

Technical Specifications for the Construction of Optical Enclosures for Hard and Soft X-Ray Beamlines at the Canadian Light Source

6.8.71.1 Rev. 0

Date: 2003-04-16

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REVISION HISTORY

<i>Revision</i>	<i>Date</i>	<i>Description</i>	<i>Author</i>
A		Original Draft	Tom Kotzer
0	2003-04-16	Issued for Use	Tom Kotzer

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1.0 INTRODUCTION

Operational photon beamlines at the Canadian Light Source Facility require optical enclosures at specified locations to ensure that personnel and members of the general public in the immediate vicinity of a beamline at the CLS facility will not be exposed to levels of radiation, from both Synchrotron and Bremsstrahlung (primary and secondary) radiation sources, which exceed the specified Dose Equivalent Limits of 1 mSv/yr [1, 2]. This technical specification establishes the requirements for the design, fabrication, inspection, delivery and erection of radiation shielding enclosures for x-ray beamlines at the Canadian Light Source Facility (CLS). These enclosures are of varying sizes, are lead lined and house experimental instrumentation. The enclosures fall into two main categories (which are defined in Section 1.2): Primary Optical Enclosure (POE) and Secondary Optical Enclosure (SOE).

1.1 PURPOSE AND SCOPE

The purpose of this document is to specify the requirements of a Proponent to supply the various optical enclosures for hard and soft x-ray beamlines at the CLS. This technical specification describes common aspects of the enclosure design, and includes general Enclosure-Specific Layout drawings specifying the configuration and design details for each typical enclosure (e.g., size, location, and position of doors, chicanes, utilities, wall penetrations, etc.). As well, design detail drawings for more common aspects of each of the enclosures (e.g. doors and door assemblies, chicanes and enclosure wall construction, etc.) are used to indicate deviations from the typical enclosure configuration.

1.2 GENERAL BACKGROUND AND ENCLOSURE DETAILS

Hard x-ray beamlines will incorporate two types of shielded radiation enclosures [2] being,

- 1) Primary Optical Enclosure(s) (POE) which contain Synchrotron and high energy Bremsstrahlung (or secondary Bremsstrahlung) radiation. There can be more than one POE on a beamline, with the final POE on a beamline containing shielding mechanisms to attenuate bremsstrahlung and scattered synchrotron radiation.
- 2) A Secondary Optical Enclosure (SOE) for synchrotron radiation

Soft x-ray beamlines require only one shielded radiation enclosure which is a Primary Optical Enclosure (POE) containing both Synchrotron and Bremsstrahlung radiation. In this document, the beamlines and their required enclosures, along with Enclosure-Specific Layout drawings, are indicated in TABLE 1. More specific details of lead shielding requirements and steel wall thicknesses of the various optical enclosures are presented in TABLES 2 and 3. Enclosure-Specific Layout drawings for the various beamline optical enclosures and associated Design Detail engineering drawings are also included within the scope of this report.

TABLE 1: Beamline ID, Beamline Description and Required Enclosures

Beamline ID	Description	Enclosure	Enclosure Layout Drawing #(s) ¹
11ID-1	High Resolution Spherical Grating Monochromator (SGM)	POE*	11ID-1/ME/0066200 11ID-1/STRC/SHD/0090900 11ID-1/STRC/SHD/0090901

11ID-2	Variable Line Spacing Plane Grating Monochromator (VLSPGM)	POE*	SAME AS ABOVE
10ID-1	Soft X-ray Spectromicroscopy Beamline	POE	10ID-1/ME/0052800 10ID-1/STRC/SHD/0091301 10ID-1/STRC/SHD/0091300
08ID-1	Canadian Macromolecular Crystallography Facility Beamline	2 POE, SOE	08ID-1/ME/0048300 08ID-1/STRC/SHD/0091601 08ID-1/STRC/SHD/0091600 08ID-1/STRC/SHD/0091501 08ID-1/STRC/SHD/0091500 08ID-1/STRC/SHD/0091401 08ID-1/STRC/SHD/0091400
06ID-1	Hard X-Ray EXAFS Beamline	POE, SOE	06ID-1/ME/0048000 06ID-1/STRC/SHD/0091801 06ID-1/STRC/SHD/0091800 06ID-1/STRC/SHD/0091701 06ID-1/STRC/SHD/0091700

Remarks

* - SGM and VLSPGM share 1 common POE

1) Note conceptual drawings only

2.0 REQUIREMENTS

2.1 GENERAL

2.1.1 The outside dimensions for each enclosure are defined on the applicable Enclosure Layout drawing attached to this technical specification (TABLE 1). Enclosure Layout drawings are for conceptual use. Proponent shall design all detailed aspects of the enclosures.

2.1.2 Submittals describing the contractors' selection of equipment and hardware shall be reviewed and accepted by CLS before procurement or installation of equipment and hardware shall begin.

2.1.3 All fasteners shall be American Standard thread.

2.1.4 Floor Elevations may vary ± 12.5 mm over a distance of 3 m.

2.1.5 Enclosure wall panels shall conform to the Experimental Hall concrete floor and fit without any gaps or voids between the underside of the panel and the floor. The use of shielding fillers and materials as gaskets to fill any gaps or voids is acceptable. Wall panels must be sealed to avoid shine and other reflected radiation which may include extending shielding beyond the wall footprint.

2.1.6 Enclosure wall panels attached to the existing concrete shielding walls shall fit without any gaps or voids between the panels and the walls. The use of appropriate shielding fillers and materials as gaskets to fill any gaps or voids is acceptable. Wall panels must be sealed to avoid shine and other reflected radiation which may include extending shielding beyond the wall footprint. The maximum deviation of the wall shielding is ± 12.5 mm.

2.1.7 MATERIALS REQUIREMENTS

- 2.1.7.1** Technical specification, and certification of materials used in the enclosure fabrication shall be submitted to CLS for review and acceptance.
- 2.1.7.2** All materials used inside the enclosure shall be capable of withstanding a high x-radiation environment.
- 2.1.7.3** Low carbon steel should be used to form all panels, and structural members.
- 2.1.7.4** Lead sheet materials used shall be constructed from single un-pierced sheet and free of oxide inclusions, fissures, voids and all other detrimental effects. Material shall be Lead Grade L5006 and will comply with ASTM B29-92.
- 2.1.7.5** Paint shall be white. A sample shall be submitted to the CLS for review and acceptance.

2.1.8 SHIELDING REQUIREMENTS

- 2.1.8.1** The lead shielding requirements are given in TABLE 2.
- 2.1.8.2** Back wall refers to the wall through which the x-ray beam exits or is stopped in the enclosure.
- 2.1.8.3** Side walls are all other walls (this encompasses “Frontwall” on SOE).

2.1.9 Lead Requirements in Enclosure Walls

- 2.1.9.1** Calculations to establish the lead thicknesses necessary for adequate shielding of Synchrotron [3] and Bremsstrahlung [4, 5] radiation and ensure ALARA for personnel working in the vicinity of the POE and SOE have been done. TABLE 2 lists the lead shielding requirements for the enclosure walls.

TABLE 2: Type of enclosure and required wall and roof lead thickness on each beamline at the CLS (refer to Enclosure Layout Drawings listed in Table 1)

ENCLOSURE TYPE	Beamline #	LEAD THICKNESS REQUIREMENTS (mm)	LEAD THICKNESS REQUIREMENTS (mm)	LEAD THICKNESS REQUIREMENTS (mm)
		ROOF	SIDEWALL (FRONTWALL) ⁵	BACKWALL
POE ¹	11ID-1	10	10(30 locally) ³	30(130 locally) ⁴
	11ID-2	10	10(30 locally) ³	30(130 locally) ⁴
	10ID-1	10	10(30 locally) ³	30(130 locally) ⁴
	08ID-1	10	10(30 locally) ³	30(130 locally) ⁴
	06ID-1	10	10(30 locally) ³	30(130 locally) ⁴
POE ¹	08ID-1	10	10(30 locally) ³	30(130 locally) ⁴
SOE ²	08ID-1	1.0	1.0	3.0
	06ID-1	3.0	4.0	5.0

Remarks

NA= not applicable

- (1) POE lead thicknesses from References [3, 4, 5]
 (2) Lead thickness for SOE from [3] - (see Table 6)

- (3) Incremental local lead shielding requirements for POE (s) sidewall (defined in Section 2.1.10.3). Reference [4]
- (4) Incremental local lead shielding requirements for POE (s) backwall (defined in Section 2.1.10.4). Reference [4]
- (5) Frontwall thickness dimension refers to Frontwall of SOE only.

2.1.9.2 The enclosure walls shall be comprised of lead and steel sandwiches. Radiation shielding calculations indicate the minimum thickness of steel, divided equally amongst inner and outer sandwiches for the enclosure walls to be as follows (TABLE 3):

Table 3: Thickness of steel for enclosure walls

Beamline	POE (mm)	SOE (mm)	Reference
11ID-1	6.0	NA	([3] – Table 11.3)
11ID-2	6.0	NA	([3] – Table 11.3)
10ID-1	6.0	NA	([3] – Table 11.3)
08ID-1	6.0	6.0	([3] – Table 11.3)
06ID-1	6.0	6.0	([3] – Table 11.3)
02B2-2	NA	6.0	([3] – Table 11.3)

Remarks:

NA= not applicable

2.1.10 Additional lead thickness requirements in Back- and Sidewalls of POE

- 2.1.10.1** POE (s) shall have additional localized lead shielding (TABLE 2) installed on the back wall and sidewalls of the enclosure interior [6].
- 2.1.10.2** The localized shielding shall be thickest at beam height and reduced at a greater distance away from beam height.
- 2.1.10.3** The localized sidewall shielding shall be comprised of an additional 20 mm thickness of lead centered at beam height and having a total vertical dimension of 1 m and a horizontal dimension equal to the total wall length as outlined in the Enclosure Layout drawings for each individual POE (s) listed in TABLE 1.
- 2.1.10.4** The localized backwall shielding shall be comprised of an additional thickness of lead which shall have dimensions of 1 m (height) x 1 m (width) x 100 mm (thick) on beamline center.

2.2 STRUCTURAL SYSTEM

- 2.2.1** Enclosure structures and their elements shall be designed following National Building Code, 1995.
- 2.2.2** Dead loads shall include: 1) 5 kPa (100 psf) for the roofs and 2) 900 N·m (200 footpounds) per horizontal linear meter (foot) of wall (to support shelving and equipment mounted on the enclosure interior Unistrut).
- 2.2.3** Live loads shall include 2 kPa (40 psf) and lateral forces of the opening and closing doors.

2.2.4 Design loads shall include loads that can occur during construction and installation of the enclosure.

2.3 GENERAL OPTICAL ENCLOSURE WALL CONSTRUCTION

2.3.1 All enclosures shall be built such that all lead shielding requirements be met in all areas of the hutches including doors, joints, service entries, etc. (Design Detail Drawing #11ID-1/STRC/SHD/0090903). E.g. All joints, corners, penetrations, doors, etc., shall be suitably overlapped and fitted with lead and steel to prevent the leakage of x-rays from the enclosure.

2.3.2 Lead lined panels shall be constructed using single lead sheets, which are approximately 1 m wide x 3.6 m high and free of any defects. Refer to TABLE 2 for default lead thickness requirements.

2.3.3 The enclosures shall be of a modular design, with panels that are bolted together and assembled on the Experimental floor.

2.3.4 Panels shall be manufactured with the lead enclosed within a steel cover having minimum thicknesses specified in TABLE 3.

2.3.5 A steel frame shall be designed and welded to each panel in order that it can be assembled with other panels into an enclosure.

2.3.6 The assembled panels shall create a structural system capable of supporting the enclosure as a whole and equipment mounted on the enclosure.

2.3.7 Each panel joint shall have Unistrut mounted on the interior side and be sandwiched between the steel frames of adjoining panels. These Unistrut tracks provide a means to mount hardware on the enclosure interior.

2.4 PERSONNEL ACCESS DOORS FOR POE, SOE

2.4.1 Access to the station for both personnel and equipment shall be provided through pneumatically operated, rail-mounted sliding doors and swinging man-doors as indicated in each of the Enclosure Layout drawings (TABLE 1).

2.4.2 The dimension, location and type of door for each optical enclosure on a specific beamline shall be as noted in the Enclosure Layout drawings (TABLE 1).

2.4.3 Design Detail drawing #11ID-1/STRC/SHD/0090902 shall be used to constrain common aspects of door construction.

2.4.4 The door panels should be constructed in a manner similar to the wall panels with lead encased in steel.

2.4.5 Thickness of lead shielding in all doors shall be equivalent to the thickest part of the relevant sidewall.

2.4.6 Sliding doors on POE (s) shall be recessed into cement floor according to Design Detail drawing # 11ID-1/ STRC/ SHD/ 0090902.

2.4.7 Vertical adjustment on sliding doors for POE shall be on the order of 30 mm (5 mm above and 25 mm below floor level).

2.4.8 Doors on SOE shall be flush-mounted with the floor with 25 mm vertical adjustment above floor level.

2.4.9 All doors shall be designed to minimize radiation leakage.

2.4.10 Doorstops are to be installed to set the open and closed position of each door.

2.4.11 Manual doors shall be provided with handles for opening and closing.

2.4.12 The pneumatic doors shall be provided with interior handles for opening the door in the manual override mode

2.5 DOOR CONTROLS

2.5.1 All access doors shall be equipped with two (2) sets of closed position limits for redundancy.

2.5.2 Pneumatically-operated doors:

2.5.2.1 Shall have an exterior control box with I/O terminal strips and gas-pressure regulator (800 kPa or 120 psi) and an interior-mounted control box with I/O terminal strips.

2.5.2.2 Shall have pneumatic actuator devices, locking mechanisms, solenoids and limit switches, all rated for 24 V DC control.

2.5.2.3 Shall have an emergency override to vent the pneumatic drive for manual operation of the door.

2.5.3 All manual doors shall be provided with interior, surface-mounted latches to secure the door to the floor and to the transom in the closed position.

2.6 CHICANED OPENINGS

2.6.1 Chicanes shall be designed to allow cables and piping to be brought into the enclosures.

2.6.2 Chicanes shall be designed to reduce radiation leaking from the enclosure.

2.6.3 The general chicane layout is shown in Design Detail drawing #1 IID-1/STRC/SHD/00909004.

2.6.4 All chicanes shall have hinged covers, which are lockable.

2.6.5 Ceiling panels shall be provided with a cutout for a chicane and mounted with a cover or blanked off as noted in the Enclosure Layout drawings.

2.6.6 Side mounted chicanes below beam level on any sidewall of the optical enclosure should have the opening facing downwards. Any chicanes mounted above beam level should have the opening facing upwards.

2.6.7 Ceiling chicanes that are mounted on the roof of the optical enclosure may have their openings facing sideways, inboard or outboard.

2.7 CRANES

2.7.1 All enclosures shall be equipped with a 1000 kg chain hoist.

2.7.2 Hoists shall be suspended from a bridge-mounted trolley. The bridge and trolley shall be supported by rails and mounted on the enclosure ceiling with their placement indicated in specific Enclosure Layout drawings (TABLE 1).

2.7.3 Clearance under the rails shall be maximized.

2.7.4 Crane design shall conform to CSA-B167 (1964).

2.8 ELECTRICAL

2.8.1 GENERAL

2.8.1.1 Final locations and sizes of conduits, wireways, and panel boxes shall be completed during the final design phase.

- 2.8.1.2** All installations shall comply with the Canadian Electrical Code.
- 2.8.1.3** Each enclosure shall be wired for 120/208VAC from two separate power sources. One power source will provide clean power using an isolated ground, the other, dirty power. Each source shall feed panel boards located on the outside of the enclosures as indicated on the applicable drawings attached to this specification.
- 2.8.1.4** Electrical equipment shall be installed in a neat and workmanlike manner and be reviewed and accepted by CLS.

2.8.2 PANEL BOARDS

- 2.8.2.1** All panel boards shall be Seimens P1C42ML250CTS copper bus.
- 2.8.2.2** All panel boards shall be surface-mount type, unless otherwise noted on the drawings.
- 2.8.2.3** All panel boards shall be 3 phase, 208V, 250 amp main lug type, unless otherwise noted on the drawings.
- 2.8.2.4** All panel boards shall be 42-circuit type, unless otherwise noted on the drawings.
- 2.8.2.5** All panel boards for clean power shall include an isolated ground bus.

2.8.3 BREAKERS

- 2.8.3.1** All breakers shall be Seimens type BL.
- 2.8.3.2** A minimum of 10% spares, one (1) of each type/size breaker shall be provided.

2.8.4 RACEWAY

- 2.8.4.1** Conduit shall be type EMT as specified in the CEC unless otherwise noted in this document.
- 2.8.4.2** Conduits located under foot traffic, such as on the roof of the hutches, shall be rigid metal conduit as specified in the CEC. Flexible metal conduit shall be kept to a minimum in these areas and only used away from foot traffic.
- 2.8.4.3** All Power circuits shall use a minimum of 3/4" conduit unless otherwise noted on the drawings.
- 2.8.4.4** No compact radius bends shall be used.
- 2.8.4.5** Power entering the hutch shall utilize the appropriate chicane using a maximum 6' length of the appropriately sized flexible metal conduit.
- 2.8.4.6** Power bars shall utilize gray, 3000 series, steel Wiremold or approved equal.
- 2.8.4.7** Wireway shall be Wiremold 3 channel 5400 series non metallic raceway with a white finish or approved equal, sized and installed per the drawings. Top channel should be used for control, middle channel for dirty power, and lower channel for clean power.

2.8.5 WIRING

- 2.8.5.1** Clean and dirty circuits shall NOT share a common raceway unless an appropriate divider is used.
- 2.8.5.2** Isolated grounds shall be run without splices or taps, to an isolated ground bus in the main panel board.

2.8.6 RECEPTACLES

- 2.8.6.1** All 120VAC receptacles shall be 15A, heavy duty, specification grade, NEMA 5-15R.
- 2.8.6.2** All 3 phase 208VAC receptacles shall be 4 pole, 5 wire, heavy duty, NEMA L21-30R, twistlock type.
- 2.8.6.3** White receptacles shall be used for all "dirty power" circuits.
- 2.8.6.4** Orange receptacles shall be used for all "isolated ground" circuits.
- 2.8.6.5** Red receptacles shall be used for all "emergency power" circuits.

2.8.7 LIGHTING

- 2.8.7.1** Power for all lighting shall be from dirty power circuits.
- 2.8.7.2** Two-bulb fluorescents shall be a Thomas DPW232-120-1/2EB-GENIS with protective bulb sleeves or approved equal.
- 2.8.7.3** Switching of lights shall be accomplished using two 3-way switches, one in the enclosure, and one outside the enclosure, as shown on the drawings.
- 2.8.7.4** Installed lighting shall provide 1000-1500 lumens per square meter of illumination at any point within the enclosure
- 2.8.7.5** Installed lighting (bulbs and ballasts) shall be easily serviceable at jobs end.
- 2.8.8 CABLE TRAY**
- 2.8.8.1** Shall be Pilgrim T30C4L30-3 (12" wide), T45C4L30-3 (18" wide), T60C4L30-3 (24" wide), or equivalent low profile tray.
- 2.8.8.2** The support span lengths shall be less than the un-spliced straight section lengths to ensure that no more than one splice is placed between supports

2.9 MECHANICAL

2.9.1 PIPING

- 2.9.1.1** The piping for each water drop noted within an Enclosure Layout drawing shall consist of four lines of 1-inch stainless-steel tubing for water (two for DI water and two for chilled water) and one line of 1/2-inch copper tubing for compressed air.
- 2.9.1.2** Tubes shall enter the enclosure through a chicane panel, extend at least 1 meter on the outside of enclosure for utility hookup, and terminate on a suitable interior manifold plate.
- 2.9.1.3** The air and water lines shall terminate with wall-mounted shutoff valves on the enclosure interior at the nominal locations shown on the drawings.
- 2.9.1.4** Shutoff valves shall all be stainless-steel ball valves with EPR seals and seats.
- 2.9.1.5** Chilled water pipes shall be suitably insulated to prevent condensation.
- 2.9.1.6** All tube couplings, connectors, etc. shall be American Standard thread Swagelok or National Pipe thread.

2.9.2 EXHAUST FANS

- 2.9.2.1** All enclosures shall be equipped with ceiling exhaust fans.
- 2.9.2.2** Fans shall be "quiet" fans producing less than 65dB of noise at distances greater than 1 meter.
- 2.9.2.3** Fans shall have capacity in excess of 450 cfm of air.
- 2.9.2.4** The fan circuit shall be provided with an on-off switch and a variable speed control that permits adjustment from 0-100%. The CLS shall review and accept the fan selection before procurement.

3.0 SAFETY AND ENVIRONMENTAL

3.1 ALL DOORS SHALL BE DESIGNED FOR "FAIL-SAFE" EXIT

3.2 ROOF ACCESS AND FALL PROTECTION SYSTEMS

- 3.2.1** All enclosures shall be equipped with anchorages for attachment of personal fall arrest equipment. These shall conform with Saskatchewan OHS Regulation #1996.
- 3.2.2** Anchorages shall be welded to the top surface of the enclosure roof approximately in the center of the roof panel.

- 3.2.3** For all enclosures wider than 2 meters, anchorages will be of sufficient number and positioned such that the distance to the next nearest anchorage is no greater than the width of the enclosure. For all enclosures 2 meters wide or narrower, no anchorage will be more than approximately 2 meters from the next nearest anchorage.
- 3.2.4** Anchorages shall be positioned so they do not obstruct access to chicanes or interfere with other structures or systems located on the roof of the enclosure.
- 3.2.5** All enclosures shall be equipped with anchorages for future installation of temporary guardrails by others. These shall conform with Saskatchewan OHS Regulation #1996.
- 3.2.6** All enclosures shall be equipped with ladders to provide for personnel access to the top of the enclosure. These shall conform with Saskatchewan OHS Regulation #1996.
- 3.3** The nominal main hall temperature is expected to be between 20°C and 25°C. The expected normal ambient temperature is 22°C ± 1°C.
- 3.4** The enclosures 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 to a maximum of 50% during the summer months.
- 3.5** There shall be no exposed lead surfaces.
- 3.6** All enclosures shall conform with Saskatchewan OHS Regulation #1996.

4.0 APPLICABLE CODES, STANDARDS, AND PROCEDURES

- 4.1** All installations of electrical and electronic equipment shall meet the requirements of the Saskatchewan Electrical Inspection Act, E6-3 [6], with special attention to Section 18 “Manufacture, Sale, etc.” of electrical equipment. This requirement may be satisfied either by certification to the relevant CSA standard by an authorized inspection agency or by special inspection carried out by an authorized inspection agency.
- 4.2** The design of all POE, and SOE for the CLS beamlines shall comply with the detail as laid out in this specification and attached drawings. The following codes shall be followed

- National Building Code of Canada, 1995
- National Fire Code, 1995
- Canadian Electrical Code, 2002
- Saskatchewan Occupational Health and Safety Act, 1993
- Saskatchewan Occupational Health and Safety Regulation, #1996
- Canadian Nuclear Safety Act and Regulations

5.0 QUALITY ASSURANCE

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

6.0 INSPECTION, TESTING AND COMMISSIONING

- 6.1** The Proponent shall develop an inspection/testing/acceptance plan and control sheets for CLS review and acceptance. This plan shall include but not be limited to the items outlined in this section.
- 6.2** The results of all inspections, and tests shall be submitted to the CLS for review and acceptance.
- 6.3** Shielding: The following items are the minimum requirements for inclusion in the acceptance tests.
- 6.3.1** The enclosure shall be considered radiation tight upon successful completion of the following shielding verification procedures.
- 6.3.2** Upon notification from the contractor that the enclosure is ready for verification testing, and the completion of the safety interlock system (PSS) by the CLS. Appropriate CLS personnel shall conduct preliminary verification testing at current levels less than 10 mA to ensure the safety of the enclosure. Test results shall be provided to the contractor within ten (10) business days following the test.
- 6.3.3** Upon notification from the contractor that the enclosure is ready for final verification testing, appropriate CLS personnel shall conduct the final verification testing at current levels greater than 10 mA but less than 200 mA. Test results will be provided to the contractor in the form of a verification map showing raw radiation data within ten (10) business days of the test.
- 6.3.3.1** The deficient areas requiring corrective measures will also be provided. The maps will be clearly marked with amount of leakage detected at each deficiency. The maximum allowable leakage should be less than 1.0 $\mu\text{Sv/h}$ [4] for the side and back walls and less than 10 $\mu\text{Sv/h}$ [4] for the roof panels as measured by the appropriate survey meter upon extrapolation to 500 mA. The measurement method is set forth in an approved CLS document [7].
- 6.3.3.2** Upon notification from the contractor that corrective actions on the deficient areas identified by the CLS personnel are complete, the enclosure shall again be tested at current levels greater than 10 mA but less than 200 mA. The results of the testing shall be provided to the contractor within ten (10) business days. The contractor shall be responsible for correction of any deficiencies in the previously identified areas or caused by the contractor's corrective action.
- 6.3.4** Secondary Optical Enclosures (SOE), carrying only monochromatic synchrotron radiation, shall be tested at current levels greater than 100 mA. The contractor shall be notified of any deficiencies within ten (10) business days. The contractor shall be responsible for correction of any deficiencies. Again, the maximum allowable leakage should be less than 1.0 $\mu\text{Sv/h}$ [4] for the side and back panels and less than 10 $\mu\text{Sv/h}$ [4] for the roof panels upon extrapolation to 500 mA.
- 6.3.5** A contractor representative authorized to sign such certifications shall sign all certification of designs, materials, hardware, processes, calibrations and test data.
- 6.3.6** All raw materials shall be examined visually to detect suspect or counterfeit parts, obvious defects and the state of cleanliness.

6.4 FABRICATION AND WELD EXAMINATIONS

6.4.1 All items shall be subjected to visual and dimensional examination to verify conformance with drawing requirements.

6.4.2 Weld repairs shall be reexamined by the examination method(s) that revealed the original defect. In addition, other nondestructive examination methods that will assure the quality of the material has been maintained may be used upon agreement between the contractor and the CLS.

6.5 CALIBRATION AND CONTROL OF INSTRUMENTS

6.5.1 The Contractor shall verify the accuracy of instrumentation used during tests by means of periodic calibration methods and traceable standards. The CLS shall be given timely notice of any calibration discrepancies or problems. Calibration records shall be available to the CLS for review and acceptance.

6.6 EXAMINATION OF LIFTING, HANDLING, AND SHIPPING FIXTURES

6.6.1 Following proof load testing of lifting, handling, shipping fixtures and attachment lugs, all structural welds of these items shall be examined by the magnetic particle or liquid penetrant method. In addition, all slings and hooks, not containing structural welds, used in lifting the item shall, as a minimum, be visually examined for structural defects.

6.7 VERIFICATION OF OVERALL DIMENSIONS

6.7.1 The maximum width and height of the assemblies with respect to the appropriate reference surfaces shall be verified to be in conformance with the assembly drawing for the item.

6.8 VERIFICATION OF DOOR PANEL MOTION

6.8.1 The motion of each moving door panel shall be tested for the following: range of motion, binding, locking, rubbing or scraping, and swing or wobble.

6.8.2 Each enclosure's pneumatically operated, personnel access doors shall be actuated 100 times to cycle the door through its normal stroke. The proper door-closed position shall be confirmed for each cycle.

6.9 AIR LINE LEAK CHECK AND FLOW TEST

6.9.1 Only clean, filtered oil-free air shall be used for testing.

6.9.2 Airlines shall be leak checked by pressurizing them to twice the normal line pressure (900 kPa) and closing the valves in the lines for one hour, during which the pressure in the line must not fall more than 5 %.

6.9.3 Airlines shall be flow tested for continuity with 1000 cm³/s (2 cfm) minimum flow required at 45 kPa (2 psi) or less pressure drop per meter (foot) of pipe.

6.10 WATER PRESSURE AND FLOW TESTS

6.10.1 Only clean, filtered tap water shall be used for testing. After testing, the water lines shall be dried by blowing them out with clean, dry, oil-free air.

6.10.2 Water lines shall be pressure tested to 3 MPa for 6 hours. No evidence of leakage is permissible.

6.11 ELECTRICAL CIRCUIT TESTS

6.11.1 Each electrical circuit shall be tested for continuity of connection from beginning of the circuit to the end and for open circuit line-to-line and line-to-ground.

6.12 CRANE AND HOIST TESTS

6.12.1 The cranes and hoists shall be tested for compliance with the appropriate CSA B167, CSA C22.2, ANSI/ASME specifications listed in Sections 2.7 and 4.0 of this specification.

7.0 OTHER REQUIREMENTS AND CONSTRAINTS

7.1 ASSEMBLY AND WORKMANSHIP

7.1.1 The parts shall be free of burrs and sharp edges, and free of dents, gouges and scratches.

7.1.2 The parts shall be clean and free of dirt, oil and grease with the exception of the appropriate lubrication on moving bearing surfaces. Bearing surfaces shall be lubricated as required (see assembly drawing).

7.1.3 All assembly requirements for alignment marks, keying or pinning specified on the appropriate assembly or sub tier drawing shall be done after verification that the assembly meets the dimensional requirements of the drawing.

7.1.4 All fasteners on moving devices shall be locked by means of wires, jam nuts, setscrews, spring washers or similar locking devices to prevent loosening. All drilled head screws shall be wired to lock them in place.

7.1.5 All structural bolts for the wall and ceiling panels shall have the nuts tack welded to prevent loosening after erection of the enclosure.

7.2 PREPARATION FOR DELIVERY

7.2.1 PACKAGE IDENTIFICATION

When a shipment contains more than one package, the shipper shall identify each package using the appropriate purchase order number, assembly number and a sequential package identity number.

7.2.2 MOVING COMPONENTS

Any moving components on an assembly shall be firmly secured for shipment in a manner that precludes damage from motion and vibration.

7.2.3 PROTECTION

7.2.3.1 Assemblies shall be secured for shipment in a fashion that protects the assembly from dust, dirt and weather or water damage.

7.2.3.2 The assemblies shall be securely fastened, padded, boxed and/or crated for shipment in a suitable manner for prevention of shipment damage to any assembly and its weather/dust protection and to insure their safe delivery to the CLS.

7.2.4 ERECTION

7.2.4.1 The enclosures shall be erected on the Experimental Floor of the Canadian Light Source at a location specified on the configuration specific drawings attached to this specification.

7.2.4.2 Final delivery and acceptance shall be after successful completion of inspection and acceptance.

7.3 JOB COMPLETION

7.3.1 Clean-up – Panel boards shall be vacuumed, and the area shall be free of all debris upon completion of the job.

7.3.2 Checkout – Panel boards shall be appropriately labeled and meggered before energization.

- 7.3.3** Receptacles, switches and all powered equipment shall be appropriately labeled.
- 7.3.4** All receptacles, switches and powered equipment shall be electrically tested for proper wiring, voltages and power source.
- 7.3.5** Start-up – All start-up activities shall be witnessed by a CLS representative after the above clean-up and checkout activities are completed.

7.4 DOCUMENTATION

- 7.4.1** The Proponent shall submit to the CLS all fabrication drawings in accordance with the contract data requirements.
 - 7.4.1.1** The Proponent shall provide plan and elevation assembly drawings of the enclosure(s).
 - 7.4.1.2** The Proponent shall provide final electronic “as-built” drawings.
- 7.4.2** The contractor is required to review the drawings and other documentation provided by CLS for errors and to inform CLS of any discrepancies and errors.
- 7.4.3** Any changes or corrections must be documented by the contractor as “marked drawing” changes to the engineering drawings for the affected item and submitted for CLS review and acceptance.
- 7.4.4** The contractor shall be responsible for the structural integrity of the enclosure and shall have each structure reviewed and certified by a certified structural engineer.
- 7.4.5** The detailed drawings and the typical configuration drawings shall be furnished to the CLS in AutoCAD (2002 and previous format).

8.0 DRAWINGS

The following applicable drawings have been referenced in this technical specification.

i) Hard X-Ray EXAFS Beamline

06ID-1/ME/00408000
06ID-1/STRC/SHD/0091801
06ID-1/STRC/SHD/0091800
06ID-1/STRC/SHD/0091701
06ID-1/STRC/SHD/0091700

ii) Canadian Macromolecular Crystallography Facility Beamline

08ID-1/ME/0048300
08ID-1/STRC/SHD/0091601
08ID-1/STRC/SHD/0091600
08ID-1/STRC/SHD/0091501
08ID-1/STRC/SHD/0091500
08ID-1/STRC/SHD/0091401
08ID-1/STRC/SHD/0091400

iii) Soft X-ray Spectromicroscopy Beamline

10ID-1/ME/0052800
10ID-1/STRC/SHD/0091300

10ID-1/STRC/SHD/0091301

iv) High Resolution Spherical Grating Monochromator (SGM)/Variable Line Spacing Plane Grating Monochromator (PGM)

11ID-1/ME/0066200

11ID-1/STRC/SHD/0090900

11ID-1/STRC/SHD/0090901

v) Doors and Assemblies

11ID-1/STRC/SHD/0090902

vi) Optical Enclosure Chicaned Openings

11ID-1/STRC/SHD/00909004

vii) Optical Enclosure Wall Construction

11ID-1/STRC/SHD/0090903

9.0 REFERENCES

- [1] M. Benmerrouche, 2002. Canadian Light Source Safety Report. CLSI Document # 11.18.40.2 Rev. 2A, 2002-09-12
- [2] E. Hallin, 2002. Photon Beam Safety Guidelines. CLSI Document # 6.1.37.1 Rev.0, 2002-09-30
- [3] S. Hodgson, 2002. Calculations for Synchrotron Radiation Shielding using STAC8. CLSI Document # 6.2.35.3 Rev.C, 2002-12-06
- [4] J. Asai and H. Hirayama, 2003. Radiological Design Study of First Optics Enclosure against Secondary Gas Bremsstrahlung for the Canadian Light Source. (Submitted to Nucl. Instr. Meth.A, April, 2003).
- [5] E. Hallin, personal communication (03/04/2003)
- [6] Available at <http://www.qp.gov.sk.ca/documents/English/Statutes/Statutes/E6-3.pdf>
- [7] M. Benmerrouche and K. Krueckl, 2002. Radiation Survey Document, CLSI Document #11.7.53.1.