfer lines it is important to assure proper alignment of the flanges to maintain proper continuity across each junction. All assemblies shall follow the procedures recommended by the manufacturer including the use of alignment tools, torque wrenches and the proper tightening sequences. The assembly procedures shall be provided to the CLS prior to equipment arrival at the CLS.

8.9 The Proponent shall be responsible to eliminate any detected ice spots on the Nitrogen lines for a period of up to 6 months after final acceptance test have been preformed. The Proponent accepts that re-piping of lines may be necessary to eliminate surface ice spots.

9 LAYOUT

9.1 The area available for installing the nitrogen system is shown on BLDG/ME/CRYO/0066000 Rev. A and its associated drawings. Deviations from this specification shall be subject to review and acceptance by the CLS. Access to the Cryogenics Room is limited. The Proponent shall identify its access needs to the CLS at the time of the bid.

9.2 The approximate location of connections to the valve box can be seen on BLDG/ME/CRYO/0066000 Rev. A. The proponent shall provide valves prior to connect to the cryogenics system equipment.

10 OTHER REQUIREMENTS AND CONSTRAINTS

10.1 The Proponent shall supply complete documentation of all components and subsystems contained in the cryogenic system. This documentation shall include but be not limited to the following:

1. Users/operation manual for the cryogenic system. These manuals shall contain, but not be limited to: specifications, operating instructions, hook-up instructions, circuit diagrams, block diagrams, PLC programs (also provided on CD-ROM), maintenance procedures (both operational and preventative), component data sheets, normal adjustments and calibration set up procedures.
2. A final parts list along with a list of recommended spare parts and their cost information.
3. A complete set of electrical and mechanical as-built drawings shall be supplied for each subsystem.
4. Layout diagrams of the full cryogenic system.
5. Mechanical layout diagram of all distribution lines.

All documentation should conform to the "CLS Documentation Specification" [10]. Electrical diagrams should be presented in Orcad® 9.2 or AutoCad® R14 or Autocad® 2000 or Cadsoft Eagle 3.5. Hardcopies shall be provided of all documentation along with copies on CD-ROM.

10.2 The Proponent shall provide the CLS with electronic copies of all custom developed source code, PLC programming and embedded logic in source and binary format on CD-ROM or equivalent media.

10.3 All measurement results shall be filed in hardcopy, on magnetic or optical media, and archived at the Proponent's location in duplicate.

10.4 One set of measurements in hardcopy and an electronic copy on magnetic media or optical (CD-ROM) shall be sent to CLS after all major assembly and measurement procedures. Frequent data transfer is encouraged.

10.5 The implementation of this specification is subject to a design review. The CLS reserves the right to hold this design review at the Proponent's facility prior to the start of fabrication. At this time, an agreement will be reached on drawings, data sheets, component specifications, manufacturing procedures, testing procedures, and production schedules. The Proponent shall notify the CLS of any changes, and all changes are subject to subsequent review and acceptance by the CLS.

10.6 The Proponent shall provide a detailed schedule for completing the work that is outlined in this specification. The CLS requires monthly updates to this schedule to track the Proponents progress. This schedule shall be accompanied by a monthly progress report to be received within the first 5 working days of each calendar month.

10.7 All equipment/structures shall be labelled with a unique serial number with details to be worked out with the CLS.

10.8 The Proponent shall assume the responsibility to evaluate and verify the feasibility of the proposed system before signing the contract with the CLS.

10.9 The Proponent shall supply adequate training for the operation and servicing of the proposed cryogenic system. This training shall include the following:

1. Supply of an operating manual (minimum 6 copies).
2. Training to a minimum of 3 CLS staff on Cryogenic operation through all operating modes outlined in section 4. During this training, the Proponent shall demonstrate operation of the cryogenic plant following the procedures outlined inside the operation manual.
3. Maintenance lists.
4. Training of CLS technical staff on the replacement of common maintenance items. When possible, the Proponent shall allow for CLS staff to replace parts under the Proponents supervision as part of the training.
5. Supply of trouble shooting checklists and instruction of its application during abnormal plant operation.

10.10 All equipment supplied will bear the approval of the Canadian Standards Association (CSA). Where CSA approval is not available, the Proponent will secure approval of the Technical Safety Services Branch of the Department of Industry and Labour, Province of Saskatchewan prior to shipment of equipment to site. Evidence of such approval will be presented to the Owner, prior to shipment of the equipment from the factory.

10.11 The Proponent shall package all components to insure acceptance and safe delivery by a common or other carrier, and so components can be delivered in an undamaged condition.

10.12 All major components shall have a stainless steel or aluminium nameplate on each unit that shall include the following information:

Manufacturer's name and address
Equipment type and serial number
Input ratings
Output ratings
Gross weight of the unit
Date of manufacture
Cooling requirements (if required)

10.13 All shipping containers shall be marked or tagged with the following information:

1. CLS purchase order number.
2. Shipping address as specified within the contract.
3. Proponent's name.
4. Components contained within each package.
5. "Top-side up" if required.
6. "Fragile" if required.

All shipping containers shall contain an accelerometer to register shocks that the equipment was subject to during shipping.

11 REFERENCES

11.1 Drawings

1. Liquid Nitrogen Layout and Piping Plan, BLDG/ME/CRYO/0066000 Rev. A
2. Main Floor Mechanical Piping Plan, BLDG/PPE/WTR/0025427, Rev. 0
3. Piping Sections, BLDG/ME/PPG/WTR/0025428, Rev. 1
4. Mechanical Piping Sections and Details, BLDG/ME/PPG/WTR/0025429 Rev. 0

11.2 Documents

1. "CLS Design Specification Control System Overview" 7.4.39.1 Rev. 1
2. BKL Report "Vibration Isolation Mechanical Equipment, Rev. 2".
3. CSA Canadian Electrical Code 1998 Safety Standards for Electrical Installations.
4. B51-97 Boiler, Pressure Vessel, and Pressure Piping Code (CSA)
5. ASME Boiler and Pressure Vessel Code Section VIII divisions 1 2 and 3.
6. B52-99 Mechanical Refrigeration Code.
7. IEC 61508 - Functional Safety of Electrical/Electronic/Programmable Electronic Systems – Parts 2 and 3.
8. The Saskatchewan Occupational Health and Safety Act and Regulations
9. "CLS Documentation Specification" 0.4.1.1 Rev. 1 (previously known as: 2.42.01.001 Rev. 1).