[Template is intended to be completed by laser manufacturer/supplier originally for each specific laser system. The "manufacturer/supplier template" is then forwarded to VDOT (with laser calculations) for completion of site specific content including any adjustments to default field use details. For work performed by Contractor, Contractor completion of site specific content and update per their operational procedures is required. Bracketed items are meant as guidance with manufacturer/supplier primarily responsible for blue items and VDOT/ Contractor primarily responsible for green items.]

[Name of laser system]

Standard Operating Procedures (SOPs) for work performed by VDOT and direct report contract employees

1. LASER SAFETY CONTACTS [Complete]
   a. Laser Safety Officer (LSO) [Contractor employee for work not performed by VDOT]:
      i. Contact Name:
      ii. Cell phone:
   b. Laser System Supervisor (LSS) for this project work:
      i. Office phone:
      ii. Cell phone:
   c. Maintenance/Repair Contact [Equipment Owner]:
      i. Contact Name:
      ii. Office phone:
      iii. Cell phone:
   d. VDOT Safety Contact [Area Safety Coordinator]:
      i. Contact Name:
      ii. Cell phone:
   e. Medical Emergencies
      i. Ophthalmologist for medical evaluation of potential laser-induced injury to the eye
      ii. Physician for potential laser-induced injury to the skin
2. LASER DESCRIPTION [Add/remove/update as applicable and provide values]
   a. Laser application (i.e. work to be performed) description: Cleaning existing coatings from structural steel members using laser ablation coating removal (LACR) or induction coating removal (ICR) followed by LACR
   b. Current description and specifications for laser system
      i. Portable, diode-pumped, Nd:YAG (λ = wavelength = 1064 nm), q-switched pulsed laser with hand-held laser optic and closed-loop scanned beam
      ii. Classification: Class 4
      iii. Mode (continuous wave, pulsed, scanning continuous wave, scanning pulsed):
      iv. Power (list separately by mode where needed):
      v. Power (at beam aperture after power loss at fiber optic in/out couplings):
      vi. Pulse frequency:
      vii. Pulse duration:
      viii. Beam profile:
      ix. Beam distribution:
      x. Output aperture:
      xi. Beam divergence:
      xii. Scan rate:
   c. Specific laser settings for all variable settings available to the laser for the application described:
      i. Mode:
      ii. Power:
      iii. Pulse frequency:

iv. Scan rate:

d. The manufacturer calculated values for the nominal hazard skin and eye distances for applicable intra-beam, specular and diffuse conditions and the ocular density of eye protection based on the specific settings to be used (attached)
e. Project location(s) for laser use and storage location (where off-site) [Enter as sub-bullets]
f. Diagram of operating area layout, equipment placement, power source, barriers, signage, equipment storage location(s) (where on-site), etc. for each project site and either each work area or superimposed on overall layout of site (attached) [Develop and attach]

3. LASER SAFETY & OPERATOR TRAINING PROGRAM
   a. Mandatory VDOT Laser Safety Training for all personnel permitted access to the Laser Control Area during operation of the laser system
   b. Mandatory "Qualified Laser Operator Training" Requirements include:
      i. General laser safety training according to ANSI Z136.1, most current version;
      ii. Technical safety measures and equipment operation;
      iii. Organizational safety procedures;
      iv. Care and use of personal protective equipment;
      v. Site/process specific hazard awareness;
      vi. Laser equipment cleanup, waste removal, and storage;
      vii. Written test; and,
      viii. Hands-on training
   c. Credential(s) for Confirmation of Laser Training
      i. Certificate or Letter of Completion (on Manufacturer's company letterhead) and signed by the Manufacturer's employee with training authority
      ii. A binder containing copies of certificates or letters of Completion for all Qualified Laser Operators who will be operating the equipment shall be stored with the equipment
4. TRANSPORT, STORAGE, AND OTHER CARE INSTRUCTIONS
      a. Care instructions are located in the equipment User Manual
      b. A copy of the User Manual shall be stored with the equipment
5. OPERATING PROCEDURES [Update default when needed for specific operational details]
   a. Establish Laser Control Area (LCA)
      i. Restrict access within a minimum radius of [XX] feet of laser operation
         1. Where laser operation will occur at various locations, the LCA perimeter can be established to include all areas where it can be effectively managed
         2. Where laser operation will occur at some locations of a bridge before proceeding to subsequent locations, the LCA perimeter can be established at the first work area followed by removing and reestablishing the LCA perimeter at the next work area location
         3. Where the LCA cannot be established to meet the minimum radius (e.g., public access must be maintained within the minimum radius), laser curtains are required
      ii. Contain laser light surrounding the laser operation work area with laser safety curtains when others must work/pass within [XX] feet of laser operation
      iii. The laser control area can be established by use of:
         1. Hazard tape around the perimeter with entrance(s) at predominant approaches to the LCA;
         2. Laser warning signs posted conspicuously at all established entrances to an LCA and other potential approaches to the LCA where hazard tape should preclude access; and,
         3. Laser warning signs posted on any enclosed working area within the LCA (e.g., on exterior and interior sides of laser curtains).
   b. Prepare work area for normal operation
      i. Clear LCA of flammables and combustibles

ii. Prepare laser system for use
    1. Move laser system into position per supplied diagram
    2. Complete check of all items in Equipment Inspection section of the Laser Safety & Operating Procedure Checklist and resolve any issues
    3. Follow setup procedures according the Laser Safety & Operating Procedure Checklist
iii. Review operator access to work area
    1. Access provided is nearly level, sound, provides sufficient range of movement to perform the work and uses movable platforms where operator would otherwise be directly under laser
    2. Work area snag hazards for fiber optic and other lines are reduced to degree possible

c. Prior to each resumption of laser application, check laser settings and functionality
    i. Check all variable laser settings are properly set [match each variable setting listed in 2.c.]
        1. Set mode to:
        2. Set power to:
        3. Set pulse frequency to:
        4. Set scan rate to:
    ii. Make sure fume extractor is properly functioning/nozzle positioned close to target surface
    iii. Confirm required safety measures are in place before activating the laser beam

d. Operation
    i. Lasers shall be operated by authorized personnel only
    ii. Only Awareness Level Trained Employees (ALT Employees) and higher level laser operators/officials shall be permitted access to the LCA during operation of the laser (ALT Employees shall only be permitted access where under the supervision of the Laser System Supervisor)
    iii. Those permitted access to the LCA during operation of the laser shall wear all required personal protective equipment (PPE) and shall not position themselves behind the area the laser is performing work in the direction of application
    iv. The Laser System Supervisor (LSS) shall:
        1. Ensure that administrative controls are properly implemented;
        2. Allow only authorized individuals to operate the laser under the requisite level of direct supervision; and,
        3. Cease operation of the lasers if there is a breakdown in controls.
    v. The laser operator (either Qualified Laser Operator and Operator in Training) shall:
        1. Follow all safety procedures;
        2. Operate the equipment as instructed;
        3. Use laser for approved applications only; and,
        4. Immediately report all injuries/accidents or near accidents to LSS or LSO if LSS is not available
    vi. The LSS shall serve as or assign a Qualified Operator or higher level safety operator/official to serve as a Qualified Operator Assistant (QOA) during laser operation. More than one such individual may be needed based on the safety needs particular to the site. The QOA(s) shall:
        1. Ensure the fiber optic, fume extraction, or other lines connected to the laser head do not become entangled as the operator progresses with work;
        2. Monitor positions of those authorized personal within or approaching the LCA in relation to the laser operation and equipment noting the presence of personal protective equipment;
        3. Ensure no authorized personnel are directly opposite the specific area the operator is currently working on keeping particular interest for a switch in bridge element (e.g., switch from work on web to work on stiffener or connector plate) which involves a change in beam direction;
        4. Be aware of operator usage of the laser and the limits of the access provided to the operator to perform the work; and,
        5. Approach the laser operator for conveyance of any safety or operational items.

vii. Prior to commencing work, the LSS shall put up signage indicating active laser operation at LCA entrance(s) and inside the LCA
viii. After the active laser signage is in place, the operator shall survey all personnel in the immediate laser control area, ensure PPE is on, and announce "Beam On" to the Operator Assistant.
ix. The operator shall release the laser trigger to instantly stop the beam whenever:
    1. They become aware of any individual directly behind the area the laser work is being performed;
    2. There is concern the fume extractor is not functioning properly;
    3. There is need to substantially change position to continue performing work; and,
    4. A platform is moved into place which enables the operator to keep the laser head angled forward while performing work (i.e., operator is not working directly under laser head to reach highest areas to clean).
x. The laser head shall be directed away from personnel, public areas, and reflective surfaces whenever the laser trigger is released
xi. During the laser ablation coating removal, the temperature of all surfaces, including beam surfaces and all attached fasteners, shall remain below 400°F and verified using a calibrated non-contact infrared temperature gun.
xii. The optic protection window shall only be checked/cleaned when the laser system is off or the E-Stop is engaged.
xiii. The laser operator shall keep hands away from face as much as possible.
xiv. The operator shall announce "Beam Off" to the QOA when discontinuing work at the end of a work interval.

e. Shutdown Procedures: Follow shutdown procedures according to the Laser Safety and Operating Procedure Checklist
f. Disposal of Waste: Disposal of hazardous waste generated during use of a laser shall be completed according to the VDOT Waste and Pollution Prevention Guide

6. CONTROLS
    a. Laser System Controls [Update list per laser system; check applicable and add controls as necessary]

Check if applicable	CONTROL	COMMENT
	Indoor entryway and exit controls (applies to dedicated room functioning as a laser control area or dedicated operating area enclosure within a room): Entryway interlocks or controls	Entryway interlocks; secure from the inside of laser control or operating area (if possible)
	Outdoor entryway and exit controls: Qualified Operator or higher level safety operator/official	At entrance(s) to laser control area and/or operating area enclosure during laser operation
	Laser housing interlocks	At resonator service cover (key locked also)
	Emergency stop/panic button	At laser control panel and end effector
	Master switch – key lock	Key access limited to authorized personnel
	Beam stops/beam attenuators	Two step "on", instant "off" shutter closes when end effector trigger released
	Protective barriers	Laser safety curtains
	Warning signs	Class 4 Laser DANGER, laser burst, eye protection required, stop before entering, authorized personnel only
	Reference to equipment manual	Maintained with laser
	Extra safety eyewear available	For visitors or to replace damaged/missing

Comments:

b. Hazards and Controls [Update list per laser system; check applicable and add controls as necessary]

Check if applicable	HAZARD	CONTROL
	Unenclosed beam: access to direct or scattered radiation	Technical measures, administrative measures, laser safety curtains, PPE (laser safety eyewear)
	Laser at eye level of person sitting or standing – NOT PERMITTED	Administrative measures, laser safety curtains, PPE (laser safety eyewear)
	Reflective material in beam path	Administrative measures, laser safety curtains, PPE (laser safety eyewear)
	Hazardous materials/waste	Special procedures for fume extractor filter maintenance/dust disposal
	Fumes/vapors	Technical measures – Fume extraction/ filter unit PPE (if specified by IH)
	Electrical	Technical measures (no exposed conductors), administrative measures
	Fire	Administrative measures, keep fire extinguisher in work area
	Housekeeping	Administrative measures
	Trip hazards	Administrative measures
Comments:		

7. PERSONNEL PROTECTIVE EQUIPMENT (PPE)
   a. Laser Safety Eyewear [Complete based on ocular density calculations for laser system]

LASER EYEWEAR				
For CL1000		**Wear this eyewear**		
Type	Wavelength	Wavelength	Optical Density (OD)	Remarks

   b. Hooded PAPR, disposable Tyvek, and double layer disposable gloves when changing fume extractor filters or emptying particle collection tray relative to application dependent hazards unless requirements otherwise reduced by Industrial Hygienist (IH) based on specific engineered system details
   c. Other – as specified by IH personnel

8. SAFETY AND OPERATING PROCEDURE CHECKLIST – [Name of laser system] – Class 4 Laser

DANGER: Failure to follow safety procedures can result in serious injury including blindness!

Review and initial the items below prior to each laser start-up

Date: Time: Completed by:

Do not plug-in or energize equipment before completing Safety Setup and Equipment Inspection check–off items.

[Insert Safety and Operating Procedure Checklist as per Special Provision requirements]