UNIVERSAL彈性鋼鐵公司

STANDARD GUIDELINE

REQUIREMENTS FOR LASER DEVICES AND SYSTEMS

UNITED STATES STEEL CORPORATION

STANDARD GUIDELINE NO. EE-007

INDUSTRIAL HYGIENE GUIDELINE I.H. – 3.5

REQUIREMENTS FOR LASER DEVICES AND SYSTEMS

DATE: June 21, 2004
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SCOPE AND INTENT</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>GENERAL REQUIREMENTS</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Review and Approval</td>
<td>3</td>
</tr>
<tr>
<td>2.2</td>
<td>Classification</td>
<td>5</td>
</tr>
<tr>
<td>2.3</td>
<td>Laser Hazard Evaluation</td>
<td>6</td>
</tr>
<tr>
<td>2.4</td>
<td>Non-Light Hazards</td>
<td>8</td>
</tr>
<tr>
<td>2.5</td>
<td>Design</td>
<td>10</td>
</tr>
<tr>
<td>2.6</td>
<td>Identification and Warning Labels</td>
<td>11</td>
</tr>
<tr>
<td>2.7</td>
<td>Safety Instructions</td>
<td>12</td>
</tr>
<tr>
<td>2.8</td>
<td>Testing and Startup</td>
<td>12</td>
</tr>
<tr>
<td>2.9</td>
<td>Operation</td>
<td>12</td>
</tr>
<tr>
<td>2.10</td>
<td>Maintenance</td>
<td>12</td>
</tr>
<tr>
<td>2.11</td>
<td>Laser Inventory</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>CONTROL MEASURES</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Class I</td>
<td>17</td>
</tr>
<tr>
<td>3.2</td>
<td>Class II</td>
<td>17</td>
</tr>
<tr>
<td>3.3</td>
<td>Classes III and IV (General)</td>
<td>17</td>
</tr>
<tr>
<td>3.4</td>
<td>Class IIIa</td>
<td>18</td>
</tr>
<tr>
<td>3.5</td>
<td>Class IIIb</td>
<td>18</td>
</tr>
<tr>
<td>3.6</td>
<td>Class IV</td>
<td>19</td>
</tr>
<tr>
<td>3.7</td>
<td>Enclosed Lasers and Laser Systems</td>
<td>20</td>
</tr>
<tr>
<td>3.8</td>
<td>Invisible Radiation</td>
<td>21</td>
</tr>
<tr>
<td>3.9</td>
<td>Maintenance</td>
<td>22</td>
</tr>
<tr>
<td>3.10</td>
<td>Warning Signs</td>
<td>23</td>
</tr>
<tr>
<td>4</td>
<td>TECHNICAL QUESTIONNAIRE</td>
<td></td>
</tr>
</tbody>
</table>
1. SCOPE AND INTENT

1.1 Lasers or laser systems emit intense coherent electromagnetic radiation that has the potential for causing irreparable damage to human skin and eyes. Therefore, all work with lasers must be designed prior to installation to minimize exposures of personnel to the beam, especially with regard to eye exposures. With this in mind, United States Steel Corporation hereby establishes this guideline to assist with the procurement, installation, safe operation, and maintenance of lasers or laser systems.

1.2 This specification shall be considered an integral part of the project specification to which it is attached. The intent of this specification is to establish the guidelines for requirements for laser devices and systems.

1.3 All equipment, methods, and materials shall meet or exceed these standard specifications, as well as the detailed project specifications. The project specifications may modify these standard specifications.

1.4 All equipment, methods, and materials shall meet or exceed the most stringent requirements of the latest editions of all applicable codes or standards, and shall be in accordance with the requirements set forth in U. S. Steel Group Standard Specification No. GE-001 - "Contractor's Drawings, Manuals, and Contract Services".

1.5 All lasers or laser systems shall have a completed Safety/Fire Protection/Hygiene Statement.

1.6 Where there are apparent conflicts between this specification and other applicable documents, it shall be the Seller's responsibility to call said conflicts to the Owner's attention.

1.7 Any exceptions to these standard specifications shall be stated in writing in Seller's proposal.
2 GENERAL REQUIREMENTS

2.1 Review and Approval

All proposals for the procurement and/or demonstration of laser equipment shall be submitted to the U. S. Steel Radiation Committee for review and approval. This applies to the following:

- Laser equipment which is intended for outright purchase
- Laser equipment included as part of an instrumentation package
- Laser equipment involved in a turnkey project
- Laser equipment provided by a vendor for testing or demonstration purposes
- Leased Lasers
- Laser equipment brought into U. S. Steel facilities by outside contractors
- Laser equipment brought into U. S. Steel facilities from other U. S. Steel facilities

2.1.1 Exemptions

All portable Class I and Class II lasers (i.e. laser pointing pens [power limit that does not exceed 5 mW], laser leveling equipment or similar devices) are exempt from the approval process.

2.1.2 Approval for Permanent Installations of Class I and Class II Lasers or Laser Systems

Approval for permanently installed Class I and Class II Lasers or Laser Systems may be granted by the Plant Department Manager of Safety and Industrial Hygiene in conjunction with the Plant Radiation Safety Officer.

2.1.3 Approval for Class III and Class IV Lasers or Laser Systems

Approval for all Class III and Class IV Laser or Laser System installations must be approved first by the Plant Department Manager of Safety and Industrial Hygiene in conjunction with the Plant Radiation Safety Officer. The Plant Department Manager in turn will forward the request to the Corporate Coordinator of Industrial Hygiene for final approval.

2.1.4 Required Documents for approval of all Lasers or Laser Systems

- Completed Technical Questionnaire
- Diagram showing the installation location of the laser with a reference to the beam path shown in relationship to the exposure potential of the closest employee. The diagram shall illustrate that employee access to the path of the laser beam is restricted. Possible reflective surfaces must be noted and eliminated.
- Any applicable Safe Job Procedures and/or Energy Control Procedures.
- A copy of the safety and operating guidelines from the manufacturer which covers the installation, operation and maintenance of their equipment.
2 GENERAL REQUIREMENTS (Cont.)

2.1 Review and Approval (Cont.)

2.1.5 Purchase Requisitions

Persons submitting purchase requisitions to the Purchasing Department are to insert the word “LASER” in a prominent location on the purchase order document. This is to provide Purchasing with a warning flag to not place the purchase order until a written approval by the Plant Department Manager of Safety and Industrial Hygiene and the Corporate Industrial Hygiene Coordinator has been received.
2 GENERAL REQUIREMENTS (Cont.)

2.2 Classification

The laser classification scheme is based on the laser’s capability of injuring personnel. The higher the classification number, the greater the potential hazard. The intent of the laser classification is to ensure adequate warning to individuals of accessible laser emissions by identifying the hazards through the use of labels and instruction. Any laser or laser system shall be classified according to its accessible radiation during operation.

2.2.1 All lasers or laser systems shall be classified and labeled as follows:

2.2.1.1 Class I, or exempt lasers or laser systems, are those which cannot, under normal operating conditions, emit a hazardous level of optical radiation. No warning label or control measure is required for this class.

2.2.1.2 Class II, or low power laser devices or systems, are those visible continuous wave or repetitive pulse lasers which do not have enough output power to injure a person accidentally, but which may produce retinal injury if viewed directly for an extended period of time (like many conventional light sources).

2.2.1.3 Class IIIa consists of lasers or laser systems that cannot injure the unaided eye of a person with the normal aversion response to a bright light, but may cause injury when the energy is collected and put into the eye with viewing optics such as binoculars.

2.2.1.4 Class IIIb consists of lasers or laser systems, which can produce accidental injury if viewed directly. This includes intra-beam viewing of specular (mirror-like) reflections.

2.2.1.5 Class IV consists of lasers or laser systems that can produce a hazard not only from direct or specular reflections, but also from a diffuse reflection.

2.2.2 When a laser system includes more than one laser, the classification of the laser considered most hazardous shall be used to determine the system design requirements.
2 GENERAL REQUIREMENTS (Cont.)

2.3 Laser Hazard Evaluation

2.3.1 General

The safe use of laser devices requires a determination of whether or not hazards exist, followed by the evaluation of the hazards as to the severity and potential effects upon the operator, the public, and transient personnel. The ultimate objective is to establish control measures, which are commensurate with the potential hazard(s).

2.3.2 Factors influencing hazards

Three aspects of the laser system influence the total hazard evaluation and thereby influence the application of control measures.

- The laser system’s capability of producing injury is determined by the laser classification scheme.
- The environment in which the laser is used (e.g., indoor or outdoor use).
- The personnel exposure potential of laser application. The principal hazard control responsibility rests with the operator for safe operation of the laser. The responsibilities include the avoidance of aiming the laser at personnel or mirror-like surfaces.

2.3.3 Indoor Laser Operations

The following procedure is required for evaluating indoor laser hazards;

2.3.3.1 Determine all potential beam paths for both fixed beam path and oscillating or rotating beam lasers. Evaluate the relative amount of time each beam path will be used.

2.3.3.2 Determine the extent of hazardous specular reflection.

2.3.3.3 Determine the extent of hazardous diffuse reflections if the emergent beam is focused. (Hazardous diffuse reflections are possible from a focused beam of a Class IIIb or Class IV laser beam).

2.3.3.4 Evaluate the potential for interaction between the laser beam and the materials on which it may impinge. This is particularly important for higher power Class IIIb and Class IV lasers.
2 GENERAL REQUIREMENTS (Cont.)

2.3 Laser Hazard Evaluation (cont.)

2.3.4 Outdoor Laser Operations

The following procedure is required for evaluating outdoor laser hazards;

2.3.4.1 Determine all potential beam paths for both fixed beam path and oscillating or rotating beam lasers. Evaluate the relative amount of time each beam path will be used.

2.3.4.2 Estimate the nominal hazardous range of the laser or have the manufacturer provide the information.

2.3.4.3 Evaluate potential hazards from specular (mirror-like) reflections. Specular surfaces ordinarily encountered are oriented vertically and will usually reflect a horizontal beam in a horizontal plane. Eight to ten percent of the beam’s original irradiance can be reflected toward the laser from a clear glass window, which is oriented perpendicular to the beam. If the beam strikes a flat, specular surface at an angle, a much greater percentage of the beam can be reflected beyond or to the side of the target. If the beam strikes a still pond or other similar surface at a low angle of incidence, effective reflectivity may also be high. Reflective surfaces, such as raindrops, wet leaves, and most other shiny natural objects, seldom reflect hazardous intensities beyond a meter from these reflectors.

2.3.5 Measurements

The laser classification scheme is designed to minimize the need for laser measurements and calculations by the user. Generally, such measurements are only required when there is no manufacturer’s information available, the laser or laser system has not been classified in accordance with the Federal Laser Products Performance Standard (21 CFR 1040), or when alterations to a system may have changed it classification. All lasers to be used in USS Corporation facilities shall be classified.
2  GENERAL REQUIREMENTS (Cont.)

2.4  Non-Light Hazards

2.4.1  Explosion Hazards

High-pressure arc lamps and filament lamps in laser equipment shall be enclosed in housings which can withstand the maximum explosive pressures resulting from lamp disintegration. The laser target and elements of the optical train which may shatter during laser operation shall also be enclosed or equivalently protected to prevent injury to operators and observers.

2.4.2  Optical Radiation Hazards – (Excluding the Laser Beam)

Ultraviolet radiation emitted from the laser discharge tubes and pumping lamps (that is, not a part of the primary laser beam) shall be suitably shielded.

2.4.3  Electrical Hazards

2.4.3.1  General

The intended application of the laser equipment determines the method of electrical installation and connection to the power supply circuit (for example, conduit vs. flexible cord). The design, component selection and fabrication of laser equipment shall be installed as in accordance with the current National Electrical Code.

2.4.3.2  Shock Hazard

Live parts of circuits and components with peak open-circuit potentials over 42.5 volts are considered hazardous, unless limited to less than 0.5 mA. Such circuits require positive protection against contact. For equipment intended for general use, interlock switches (and capacitor bleeder resistors, if applicable) or their equivalent shall be installed to remove the voltage from accessible live parts to permit servicing operation. Bleeder resistors shall be of such size and rating as to carry the capacitor discharge current without burnout or mechanical injury. Circuits and components with peak open-circuit potentials of 2500 volts or more shall be adequately covered or enclosed if an appreciable capacitance is associated with the circuits. If servicing of equipment requires entrance into an interlocked enclosure within 24 hours of the presence of high voltage within the unit, a solid metal grounding rod shall be utilized to assure discharge of high voltage capacitors. The grounding rod shall be firmly attached to ground prior to contact with the potentially live part. A resistor grounding rod (for example, a large-wattage ceramic resistor) may be used prior to application of the aforementioned solid conductor grounding rod to protect circuit components from overly rapid discharge, but not as a replacement. This type of work should only be performed by a service representative from the manufacturer of the laser.

2.4.3.3  Grounding

The frames, enclosures, and other accessible metal non-current-carrying metallic parts of laser equipment shall be grounded. Grounding shall be accomplished by providing a reliable, continuous metallic connection between the part or parts to be grounded and the grounding conductor of the power wiring system.
2 GENERAL REQUIREMENTS (Cont.)

2.4 Non-Light Hazards (cont.)

2.4.3 Electrical Hazards (cont.)

2.4.3.4 Electrical Fire Hazards

Components in electrical circuits shall be evaluated with respect to fire hazards. Circuit components of combustible material such as transformers, that do not pass a short-circuit test without ignition (see American National Standard Safety Standard for Radio Receivers, Audio Systems and Accessories, ANSI/UL 1270-1978) shall be provided with individual noncombustible enclosures. Power supply circuit wiring shall be completely enclosed in noncombustible material.

2.4.3.5 Electrical Hazards from Explosion

Gas laser tubes and flash lamps shall be supported to ensure that their terminals cannot make any contact which will result in a shock or fire hazard in the event of a tube or lamp failure. Components such as electrolytic capacitors may explode if subjected to voltages higher than their ratings, with the result that ejected metal may bridge live electrical parts. The manufacturer shall certify that such capacitors can withstand the highest probable potentials should other circuit components fail, unless the capacitors are adequately contained so as not to create a hazard.
2 GENERAL REQUIREMENTS (Cont.)

2.5 Design

2.5.1 All lasers and laser systems shall comply with Title 21 CFR 1040 - Performance Standards for Laser Products of the Department of Health and Human Services, Food and Drug Administration.

2.5.2 The minimum power output shall be used for the required application. Calculation sheets to support the proposed laser power requirements shall be prepared and shall be available upon request.

2.5.3 The laser source housing and control enclosure shall be dust proof and air/water tight.

2.5.4 The manufacturer, contractor, or vendor shall provide specific information on the equipment's characteristics. The minimum information to be included shall be as specified in the attached questionnaire.

2.5.5 The beam height must be maintained at a level other than the normal position of the eye of a person standing or in the seated position.

2.5.6 Enclosure of the laser equipment or beam path is the preferred method of control, since the enclosure will isolate or minimize the hazard.

2.5.7 If engineering controls are impractical or inadequate, then administrative, procedural controls, and/or personnel protective equipment must be used.

2.5.8 Reference Standards:

- American National Standard Institute (ANSI) Z-136.1 (latest version) - Safe Use of Lasers

- Bureau of Radiological Health (BRH) of the U. S. Food and Drug Administration - Performance Standard for Laser Products
2 GENERAL REQUIREMENTS (Cont.)

2.6 Identification and Warning Labels

The manufacturer, contractor, or vendor shall provide all required identifying labels, warning labels, and warning signs as described below. Sign dimensions, letter size and color, etc., shall be in accordance with American National Standard Specification for Accident Prevention Signs, ANSI Z535 (latest revision). There are two possible symbol designs that may be used: 1) ANSI Z535 or 2) IEC (International Electrotechnical Commission) 60825-1. If the laser device is provided with electrical safety interlocks, warning notices instructing the user not to defeat the interlock shall be applied immediately adjacent to the interlocks. Identifying labels, when required, shall be complete with the following information as a minimum, and shall be affixed to all lasers and/or laser systems:

- Wavelength or wavelength range
- Pulse duration (pulsed laser only)
- Laser classification
- Indication of compliance with 21 CFR 1040
- Name and address of manufacturer of laser tube
- Product identification number (e.g., date of manufacture, serial number, etc.)

2.6.1 Class I

No warning labels are required.

2.6.2 Class II and Class IIIa

Class II and Class IIIa lasers shall have a warning label affixed to a conspicuous place on the laser housing or control panel. Such labels shall be placed on both the housing and control panel if these are separated by more than ten (10) feet. The labels shall be similar to those shown in Figure 2-1 for Class II lasers and Figure 2-2 for Class IIIa lasers.

2.6.3 Class IIIb and Class IV

Class IIIb and Class IV lasers shall have warning labels affixed to a conspicuous place on the laser housing and control panel. The labels shall be similar to those shown in Figure 1-3 for Class IIIb lasers and Figure 2-4 for Class IV lasers.

2.6.4 The manufacturer, contractor, or vendor shall provide all required warning signs as specified in Section 2.10 for the controlled areas.
2.7  Safety Instructions

The manufacturer, contractor, or vendor shall provide adequate safety instructions covering the installation, operation, and maintenance of their equipment. This is applicable to all classes of lasers. Instructions shall be written in such a manner that they can be readily understood by persons minimally informed in laser technology.

2.8  Testing and Startup

The initial testing and startup of a laser device or system shall be performed only by a qualified representative of the laser device or system manufacturer or supplier.

2.9  Operation

Only trained and authorized personnel are to operate the laser.

2.10  Maintenance

Only factory-authorized personnel should perform maintenance on any system component that could result in a laser beam exposure.

2.11  Laser Inventory

Each operating facility must maintain an inventory of all permanently installed lasers. Purchase, installation, disposal, or transfer of a laser is not to be made without prior notification of and approval from the Plant Radiation Safety Officer, and if applicable as noted in Section 2.1 of this guideline, the Corporate Radiation Safety Officer.
CAUTION

LASER RADIATION
DO NOT STARE INTO BEAM
(Class II Laser Product)

0.9 mW He - Ne

FIGURE 2-1
BRH LABEL FOR CLASS II HELIUM-NEON LASER (LA02.DWG)
FIGURE 2-2
BRH LABEL FOR CLASS IIIa HELIUM-NEON LASER (LA03.DWG)
FIGURE 2-3
BRH LABEL FOR CLASS IIIb NEODYMIUM LASER (LA03B.DWG)
FIGURE 2-4
BRH LABEL FOR CLASS IV CARBON DIOXIDE LASER (LA04.DWG)
3  CONTROL MEASURES

Control measures shall be employed to reduce the possibility of exposure of the eyes or skin to hazardous laser radiation and to other hazards associated with the operation of laser devices. For all uses of lasers, it is required that the minimum radiation level be used for the required application. Engineering control measures which are incorporated into the laser or laser system itself, or added to the installation by the user, are almost always the preferred method for controlling access to laser radiation. If these measures are impractical or inadequate, protective equipment and administrative and procedural controls shall be used.

3.1  Class I

No control measures or warning labels are required. Only Class I laser or laser systems shall be used for unattended operation in unsupervised areas without the implementation of additional control measure requirements.

3.2  Class II

Class II is defined as low-power visible lasers or laser systems, which because of the normal human aversion response (0.25 second blink reflex time), do not normally present a hazard, but which may produce retinal injury if an individual overcomes his natural aversion to bright light and stares directly into the beam. The laser use area is to be posted with warning signs as described in Section 3.10.

3.3  Classes III and IV (General)

3.3.1  All Class III and Class IV lasers or laser systems shall be provided with a permanently attached beam stop or attenuator, such as a shutter or laser output filter, which reduces the output emission to a level at or below the applicable limit when the laser system is on standby.

3.3.2  All Class IIIb and Class IV lasers or laser systems shall be provided with a remote control connection point for de-activation of the laser by door interlocks or other remote switches.

3.3.3  All Class IIIb and Class IV lasers or laser systems shall be provided with a warning system, such as an audible tone or bell, and/or a visual warning device to alert personnel working inside the controlled area that the laser is activated. The warning system shall consist of a rotating beacon, flashing light, or red and green status lights. A red light indicates that the laser or laser system is powered ON with the shutter OPEN, while a green light indicates that the laser or laser system is powered OFF or de-activated. A third yellow status light may be used to indicate that the laser power is ON and the shutter is CLOSED.

3.3.4  All Class IIIb and Class IV lasers or laser systems shall be provided with an operative keyed master interlock or switching device. The key must be removed and the laser rendered inoperative when the key is removed.
3 CONTROL MEASURES (Cont.)

3.4 Class IIIa

Class IIIa is defined as medium-power lasers and laser systems, which cannot cause injury to a person with the normal aversion response when viewed within the beam with the unaided eye, but which may cause damage if the energy is collected and focused into the eye with magnifying lens systems such as binoculars or telescopes.

3.4.1 A controlled area shall be established whenever practical. The area shall be posted with warning signs as described in Section 3.10.

3.4.2 The beam path shall be located above or well below eye level whenever possible.

3.4.3 Alignment of laser optical systems (mirrors, lenses, beam deflectors, etc.) shall be performed in such a manner that the primary beam, or a specular reflection of the primary beam, does not expose the eye to direct irradiation.

3.5 Class IIIb

Class IIIb is defined as medium-power lasers and laser systems, which may produce injury if accidentally viewed directly. Intrabeam viewing of either the direct beam or a specular (mirror-like) reflection of the beam should be considered hazardous.

3.5.1 The entire beam path shall be contained within an enclosure whenever practical. If the entire beam path is contained within an enclosure, and the beam enclosure is provided with safety interlocks to prevent operation unless the enclosure is properly installed, and all means of operation access are secured, then the laser or laser system meets all requirements for a Class I system and may be operated as such in the enclosed manner without additional measures.

3.5.2 Laser beams emitted by non-enclosed systems shall be terminated at the end of their useful beam path by a diffusely reflective material.

3.5.3 When the entire beam path from a Class IIIb laser is not sufficiently enclosed and/or baffled such that access to radiation is impossible, a controlled area shall be established. The requirements for such an area include the following:

3.5.3.1 The warning system described in Section 3.3.3 shall be activated a sufficient time prior to laser emission to allow appropriate action to avoid exposure to the laser radiation.

3.5.3.2 The controlled area perimeter shall be posted with signs as described in Section 3.10 (blank format shown in Figure 3-2). Signs shall include the warning "RESTRICTED AREA - KEEP OUT".

3.5.3.3 Red and green status lights shall be provided at all entrances to the controlled area. A red light indicates that the laser or laser system is activated, while a green light indicates that the laser or laser system is de-activated.

3.5.3.4 Materials which will diffusely reflect the beam shall be used in the controlled area whenever possible.
3 CONTROL MEASURES (Cont.)

3.6 Class IV

The following shall apply in addition to the requirements for Classes IIIa and IIIb.

3.6.1 Whenever possible, the entire beam path shall be enclosed, including the area in which the irradiation of materials by the primary or secondary beam occurs.

3.6.2 Enclosures shall be equipped with interlocks so that the laser system will not operate unless such enclosures are properly installed.

3.6.2.1 For pulsed lasers, interlocks shall be designed so as to prevent firing of the laser, by dumping the stored energy into a dummy load.

3.6.2.2 For continuous wave lasers, the interlocks shall turn off the power supply or interrupt the beam by means of shutters. Interlocks shall not allow automatic re-energizing of the power supply, but shall be designed so that after tripping the interlock, the power supply or shutter must be reset manually.

3.6.3 Under conditions where the entire beam path is not fully enclosed, a controlled area shall be designed to fulfill the requirements of Section 3.5.3 and a "panic button" (control disconnect switch or equivalent device) shall be provided for de-activating the laser to provide admittance to the controlled area under emergency conditions.
3 CONTROL MEASURES (Cont.)

3.7 Enclosed Lasers and Laser Systems

3.7.1 The protective housing on the laser device shall limit the maximum accessible laser radiation to that level which defines the laser classification. The control measures appropriate to that classification shall apply when the laser system is in normal operation.

3.7.2 Each enclosed laser or laser system shall be provided with safety interlocks for any portion of the protective housing which, when removed or displaced, allows human access to radiation in excess of the applicable limits.

3.7.2.1 Failure of any single mechanical or electrical component in the interlock system shall not prevent the total interlock system from functioning.

3.7.2.2 Service adjustments or maintenance procedures on the laser contained within the enclosure shall not cause safety interlocks to become inoperative.

3.7.3 Failure of any part of the laser, or the enclosure containing a laser or laser system, shall not cause the laser or laser system to be in non-compliance with the requirements of an enclosed laser operation.

3.7.4 All viewing portals, viewing optics, or display screens included as an integral part of an enclosed laser or laser system shall incorporate suitable means to attenuate the laser radiation transmitted through them to levels below the applicable limits under any conditions of operation of the laser or laser system.
3 CONTROL MEASURES (Cont.)

3.8 Invisible Radiation

3.8.1 Infrared Laser Systems

Lasers or laser systems utilizing infrared radiation (> 700 nm), shall conform to the requirements applicable to the laser classification, and shall also conform to following:

3.8.1.1 The beam from a Class III or IV laser or laser system shall be terminated by a highly absorbent, non-specular backstop whenever possible.

3.8.1.2 The beam from a Class IV laser or laser system shall be terminated in a fire-resistant material whenever applicable.

3.8.1.3 Areas, which are exposed to reflections from Class IIIb or IV lasers or laser systems, shall be protected by appropriately screening the beam or the target area with infrared-absorbing material. In the case of beams from a Class IV laser or laser system, the screening material shall be fire resistant.

3.8.2 Ultraviolet Laser Systems

Lasers or laser systems utilizing ultraviolet radiation (< 400 nm), shall conform to the requirements applicable to the laser classification, and shall also conform to the following:

3.8.2.1 Beam shield material shall be such that the radiation level is attenuated to below the applicable limit for the specific ultraviolet wavelength.

3.8.2.2 Ultraviolet radiation not emitted as an intended primary beam, (such as that generated by laser discharge tubes and pumping lamps used in lasers) shall be suitably shielded.
3 CONTROL MEASURES (Cont.)

3.9 Maintenance

Access panels which are intended to be removed only by service personnel shall be interlocked, shall require a tool for opening, or shall have an appropriate warning label on the panel if removal would permit direct access to laser radiation above the appropriate limit for the laser's wavelength and time duration. If the interlock can be bypassed, a warning label with the appropriate indications shall be located at or near the access panel.

3.10 Warning Signs

Refer to Figures 3-1 and 3-2.

3.10.1 The dimensions of the sign, letter size, color, etc. shall be in accordance with the American National Standard Specifications for Accident Prevention Signs, ANSI Z35.1 - latest revision.

3.10.2 The laser hazard symbol shall be a sunburst pattern consisting of two sets of radial spokes of differing lengths and one longer spoke, radiating from a common center. The color, dimensions, and location of the symbol within the sign shall be as specified in ANSI Z35.1 - latest revision.

3.10.3 The signal word CAUTION shall be used with all signs and labels associated with Class II and IIIa lasers and laser systems.

3.10.4 The signal word DANGER shall be used with all signs and labels associated with all Class IIIa that exceed the appropriate MPE for irradiance and all Class IIIb and IV lasers and laser systems.

3.10.5 The appropriate signal word (CAUTION or DANGER) shall be located in the upper panel.

3.10.6 Signs shall be large enough so that adequate space remains for information as listed in Section 3.10.7 to be placed on the sign, either during the printing of the sign or legibly handwritten thereon.
3 CONTROL MEASURES (Cont.)

3.10 Warning Signs (Cont.)

3.10.7 Above the tail of the sunburst, include one of the following:

- Class II - "Laser Radiation - Do Not Stare into Beam"
- Class IIIa - "Laser Radiation - Do Not Stare into Beam or View Directly with Optical Instrument"
- Class IIIb - "Laser Radiation - Avoid Direct Exposure to Beam"
- Class IV - "Laser Radiation - Avoid Eye or Skin Exposure to Direct or Scattered Radiation"

3.10.8 At position 1 above the tail of the sunburst, provide any additional precautionary instructions or protective actions required by the reader shall be provided, such as: "Invisible Radiation", "Knock Before Entering", "Do Not Enter When Light is On", "Restricted Area", etc.

3.10.9 Below the tail of the sunburst at position 2, provide the type of laser (ruby, helium-neon, etc.) or emitted wavelength, pulse duration for pulsed lasers, and maximum output power.

3.10.10 At position 3, provide the class of the laser or laser system.
FIGURE 3-1
SAMPLE WARNING SIGN FOR CLASS II AND IIIa LASERS (LA02-03A.DWG)
FIGURE 3-2
SAMPLE WARNING SIGN FOR CLASS IIIb AND IV LASERS (LA03B-04.DWG)
4 TECHNICAL QUESTIONNAIRE

Note to Bidder:

The following questions must be answered to provide information and/or explanations of negative responses to the U. S. Steel Radiation Committee. Attach additional sheets if necessary.

4.1 Name and address of manufacturer of laser and/or laser system:
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________

Contact Person: ___________________________________________

4.2 Name and address of supplier of laser and/or laser system:
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________

Contact Person: ___________________________________________

4.3 Trade name and model number of laser-based system to be supplied

Trade Name: _____________________
Model Number: ___________________
4 TECHNICAL QUESTIONNAIRE (Cont.)

4.4 Reason for supplying laser and/or laser system (check all that apply):

- Demonstration
- Permanent Installation
- Other (Explain)

____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________

4.5 Type of transaction:

- Purchase
- Lease

4.6 Give a brief description of intended use of device, (i.e., gauging, alignment, optical sensing, scanning, etc.):

____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________

4.7 Type of laser, (helium-neon, ruby, argon, etc.): ______________________
4 TECHNICAL QUESTIONNAIRE (Cont.)

4.8 Radiation emission data and classification for appropriate laser or laser system:

4.8.1 Continuous-wave (CW) lasers only

Wavelength or wavelength range: __________________
Emergent beam size: __________________
Beam size at area of use or termination area: __________________
Beam divergence (milliradians): __________________
Maximum power output: __________________
Maximum emergent beam irradiance at point of use: __________________
Maximum emergent beam irradiance at point of possible exposure: __________________
Laser classification: __________________
Laser system classification: __________________

4.8.2 Pulsed lasers (all lasers not CW)

Wavelength or wavelength range: __________________
Pulse-repetition frequency (prf): __________________
Pulse duration: __________________
Average energy output (single pulse): __________________
Average power output (high performance systems): __________________
Exit beam shape: __________________
Exit beam dimensions: __________________
Maximum emergent beam radiant exposure: __________________
Laser classification: __________________
Laser system classification: __________________
4 TECHNICAL QUESTIONNAIRE (Cont.)

4.9 Beam type (check and fill in whichever apply)

4.9.1 Stationary
Required beam length: _____________

4.9.2 Rotating
Required beam length: _____________
Degrees of rotation: _____________

4.9.3 Traversing
Required beam length: _____________
Length of travel: _____________

4.9.4 Surveying and alignment
Maximum beam length: _____________
Maximum power density: _____________
Minimum beam length: _____________
Minimum power density: _____________

4.9.5 All other beam types (explain)
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
4   TECHNICAL QUESTIONNAIRE (Cont.)

4.10  Indicate whether device will be fixed or portable:

Fixed   [ ]

Portable [ ]

4.11  If device or system so warrants, does bidder intend to provide drawings and
description of the required controlled area and associated warning signs?

Yes   [ ]  No   [ ]

4.12  Indicate position and colors of laser status indicating lights to be utilized:

____________________________________________________________________________________________

____________________________________________________________________________________________

____________________________________________________________________________________________

4.13  Is a sketch included showing the area in which the laser will be located
in relation to equipment and personnel?

Yes   [ ]  No   [ ]

4.14  Are drawings of equipment, labels, and warning signs included?

Yes   [ ]  No   [ ]

4.15  Are operating, maintenance, and safety manuals
pertaining to the laser system included?

Yes   [ ]  No   [ ]

4.16  Is a general arrangement drawing of laser device/system,
indicating beam path, included?

Yes   [ ]  No   [ ]

4.17  Are startup services included as specified in Section 2.6?

Yes   [ ]  No   [ ]

If yes, how many man-hours are included?    __
4  TECHNICAL QUESTIONNAIRE (Cont.)

4.18 If any of the above items are not being supplied, explain:

____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________

PREPARED BY: ___________________________________________
COMPANY: ___________________________________________
ADDRESS: ___________________________________________
PHONE: ___________________________________________
DATE: ___________________________________________