CLS Half-sine Kicker Specification
CLS 5.4.30.1

Rev. 0

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Canadian Light Source
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Signature Date

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REVISION HISTORY

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A	2001-11-02	Draft	Neil G. Johnson
B	2001-12-04	Updated with comments from Mark Silzer and Les Dallin. Issued for RFP.	Neil G. Johnson
0	2002-02-14	Updated with comments from Jack Bergstrom, Dan Lowe, Mark Silzer, and Les Dallin.	Neil G. Johnson

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1. INTRODUCTION

1.1 Purpose

This document specifies the requirements of the half-sine kickers used for injection into the main storage ring (SR1) at the Canadian Light Source (CLS). Four (4) kickers are required, each consisting of a kicker magnet, vacuum chamber and flanges to mate with the CLS storage ring, drive electronics, and high voltage power supply.

1.2 Scope

The Proponent shall furnish all equipment, materials, tools, facilities, and labour to perform all the work necessary to design, manufacture and test the kickers as per this specification. This work includes, but is not limited to:

- Materials
- Equipment
- Commercial components
- Detailed drawings
- Operation and maintenance manuals
- Fabrication
- Assembly
- Cleaning of vacuum chamber as described in References [10], [11], and [12]
- Testing and Inspections
- Quality Assurance /Quality Control documentation
- Delivery to site

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 will be a 3rd generation synchrotron light source, which will produce a high intensity source of infrared, visible, ultraviolet and x-ray radiation.

The document “Canadian Light Source Injection Scheme”[13] describes the plan for transferring the electron beam from the booster into the storage ring. Half-sine kickers are used to deflect the stored beam in the storage ring close to the injection point, then restore the beam to its nominal position. Resonant discharge of an LC circuit is normally used to provide the magnetic pulse which deflects the beam. The name “half-sine kicker” comes from the shape of this pulse which is similar to the first 180 degrees of a sine function. The timing and shape of the flux generated by the kickers must be closely matched in order to avoid beam losses during injection. Adjusting the initial voltage on the capacitor may be used to control the amplitude of the magnetic pulse.

During CLS operation up to 500 mA average electron beam current is bunched at 500 MHz (s = 1 cm) over 196 ‘buckets’. A corresponding image current flows through the wall of the vacuum chamber. It is critical that the kicker assembly provides a path for this image current without introducing a significant impedance mismatch. Two approaches are commonly used in the design of the vacuum chamber associated with a kicker. The inside of a ceramic section shall be coated with a thin conductive layer. The thickness of the conductive coating should be chosen as a compromise between fast magnetic field penetration (eddy currents) and resistive heat loading caused by image currents. This layer may be "striped" to reduce eddy current effects. Such an interdigitated design has been developed at the ALS. An alternative design, referred to as a "DELTA" kicker, encloses a machined section of vacuum chamber in the vacuum chamber.

1.4 Definitions

ANSI	American National Standards Institute
DCCT	Direct Current Current Transformer
DCS	Distributed Control System
EMI	Electromagnetic interference
IEEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
CSA	Canadian Standards Association
PLC	Programmable Logic Controller
RMS	Root Mean Square
UHV	Ultra High Vacuum

2. KICKER REQUIREMENTS

2.1 General Requirements

2.1.1 This section of the specification describes the performance and physical characteristics of the units required. Alternate products or schemes offered by the Proponent, that may provide equal or better performance and reliability may be considered, but shall be subject to review and acceptance by CLS.

2.1.2 The kickers shall be completely assembled units that can be installed and interfaced to CLS control computers located remotely.

2.1.3 Each kicker shall have provision for adjustment of its output amplitude and timing without affecting the other kickers and causing them to deviate from the performance specifications in section 2.4.

2.1.4 Two of the kickers shall deflect the beam to the left as it goes through the kicker (North pole on the bottom). The other two shall deflect the beam to the right (North pole on the top). These polarities shall be clearly identified.

2.2 Functional Requirements

2.2.1 The ratings of all components in this equipment shall be interpreted to be continuous ratings except where noted.

2.2.2 As a minimum, each kicker shall consist of a kicker magnet assembly which can be connected to the UHV storage ring, driver electronics, remotely controlled high voltage supply, waveform monitoring device(s), and any required high voltage cabling.

2.2.3 The kicker drive electronics shall use a fibre optic trigger signal based on an 820 nm receiver with an ST type connector. Transition from dark to light shall initiate the kicker pulse.

2.2.4 The high voltage supply shall have provisions for remotely monitoring the actual high voltage output level. This should be a 0-10 V signal.

2.2.5 The high voltage supply should have provisions for remotely monitoring the actual current output. This should be a 0-10 V Signal.

2.2.6 The high voltage supply shall have provisions for remotely adjusting the high voltage level. This should be a 0-10 V signal.

2.2.7 The high voltage supply shall have provisions for remotely turning the high voltage on and off.

2.2.8 The high voltage supply shall include current limiting or other means to ensure safe operation if the drive electronics fail in an ON or shorted state. This protection shall be in addition to fuses or breakers which remove AC power.

2.2.9 The kicker shall include a method to monitor the current to the kicker magnet. This should be suitable for connection to a properly terminated 50 Ω coaxial cable (CLS oscilloscope).

2.2.10 The kicker should include a method to monitor the magnetic flux produced by the magnet. One suitable method is commonly referred to as a B-dot monitor. This should be suitable for connection to a properly terminated 50 Ω coaxial cable.

2.2.11 Each kicker shall include a method to adjust the amplitude and period of the output waveform. CLS anticipates this adjustment will be required to meet performance specifications as component values change due to aging or replacement.

2.2.12 The kickers should be designed to minimize EMI as well as noise feeding back through the AC power feeds or through the grounding system.

2.2.13 AC input power will be supplied through a CLS-installed, external, manually operated disconnect switch or breaker, which is normally closed. It will be possible to lock this switch in the OFF position so no power is fed to the supply, in compliance with CLS lock-out procedures.

2.2.14 The electrical power supplied by the CLS will be 60 Hz AC. Each load connection shall be one of the voltage levels listed and should 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

Line voltage will exhibit instantaneous (< ½ cycle) fluctuations of +/- 1.5 % and gradual variations of +/- 10 %. Brownout conditions involving instantaneous drops and restorations of up to 10 % are also observed.

2.2.15 All power supplies with an input power requirement exceeding 2.5 kVA shall incorporate circuitry to reduce harmonic current components on the supply lines. As a minimum, this performance of this circuitry shall be the equivalent of 12 pulse rectification (refer to ANSI/IEEE Standard 519-1992[6]).

2.2.16 The system shall include a circuit breaker with an interrupting capacity of at least 5000 A RMS for the AC inputs.

2.2.17 Bolted electrical connections should use Belleville washers, flat stainless steel washers, lock nuts, and a joint compound reviewed and accepted by CLS.

2.2.18 The use of liquid dielectrics (high voltage oil) as an insulator should be avoided. A major disadvantage of oil is the possible contamination of the CLS UHV vacuum system when oil is used in close proximity. The use of large volumes of oil may require an elaborate fire protection system (CO_2 system and fire rated service room) to comply with the Canadian Electrical Code and National Building Code of Canada. If required, capacitors filled with flammable liquids shall limit the volume of the liquid to 14 litres or less and comply with the Canadian Electrical Code requirement 26-012 part (4). All required fire protection systems resulting from the use of liquid dielectrics shall be the responsibility of the Proponent. Any use of oil shall be subject to review and acceptance by the CLS.

2.2.19 Every effort shall be made through careful design to keep the acoustic noise levels below 60 dB measured at a distance of 1 meter from the supply cabinet. Noise levels above 60 dB limits effective communication and warning sounds such as sparking are masked.

2.2.20 All equipment/structures shall conform to the BKL report “Vibration Isolation Mechanical Equipment.”[9]

2.2.21 A local emergency off switch with mechanical latching shall be provided for each kicker, located at or near the kicker magnet. This system shall employ redundant and independent means of shutdown including a hardwired connection to remove AC power from all power supplies.

2.2.22 The junction temperature of any power semiconductors shall not exceed 100 ^{o}C with an ambient temperature of 40 ^{o}C.

2.2.23 All wiring shall have a minimum insulation rating of 600 V.

2.2.24 The kicker enclosure should be designed to reduce and limit electromagnetic radiation. Doors and removable panels shall use a grounding conductor to bond them to the rest of the frame. The use of copper finger stock, or wire knitting or braiding to improve connectivity between doors, panels, and the frame is encouraged.

2.2.25 The required vacuum vessels shall be designed to form an ultra high vacuum system. The system is expected to reach a pressure of < 130 nPa.

2.2.26 Provision shall be made to monitor the temperature of the ceramic vacuum chamber. This shall be used as an interlock for the kicker control system. Provision (in the form of a dry contact or optoisolated output) shall be made to supply a vacuum chamber overtemperature interlock to the CLS control system.

2.2.27 The kicker shall include a method to provide a path for beam image currents.

2.3 Control System

2.3.1 Provisions shall be made for remote control and monitoring by CLS computers. The control system shall be designed to interface with the CLS Distributed Control System. The interface may use EPICS communication protocols, Modbus TCP/IP, or Profibus. Designs using RS-232 protocols may be considered, but shall be subject to review and acceptance by CLS. Unless explicitly stated, all control and monitoring shall conform to the “Control System Technical Specification.“[3] The interface shall be subject to review and acceptance by CLS prior to implementation.

2.3.2 Unless specified otherwise, control and interlock signal inputs shall be 24 V DC and shall require less than 50 mA drive and use optical or some other form of isolation. Interlock inputs shall be designed to be fail safe; the presence of 24 V indicates the interlock condition is good. If applicable, On/Off control shall be designed so that a transition from 0 to 24 V turns the supply on and a transition from 24 to 0 V turns the supply off.

2.3.3 Unless specified otherwise, 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. Interlock outputs shall be designed to be fail safe; outputs provide 24 V when the interlock condition is good.

2.3.4 The Proponent shall provide electronic copies of all PLC control software programs if a PLC is included in the design.

2.3.5 Controller hardware and software interfaces shall be reviewed and accepted by the CLS to verify adherence to the CLS control protocols and standards.

2.3.6 Indicator lights and status bits shall indicate true operation, not just control activity.

2.3.7 The following interlocks shall be incorporated and where indicated shall be used to de-energize the main AC supply directly (hard-wired) without intervention by the power supply control system, as well as being used as an interlock by the control system.

1. Door/Panel microswitches – hard-wired; these should have a manual bypass capability which is automatically reset when the door is closed.
2. Control power failure – hard-wired
3. Local Emergency Off (mechanical latching pushbutton) – hard-wired.
4. Semiconductor junction/heat sink overtemperature.

5. Vacuum chamber overtemperature
6. Two external (customer) interlocks, with +24 V indicating AC power can be energized and 0 V causing the system to enter the FAULT state.

2.3.8 The kicker control system should have a minimum of four operational control command states. These should be OFF, FAULT, STANDBY, and RUN. Where practical the control state machine shall be based on the CLS Control System Reference State Machine as defined in Reference [3]. Deviations from this specification on the operational states are permitted. The operational states and the implementation of the transitions between states shall be subject to review and acceptance by the CLS.

2.3.9 All interlocks status and alarm information shall be latched and monitored by the internal control system and available for readout by the CLS DCS. Provision shall be made to clear the latched fault indication prior to entering the STANDBY state.

2.3.10 The status of the system shall be displayed locally including FAULT, STANDBY, and RUN.

2.3.11 The design of the control system shall be fail-safe. On a loss of control power all power supplies shall safely trip OFF. Upon return of power, the power supply shall remain in the OFF state.

2.3.12 The interlocks and indication system shall be subject to review and acceptance by the CLS.

2.4 Performance

2.4.1 The kicker shall be able to bend a 3.2 GeV electron beam 2.5 mrad. The kicker shall produce an integrated field at peak excitation of 0.027 T-m inside the vacuum chamber.

2.4.2 The integrated field at peak excitation shall be adjustable over a minimum range of 10% to 100% of the value in 2.4.1.

2.4.3 The kicker's vertical flux shall have a transverse homogeneity better than ±1% within +/- 20 mm of the centre of the vacuum chamber in the horizontal plane.

2.4.4 The duration of the half-sine output shall be 3420 ns ±30 ns.

2.4.5 The kicker shall be capable of continuous operation at a 1 Hz trigger rate.

2.4.6 For any pair of kickers set to produce the same integrated field, the RMS difference in the magnetic flux reaching the electron beam at the centre of the vacuum chamber shall be less than ±1% of the RMS flux of each kicker, evaluated over the entire pulse, for all output levels from 20% to 100%.

2.4.7 If any pair of kickers are set to produce different peak integrated fields, the RMS difference in the normalized magnetic flux reaching the electron beam at the centre of the vacuum chamber shall be less than ±1% of the normalized RMS flux of each kicker, evaluated over the entire pulse, for all output levels from 20% to 100%

2.4.8 The total of jitter and drift of the output pulse over any 1-week period shall be less than ±30 ns from the average value.

2.4.9 All power supplies shall regulate against instantaneous (< ½ cycle) line voltage fluctuations of ± 1.5% and gradual variations of ± 10% to maintain the tolerances in this section.

2.4.10 All power supplies with an output greater than 1 kW shall have an efficiency in excess of 80 % and a power factor in excess of 0.9 at all power output levels greater than 80%.

2.4.11 The control system shall respond to a change in the interlock status in less than 25 ms. Response times to user inputs should be less than 150 ms so that the user perceives immediate response.

2.4.12 The maximum length of the kicker shall be 401.11 mm.

2.4.13 Capacitors shall be provided with a means of draining the stored charge in accordance with Canadian Electrical Code Section 26-222.

2.4.14 Vacuum chamber vessels shall have a helium leak rate < 20x10-9 Pa l/s and a specific desorption rate < 100 pPa l/s/cm2 after cool down from a 24 hour bake-out at 250*C.

2.4.15 High voltage power supplies shall have regulation (including ripple, drift, temperature, line and load variations) better than 0.1% of maximum output.

2.5 Cleaning/Cleanliness

2.5.1 Proponents shall in addition follow Canadian Light Source Vacuum Component Cleaning Technical Procedure[4], CLS Technical Procedure 8.7.33.1. Proponent may recommend alternate cleaning procedures for CLS review and acceptance. Where procedures may be incompatible with ultra high vacuum systems, the Proponent shall identify the procedure and suggest alternate method.

2.5.2 Vacuum production, and handling procedures shall be compatible with ultra high vacuum requirements for the storage ring.

2.5.3 A high degree of cleanliness shall be observed during all stages of production to guarantee an acceptable low out-gassing rate and weld integrity.

2.5.4 Plate material shall be cleaned prior to any cutting or forming operation commences. It will be sufficient to swab with acetone or similar solvent. If a shear or press is to be used, the blades should also be cleaned with this solvent.

2.5.5 The vacuum surfaces of plate material or any other component forming part of or within the vacuum envelop has been cut, formed, finally machined and cleaned shall never be in contact with oily or greasy objects (including bare hands leaving finger prints), unless a thorough cleaning operation is scheduled to follow immediately afterward.

2.5.6 Components that will be immersed in vacuum shall be wrapped in aluminium foil and kept separately in polyethylene bags. The bags shall be suitably labelled when the components are too small to be inscribed with their drawing numbers, or other identification number.

2.5.7 A clean facility shall be provided with partition walls and a clean washable floor, for all welding assemblies. The clean facility shall be kept free from carbon steel contamination.

2.5.8 Final machining after welding of the vessel body shall be carried out in an area protected by, at a minimum, a plastic sheet enclosure.

2.5.9 Proponent shall propose a method to vacuum fire the vacuum chambers (excluding bellows assemblies) to 900º C.

2.6 Safety and Environmental

2.6.1 Materials defined as Notifiable Chemical and Biological Substances and Designated Chemical Substances according to Table 19 and 20 respectively of the appendix of the Saskatchewan Occupational Health and Safety Regulations (OHS Regs. 1996) shall not be used without written permission from CLS. Contamination limits set out in Table 21 of the Appendix of OHS Regs 1996 shall not be exceeded in any area where a worker is usually present; see also any applicable Sub-Sections of 4 Oct 96 co-1.1 Reg 1 s307, s309, and clause 346(f).

2.6.2 Asbestos or asbestos-type insulation, insulating or dielectric fluids containing PCBs shall not be used. Where a choice of materials is available (e.g. cables, support hardware), preference shall be given to materials or equipment exhibiting a higher level of fire resistance.

2.6.3 The kickers shall be constructed with a view towards safety. All high voltages (greater than 30 V_{ac}) shall be barriered or compartmentalized. High voltage components, connectors, wiring terminations, etc. shall be physically separated from low voltage control circuits. Personnel should not be exposed to high voltages while performing routine service on energized control circuits. The enclosures should be designed so it is impossible to touch high voltage potentials from the outside using a thin conductor of reasonable length.

2.6.4 The enclosure containing the energy storage capacitor shall include a grounding rod which can be used to safely discharge the capacitor.

2.6.5 All high voltage access points shall be labelled with standard type labels.

2.6.6 The kicker 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 ±1° during normal operation. The expected temperature inside the storage ring tunnel is 27° C ±1° during normal operation.

2.6.7 The components shall be able to withstand a relative humidity range of 0 % to 95% noncondensing. The expected relative humidity limits under operation are from 25% during the winter months to 50% during the summer months. The expected relative humidity range for components under storage will be the same as previously mentioned.

2.6.8 The areas outside the shielding are equipped with an overhead sprinkler system for fire protection. Equipment in these areas should be designed to withstand moderate exposure to water or other fluids.

2.6.9 All components shall be designed for operation in a radiation environment. The vendor shall avoid all materials that are subject to damage by ionising radiation.

2.6.10 In the tunnel environment, there will be a small amount of production of radioactive air and noxious gasses. These are estimated to be:

7. For N-13,O-15, and C-11: 0.0002 Bq/cc.
8. For ozone: $5.6x10^8$ mol/cc.
9. Nitrogen dioxide: $2.7x10^8$ mol/cc.
10. Nitric acid: $0.8x10^8$ mol/cc.

2.7 Applicable Codes, Standards and Procedures

2.7.1 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.
2. All other applicable CSA standards.
3. ANSI/IEEE Std. 519-1992 IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
4. Industry Canada ICES-001 Industrial, Scientific and Medical Radio Frequency Generators.
5. Radiation Health and Safety Regulations of the Saskatchewan Occupational Health and Safety.

2.7.2 Unless otherwise specified, the issue date or revision level shall be that in effect on the date of the Request for Proposal. Exceptions to these standards shall be reviewed and accepted by the CLS.

2.8 Quality Assurance

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

2.8.2 The kicker system shall be CSA certified or certified by a CSA accredited testing laboratory or by a testing laboratory recognized by the Chief Electrical Inspector of Sask Power.

2.9 Inspection, Testing and Commissioning

2.9.1 Installation shall be performed by CLS staff.

2.9.2 Installation and testing shall conform at all times to the local safety codes.

2.9.3 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.

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

2.9.5 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. These test procedures are subject to CLS review and acceptance.

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

2.9.7 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.

2.9.8 Testing shall include but not be limited to the following:

1. Control functions shall be exercised through all states.
2. All interlock functions shall be checked for proper operation and indications. All fault status indicators shall latch until reset.
3. After the unit's warm up period, the regulation and reproducibility of the power supply shall be measured at a minimum of four output values spanning the power supplies working range, operating for a period of 4 hours for each value.
4. Heat checking shall be done on all critical components. The Proponent shall temporarily install thermocouples on critical components and on power supply critical points. These points shall be agreed on between the Proponent and the CLS. A heat run shall be conducted at 110% load conditions, concluding after equilibrium temperatures have been reached.
5. The magnetic flux shall be measured inside the vacuum chamber and compared with the requirements of section 2.4.
6. All kickers shall be operated at the same time and independent control of each kicker shall be verified. Power supplies shall be connected to the same source of power. If the power supplies are not integral to the kicker they shall be mounted in a common rack. The maximum distance between any two kicker magnets shall be 3 meters.
7. The sequence of inspections and tests for the factory acceptance test on each completed and cleaned vacuum chamber vessel shall include but not limited to:
   Visual internal and external inspection.
   Vacuum leak test and desorption test after cool down from a 24 hour bakeout of the vessel at 250 ºC. A helium leakage rate of < 20 nPa l/s and a specific desorption rate of < 100 pPa l/s/cm2 is to be demonstrated. The upper limit of the leak rate shall be documented for each vacuum chamber vessel in the quality assurance document.
8. Proponent shall demonstrate that all dimensions indicated on the corresponding drawings have been met. The quality assurance document shall document all dimensions against tolerances given on drawings.
9. Visual inspection of the sealing surfaces of flanges immediately prior to protective packing for dispatch.Proponent shall visually inspect the vacuum chamber vessels internally and externally for any defects that may render them unfit for service. Attention shall be paid to the form and state of the vacuum surfaces, quality of weld joints, and sealing surfaces of the flanges.

2.9.9 Proponent shall submit certified test reports to CLS for approval before shipping the kickers.

2.9.10 Final Acceptance

2.9.10.1 For purpose of warranty under an order for these power supplies, final acceptance is defined as the successful completion of acceptance tests at CLS to substantiate the compliance with this specification. Final Acceptance tests will be completed within three months of the required delivery date. The Proponent will be notified of the test dates and may have a representative present to witness the tests. The Proponent shall be held responsible for the contracted performance of the modules produced and delivered to CLS.

2.9.10.2 Final Acceptance testing shall include any or all of the following tests:

1. Tests described in sections 2.9.8.
2. Installation of all kickers at CLS and operation with 2.9 GeV electron beam to verify compliance with the requirements of section 2.4.
3. Verification of ultra high vacuum compatibility, including operation after installation.

2.10 Reliability and Maintainability

2.10.1 The kicker system shall be manufactured with strong consideration for unit reliability and serviceability. Any units that need to be removed from cabinets or racks for service shall be mounted on slides. Safe and easy access to all external connection points must be incorporated into the overall design. Easy access shall be made available to all components, especially pulsed power components. Provision shall be made to allow replacement of all electronic components without breaking the vacuum. The Proponents drawings shall show the positions of the major components in the power supply.

2.10.2 The Proponent shall supply a list of recommended spare parts along with cost information.

2.10.3 The equipment shall be manufactured in accordance with the best existing techniques and recognized good engineering practices available at the time of construction. The kicker system shall be designed and constructed with an expected operational lifetime of greater than 20 years. It is understood that maintenance may be required during this period. Subassemblies should be designed for repair rather than replacement.

2.10.4 The equipment shall be designed and constructed to be in continuous use with only 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. The kicker system shall have a minimum mean time between failure (MTBF) of 20,000 hours in the operational environment at the CLS as outlined in this specification.

2.10.5 Different coloured wires shall be used wherever possible to facilitate troubleshooting.

2.10.6 Each cable and wire shall be identified using typed heat shrink markers at each end. These shall be keyed to identical numbers used on electrical schematics.

2.10.7 All threaded mechanical fasteners should be American Standard Thread. The use of metric standards is negotiable with the CLS. If metric standards are used, additional spare nuts and bolts shall be provided by the Proponent.

2.11 Layout

2.11.1 The location of the kickers, and penetrations through the shielding to the racks above the shielding are shown in diagram Booster/Storage Ring Top of Shielding[2].

2.11.2 The kicker shall be designed so the pulser electronics are located in close proximity, or integral to the kicker magnet assembly. The high voltage power supply may be integral to the pulser, or may be mounted in a 19-inch rack on top of the SR1 shielding tunnel.

2.11.3 The drawing SR1 Kicker Assembly[1] shows the available length for the kicker, the vacuum flanges, and the cross section of the vacuum chamber. The kicker shall be designed for compatibility with this arrangement.

2.12 Other Requirements and Constraints

2.12.1 All labelling, manuals, programming, and other documentation shall be in English.

2.12.2 The Proponent shall supply complete documentation of all components and subsystems. Hardcopies (4) and electronic copies (including editable source files) of all documentation shall be provided.

All documentation shall conform to the "CLS documentation specification" [4].This documentation shall include but be not limited to the following:

1. Users/operation/maintenance manuals, which shall contain, but not be limited to: specifications, operating instructions, control system interface commands/protocols, hook-up instructions, circuit diagrams, block diagrams, maintenance procedures (both operational and preventative), component data sheets, normal adjustments and calibration setup 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 system.

Electrical diagrams should be presented in Orcad® 9.2 or Autocad® R14 or Autocad® 2000 or Cadsoft Eagle 3.5.

2.12.3 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.

2.12.4 All test measurement results shall be provided in hardcopy, on CD-ROM, and archived at the Proponent's location.

2.12.5 Each kicker assembly shall have a stainless steel or aluminium nameplate on each unit that shall include the following information:

CLS Equipment Tag number (Details to be worked out with CLS)
Manufacturer's name and address
Serial number
60 Hz voltage and current input ratings
Kicker output voltage and current ratings
Gross weight of the unit
Date of manufacture
Cooling requirements (if required)

2.12.6 The nameplate information should be in 14 point size fonts.

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

CLS purchase order number.
Shipping address as specified within the contract.
Proponent's name.
Components contained within each package.
"Top-side up" if required.
"Fragile" if required.
Shock and Tip sensors on containers are encouraged.

2.12.8 Where possible shipping should be by air cushion truck. Shipping by rail or flatbed truck is discouraged.

2.12.9 Proponent shall notify CLS ten (10) days prior to shipment. The notice shall include a list of equipment, origin, shipping date, shipping firm, routing of shipment, anticipated date of arrival, and shipping weight. CLS reserves the right to approve shipping firm and route.

3. REFERENCES

3.1 Drawings

1. SR1 Kicker Assembly, SR1/ME/KCK/0059200 Rev 0.
2. BLDG/EE/0049701 Rev. A. Booster/Storage Ring Top of Shielding Equipment Layout.

3.2 Documents

3. "Control System Technical Specification" 7.4.39.1 Rev. 1

4. “CLS documentation specification” 0.4.1.1 Rev. 1.
5. CSA Canadian Electrical Code 1998 Safety Standards for Electrical Installations.
6. ANSI/IEEE Std. 519-1992 IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
7. Radiation Health and Safety Regulations of the Saskatchewan Occupational Health and Safety.
8. Saskatchewan Occupational Health and Safety Regulations (OHS Regs. 1996).
9. “Vibration Isolation Mechanical Equipment”, BKL report.
10. “Canadian Light Source High Vacuum Design Specification”, CLS Design Specification 8.44.33.1 Rev 2.
11. “Canadian Light Source Vacuum Component Cleaning Technical Procedure”, CLS Technical Procedure 8.7.33.1 Rev1.
12. “Canadian Light Source Vacuum Component Leak Test Technical Procedure”, CLS Technical Procedure 8.7.33.2 Rev 2.
13. “Canadian Light Source Injection Scheme”, CLS Design Note 2.1.11 Rev B.