

VIRGINIA DEPARTMENT OF TRANSPORTATION  
ALTERNATE BID ITEM SPECIAL PROVISION FOR  
**LASER ABLATION OR INDUCTION AND LASER ABLATION COATING REMOVAL OF  
STRUCTURAL STEEL MEMBERS**

March 21, 2023,

**I. DESCRIPTION**

This work shall consist of cleaning existing coatings from structural steel members using either laser ablation coating removal (LACR) or induction coating removal (ICR) followed by LACR. This special provision establishes requirements for Contractors to employ either LACR or ICR followed by LACR in removing existing coatings from structural steel on bridges designated by the Engineer.

**II. EQUIPMENT DESCRIPTION**

**a) Fume Extraction Unit**

The fume extraction unit (FEU) is a system designed to use a negative draft to pull fumes and particulate into a contained filtration system that includes a gross debris filter, a High-Efficiency Particulate Air (HEPA) filter and a granular activated carbon filter before discharging clean air from the unit.

**b) LACR Unit**

The LACR Unit uses a pulsed laser that is designed specifically for coating removal through ablation of the coating with a FEU attached to ensure fume and debris are captured. A pulsed laser is defined in ANSI Z136.1-2014 as, "A laser that delivers its energy in the form of a single pulse or a train of pulses where the duration of a pulse is less than 0.25 seconds". During LACR, the LACR handheld unit is designed so that the FEU is attached. The FEU then creates a negative draft at the surface of the steel while the coating is being removed to ensure fume and debris are captured by the filtration system. The LACR unit shall be interlocked to the FEU to prevent operation in case of malfunction.

**c) ICR Unit**

The ICR Unit uses an induction unit that is designed specifically for coating removal through the controlled inductive heating of the steel surface, less than 2 mils deep, which causes the coating to debond from the steel surface. During ICR, the frequency of the AC current selected that passes through a coil, which creates the electromagnetic field that induces eddy currents in the steel, will influence the depth of heating in the steel. The ICR device, therefore, use a carefully selected frequency that ensures controlled heating at the steel/coating interface as the ICR device is moved over the area where the coating is being removed. A FEU can be attached to the ICR device to capture fume and smaller debris, but unlike LACR some of the coating removed using ICR could be larger in size so capturing the larger coating pieces might require a different procedure.

**III. CONTRACTOR TRAINING, EQUIPMENT VERIFICATION, SITE SPECIFIC PLAN, SUBMITTALS AND ACCEPTANCE**

Contractor-developed items involving LACR shall conform with guidelines found in the American National Standard for Safe Use of Lasers, ANSI Z136.1, and applicable federal and state regulations.

**a) Contractor Training**

When performing the work, the Contractor shall receive training from the LACR and ICR (when utilized) Equipment Manufacturer on proper set up and operation of the equipment to safely and effectively remove coatings from structural steel substrates. Training content shall be based on who (Contractor or Equipment Manufacturer) will be operating the laser hardware (laser, chiller, etc.) and who will be cleaning the beam surfaces (i.e., operating the laser head). Training shall occur at a location where noise level and space will not detrimentally affect the training. Operational training involving live cleaning of sample specimens are subject to the same operational details of the laser control area in following requirements (i.e., containment of laser light). When not performing the work, the Contractor shall receive safety awareness training from the specialty subcontractor for any personnel who will be on-site during operation.

The Contractor shall certify to the Department they have received training from the Equipment Manufacturer(s) for the equipment utilized. A Certificate of Completion or Letter of Completion (on Manufacturer's Company Letterhead) and signed by the Manufacturer's employee with Training Signature Authority shall state the Contractor and employees (by name) responsible for subsequent training have successfully completed training and are qualified to safely setup and operate the equipment planned for use in accordance with the Manufacturer's written instructions.

The Contractor shall provide this training to all operators of the LACR and ICR (when utilized) equipment. At the conclusion of training the Contractor's employee responsible for subsequent training shall certify in writing that each operator (by name) has successfully completed the training and is qualified to safely setup and operate the equipment planned for use in accordance with the Manufacturer's written instructions.

#### **b) Equipment Verification**

The Contractor shall provide a copy of the equipment verification report from the equipment manufacturer establishing that the LACR and ICR (when utilized) equipment proposed for use on the project properly cleans the surface and does not change the bulk mechanical properties of the structural steel. Testing and documentation of results are required to be provided to the Contractor by the equipment manufacturer for mechanical properties testing in accordance with Virginia Test Method - ###

#### **c) Site Specific Plan**

The Contractor shall submit a Plan for review by the Engineer describing in detail the proposed methodology for employing either LACR or ICR followed by LACR and documenting the efficacy of their use with test results. The Contractor may propose the use of one or both of these technologies in the Plan, but if ICR is used, it must be followed by LACR. The proposed methodology shall include the Manufacturer's standard operating procedures (SOPs) for the individual technologies used modified by the Contractor to include the site specific operational details of the individual technologies for the work to be performed.

The Contractor shall submit as part of the SOPs the following additional items:

- 1.) The current specification sheet from the equipment manufacturer for the proposed LACR and ICR (when utilized) equipment (i.e., including any modifications made to the equipment);
- 2.) Where the LACR and ICR (when utilized) equipment has variable settings, the specific settings to be used. As example for LACR equipment, this would include power level, wavelength, mode (continuous wave, pulse or scanning pulse), and specifications relevant to mode; and,
- 3.) For LACR, the equipment manufacturer supplied calculations 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.
- 4.) Diagram of operating area layout, equipment placement, power source, barriers, signage, equipment storage location(s), etc. for each project site and either each work area or superimposed on overall layout of site.

The SOPs will distinguish who (Contractor or Equipment Manufacturer) will be operating the laser hardware (laser, chiller, etc.) and who will be cleaning the beam surfaces (i.e., operating the laser head). Operational details of the laser control area shall be based on the equipment manufacturer supplied calculations for the nominal hazard skin and eye distances for applicable intra-beam, specular and diffuse conditions. The SOPs shall follow the format of VDOT's SOP template and include a Safety and Operating Procedure Checklist developed by the Equipment Manufacturer to be completed by the Contractor for each laser start-up. The Safety and Operating Procedure Checklist shall include items for safety setup of the laser control area, laser equipment inspection, laser setup procedures, laser operating procedures and shutdown procedures.

#### **d) Submittals and Acceptance**

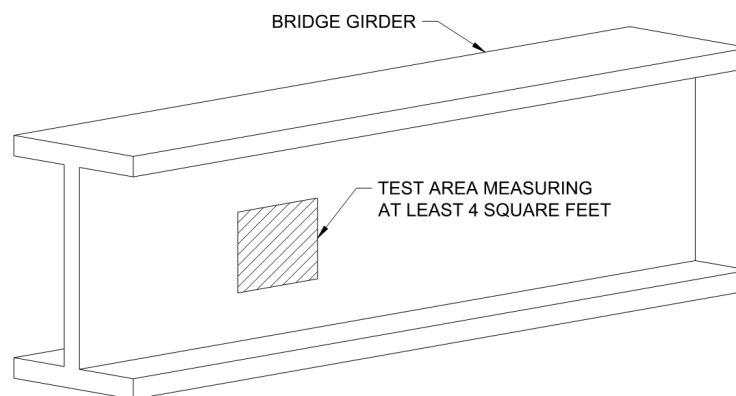
The Contractor shall submit the Equipment Manufacturers test results from Virginia Test Method - ### for the Engineer's review with the site specific Plans. Plans shall include all Quality Control measurements with frequencies of measurements during operations. The site specific Plan will become part of the Engineer's record for the work being performed. The Contractor shall not construe site specific submittal acceptance as implying any approval of means and methods by the Engineer. The Plan shall be comprehensive and cover all facets of operations. This Plan shall be provided at least two weeks before LACR and ICR (when utilized) may be used on the project site(s). No work shall proceed until the Engineer has notified the Contractor of Plan acceptance.

### **IV. DEMONSTRATED EQUIPMENT USE AND PROCESS ACCEPTANCE**

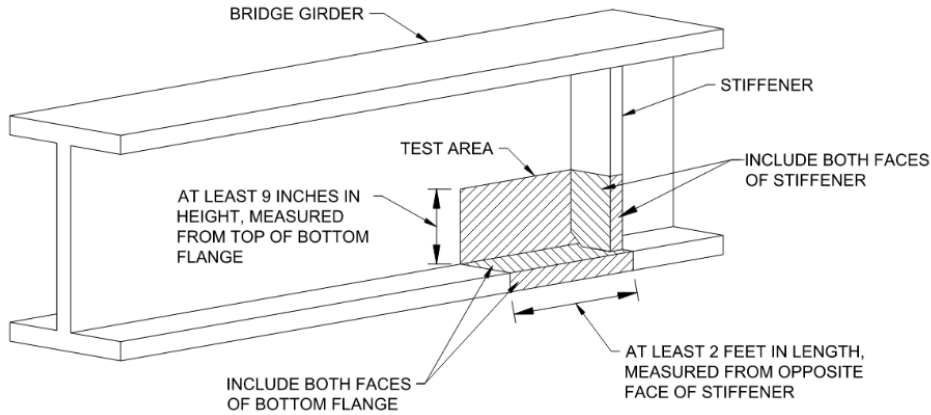
After implementing the environmental, worker protections and equipment setup, the Contractor shall perform ICR (if utilized) and LACR on representative bridge test areas prior to removing coatings from any other location as determined by the Engineer. The following representative surfaces shall be cleaned to bare metal in accordance with the Equipment Manufacturers written instructions and in accordance with this Provision and contract documents.

#### **a) Test Locations**

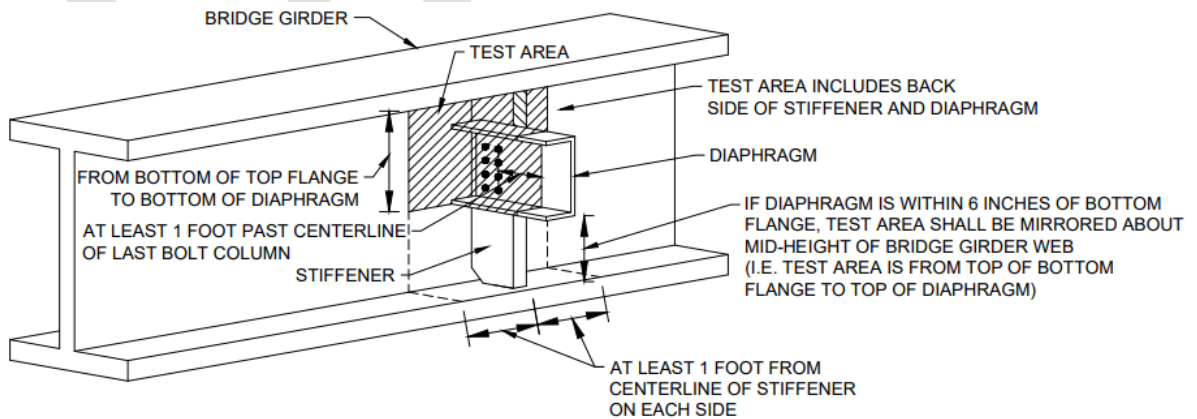
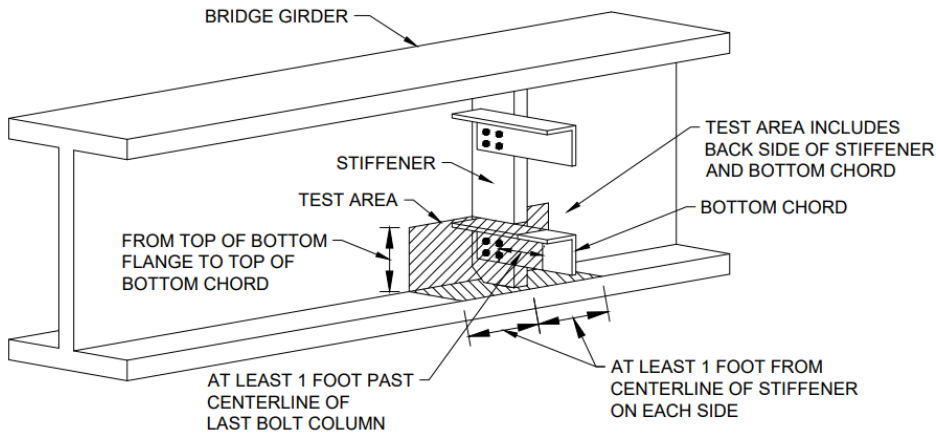
1.) 4-square-feet of area on a flat surface, such as a beam web. An example is shown below.



2.) 2 feet in length of an interior angle such as a stiffener to web, including the interior corner where the stiffener meets the top of the bottom flange to include 1 square foot of the flange surface. An example is shown below.



- 3.) Both sides of a representative bolted connection found on the structure between a secondary member (such as cross frame or diaphragm) and a stiffener or connector plate consisting of at least 4 bolts in a cross frame connection or 3 bolts in a diaphragm connection. Two examples are shown below (cross frame and diaphragm respectively) with minimum limits of the test area. Where the cross frame consists of a gusset plate bolted to the connector plate (i.e., stiffener), the test area shall similarly extend 1 foot past the centerline of the last bolt column which will include any portion of chord(s) welded to the gusset plate within that distance.



Particular attention of substrate temperatures shall be monitored in locations where multiple passes of LACR and ICR (when utilized) are required to remove coatings as indicated in Section 4 Procedures of this special provision.

If the scope of work does not include coating removal on one of the previously listed bridge test locations, a written request to omit a specific test can be submitted by the Contractor to the Engineer for their consideration.

#### **b) Inspection of Test Locations and Acceptance**

After the coatings have been removed from the test locations, surface preparation of these locations shall be verified by means of naked eye inspection. Chloride, sulfate, and nitrate testing shall be performed in accordance with Section 411.04(c)4 of the Specifications to determine the process(s) has successfully removed the non-visible contaminants.

Test locations will be deemed acceptable when 1) the existing coating material, loose mill scale, and surface rust have been removed to expose the base metal (hard mill scale and a small amount of well-adhered residual coating material within the surface profile may remain) and 2) chloride, sulfate, and nitrate test results are in accordance with Section 411.04(c)4 of the Specifications.

When test locations are deemed acceptable, the demonstrated process will be accepted for use per the equipment settings utilized. The settings and process utilized shall be documented on a quality control form and shall be used on the remaining surfaces designated for coating removal. Quality control documentation shall be submitted for Engineer's record.

The accepted test locations shall be photographed and/or preserved as a reference standard for final surface conditions.

### **V. PROCEDURES**

The surfaces to be coated shall be cleaned in accordance with Section 411.04(a)2. Method 2 to remove loose materials or Method 3 for heavy thick rust locations from the surfaces prior to using ICR or LACR. Section 411.04(a)2. Method 1 and Method 7 are not required prior to ICR or LACR operations.

During any ICR or LACR processes, 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.

The Contractor shall measure surface temperatures in locations where several passes are required to remove coatings using either ICR or LACR equipment. This includes both areas where coatings are currently being removed and adjacent areas where coatings have already been removed and are going to be removed. For areas in need of another pass using the ICR equipment, a subsequent pass shall not be initiated prior to a surface temperature check. Where the surface temperature is recorded to be above 300°F, a subsequent pass with ICR equipment shall not be permitted until the temperature has cooled below 300°F. Work with the ICR equipment may continue in areas where the coating is to be removed provided the work skips an area approximately two times the removal width ahead and the surface temperature at that location is recorded to be below 300°F.

Any areas where temperatures exceed 400°F shall be brought to the Engineer's immediate attention and the contractor shall verify equipment settings and process acceptance. Any areas where temperatures exceed 350°F shall be recorded as to location in the daily work report records

The Contractor shall provide access to all locations where LACR and ICR (when utilized) will be performed, including power equipment to operate the LACR and ICR (when utilized) systems, all filters used in waste removal for the LACR and ICR (when utilized), and any auxiliary heads used for performing LACR and ICR (when utilized) in restrictive accessible locations.

Only Awareness Level Trained Employees (ALT Employees), Contractor or other, and higher level trained laser operators/officials shall be permitted access to the laser control area during operation of the laser and ALT Employees shall only be permitted access where under the supervision of the Laser System Supervisor.

The Engineer shall verify the surface preparation and cleanliness of surfaces prior to completion of the work by means of naked eye inspection and instrumentation methods. If deficiencies are detected, such deficiencies shall be corrected until the existing coating material, loose mill scale and surface rust have been removed to expose the base metal (hard mill scale and a small amount of well-adhered residual coating material within the surface profile may remain).

## VI. ENVIRONMENTAL PROTECTION AND WORKER HEALTH AND SAFETY PLANS

The Environmental Protection Plan (EPP) requirements in Section 411.09 of the Specifications and the Worker Health and Safety Plan (WHSP) requirements in Section 411.10 of the Specifications are amended as follows associated with coating removal using laser ablation and ICR:

- The EPP and WHSP sections associated with LACR and ICR (when utilized) must be prepared by either a Certified Industrial Hygienist (CIH) or a Certified SSPC QP-2 Competent Person.
- Full containment during coating removal is not required, however, when ICR is used tarpaulins or other methods shall be employed to capture and prevent removed coatings or other debris from falling to the ground or into waterways. The removed coatings and debris waste shall be recovered and managed per 411.09 and any applicable project EPP.
- When LACR is used, the laser shall have a built-in fume extraction unit capable of capturing and controlling fume and debris generated while ablating the coating that pulls a minimum face velocity of 1300 feet per minute (fpm) at the surface of the material being ablated. The fume extraction unit shall be connected to a filtration unit that filters the fume and debris through a series of filters to include: 1) a gross debris filter, 2) a High-Efficiency Particulate Air filter; and, 3) granular activated carbon filter before discharging clean air from the unit.
- The contractor shall use a combination of fume extraction and natural ventilation, local exhaust ventilation, or general mechanical ventilation sufficient to limit airborne lead concentrations to levels below the OSHA Action Level and National Ambient Air Quality Standards for lead established by the EPA.
- All series filters used in LACR removal shall be monitored and replaced before breakthrough of any fume and/or debris discharge to the environment. Filter removal and procedures must contain debris collected and provide for worker health and safety.
- An initial exposure assessment is required, as defined in 29 CFR 1926.62 (d), at the start of work unless it has been completed and established with acceptance by the Engineer. Where initial exposure assessment has not occurred, lead controls, including respiratory protection, shall be required during the use of LACR and ICR units during the removal of toxic coatings.
- The Contractor must submit results of the applicable initial exposure assessment and periodic monitoring conducted at the VDOT structure, with personal identifying information (PII) redacted, to the Engineer for review.
- Environmental air monitoring shall be conducted at the filtration unit and at the boundary of the controlled area, which should be located at least 20 feet from the work area or as directed by the Engineer. At a minimum, air samples shall be collected and analyzed for lead.
- The Contractor shall propose how they plan to manage waste to the Engineer for review. On multi-bridge projects, the units (equipment and containment devices) shall arrive at the first location in a decontaminated condition. The units shall be decontaminated at the completion of a multi-bridge project.
- Waste storage shall conform to Section 411.09 and, upon completion of the project waste characterization, samples shall be collected for each of the sections of the filtration unit and analyzed for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver using a Total and TCLP analysis. The waste filters and debris from laser ablation shall be classified as hazardous if the total lead level exceeds 0.01%.

- The WHSP shall document proposed methods to protect against and mitigate harm due to laser exposure when LACR is used and induced heat when ICR is used. It shall include occupational safety hazards and controls in protecting workers and public within the requirements described herein. These include details of the laser control area established at the perimeter of the nominal hazard zone based on the submitted calculations and laser curtains or other means of public protection when public accessibility within the nominal hazard eye distance must be maintained. These also include requirements for the minimum level of training required for Awareness Level Trained Employees (ALT Employees), Contractor or other, provided supervised access to the laser control area during operation of the laser.

VII. Measurement and Payment

**Induction Coating Removal and Laser Ablation Coating Removal** will be measured in square feet and paid for at the Contract square feet price. This price shall include all labor, materials, and equipment required to perform verification testing and the actual ICR and LACR work defined by the Contact.

**Laser Ablation Coating Removal** will be measured in square feet and paid for at the Contract square feet price. This price shall include all labor, materials, and equipment required to perform verification testing and the actual LACR work defined by the Contact.

**Environmental protection and Health and Safety** will be paid for at the Contract lump sum price for the designated structure. This price shall include all labor, materials, and equipment required to prepare, set up, maintain, dismantle, and execute the environmental protection Plan and worker safety and health Plan; providing CIH and/or Competent Person oversight, industrial hygiene monitoring services; environmental and worker protection equipment and containment; and all other related costs. Payment for the Environmental Protection Plan and Worker Safety and Health Plan and execution will be made on the basis of two installments. The first installment will be made at 90 percent of the contract lump sum price per structure and will be made on the next progress estimate after an acceptable Environmental Protection and the Worker Safety and Health Plan are received by the Department. Payment of the remaining 10 percent will be made on the progress estimate following the submission of the certifications of compliance for the environmental protection and the worker health and safety Plans.

**Disposal of material** will be measured and paid for in accordance with Section 411.

Payment will be made under:

<b>Pay Items</b>	<b>Pay Unit</b>
Induction Coating Removal and Laser Ablation Coating Removal	Square Feet
Laser Ablation Coating Removal	Square Feet
Environmental Protection and Health and Safety	Lump Sum
Disposal of Material	Lump Sum