AII Laser Ablation Coating Removal (LACR) plus Induction Coating Removal (ICR) Webinar Responses to Questions

Note that AASHTO does not endorse, recommend or promote any specific proprietary product mentioned in the Q&A document. The proprietary product names were mentioned for information purposes only and does not constitute an endorsement or recommendation by AASHTO.

Field Work and Surface Preparation Questions and Answers

Question 1: Does report address the challenges and ways for workers to deal with the layers of bird droppings, corrosion by-product, road debris, and peeling paint flakes that exist in thick layer along the top of the bottom beam flanges in the real world? Any guidance references would be useful.

Answer 1: Most of our samples are real bridge steel samples that were from structures being replaced. We did this because we wanted to test removal of lead rich primers, however, VDOT stopped using those types of coating systems in the early 1980s, so we needed to gather samples from older structures in order to test the older coating systems. As you can see in our first report, (http://www.virginiadot.org/vtrc/main/online_reports/pdf/20-R1.pdf), these beams were not only coated in some of our older coating systems, but they also had the items you listed. For most of those items, we found scraping the surface and capturing the debris on a tarp worked just fine.

Question 2: What abrasive blasting standard was used when comparing cleanliness and adhesion between blast and ICR plus LACR preparation? Please reference AMPP surface preparation specifications, like SSPC-SP5, SSPC-SP6, or SSPC-SP10.

Answer 2: While the grit blasted surface was not fully classified to meet an SSPC surface preparation standard, it was determined that it closely matched an SP10 blasted surface, and also complied with the 2020 VDOT Road and Bridge Specifications method 5, section 411.04, with the exception of a profile that was slightly outside the range specified (An average of 5.4 mils was measured by the coating applicator, which is outside the limit of 4 mils as noted in the 2020 VDOT Road and Bridge Specifications.) The focus was not on qualifying a surface standard for each surface condition (LACR vs. grit blasting), but instead on comparing the adhesion of coatings to each of the surface conditions. We are currently working on producing a new surface preparation standard for pulsed laser ablation (LACR) with AMPP.

Question 3: Induction seems good for bulk paint removal on flat surfaces, but what about near interior corners or around fasteners (esp. rivets).

Answer 3: Most induction coating removal systems have different coil sizes that can be used with the system. For bulk paint removal on flat surfaces, a larger square or rectangular coil would be used to heat the coating on a larger area at one time. For interior corners or around fasteners, a smaller coil would be used to focus the heat on a smaller area. Removing the coatings around interior corners or fasteners would require more time because of the need to change the coil and the additional care when scraping the coating after applying induction, but it can certainly be done.

Question 4: Is it true that LACR is always required to follow ICR to achieve full paint removal?

Answer 4: In brief, the answer is no. LACR can and is used stand along on many similar projects, this is shown in prior work both by this group and others in the literature. Depending on the starting coated surface, the speed of LACR is sufficient. However, with thicker coatings, augmenting with a process combination like ICR can be advantageous. In this program, the efficacy of ICR/LACR was examined. The beams utilized for this project had the legacy mill scale layer along with the lead primer (circa. late 1930s). In this program, an acceptably clean surface for recoating was only observed for ICR plus LACR, LACR, and grit blasted samples. Coating removal on this system with ICR alone did not result in a clean surface and these samples showed markedly lower adhesion values after recoating.

Question 5: Many zinc-rich primers have relatively high heat resistance, especially Carbozinc 11 HS. Is there an opinion if that particular property may limit the effectiveness or economy of ICR & LACR?

Answer 5: For this project Carbozinc 11 HS primers were used. ICR was able to remove bulk three-layer coating systems from freshly grit blasted and coated beams that were recoated with this primer. Previous work in the past with LACR has shown the ability to remove multiple primer and coating systems efficiently.

Question 6: Can ICR and LACR be used on a steel structure protected with cathodic protection with sacrificial or impressed current?

Answer 6: VDOT sometimes uses cathodic protection on reinforced concrete structures that are in the atmospheric, splash, and submerged exposure regions. Of these different regions, the atmospheric region is where VDOT is currently focused on performing ICR and LACR. For structural steel that is exposed to the atmospheric region, VDOT commonly uses different coating systems if the steel doesn't have inherent corrosion resistance as a result of alloying. Therefore, we have not used ICR and/or LACR on a structural steel that is using cathodic protection to mitigate corrosion.

Question 7: Are there other possible applications for LACR or ICR?

Answer 7: VDOT sees the primary application as beam end recoating or repair work, but this technology can be applied to any targeted coating removal work.

Question 8: Does the ICR and LACR leave the original steel profile or does it leave a smoother profile due to remaining particles sitting in the pits?

Answer 8: In general, ICR and LACR do not alter the macro profile of original surface. The LACR process results in localized smoothing on a microscopic level, which does not affect adhesion. The reason for the smoother ICR and LACR surface profiles in this project is due to the fact these beams were never grit blasted and the original mill scale that remained present already has a smooth profile to begin with. Despite this large difference in surface profile in comparison to grit blasted surfaces (1/3 the roughness), standard testing to date has shown that adhesion is equivalent.

Question 9: Has there been any probing to see how coating manufacturers will respond as far as their required surface profile requirements?

Answer 9: We have not discussed surface profile requirements with coating manufacturers, but if they contacted us we would be willing to share information so they can decide how they will proceed.

Question 10: What was the contractor's opinion a on this technology?

Answer 10: Prime contractors do not see LACR as a viable option for repainting an entire structure and are waiting to see how the technology develops. Specialty contractors with their own equipment have entered the market to clean and potentially recoat targeted areas of bridges such as beam ends.

Question 11: Are ICR and LACR equipment readily available if required for a VDOT project?

Answer 11: ICR and LACR equipment is available for rental in Virginia. This equipment is used in other industries so rental does need to be scheduled in advance and transported to/from the site. Specialty contractors currently travel from out of state.

Question 12: Does the LACR method also remove rust, and if so, what are the limits for rust removal?

Answer 12: Thick mill-scale and pack rust (> ¼-inch thick) are not removed by LACR, however fully cleaned LACR surfaces still provide clean surfaces with good adhesion characteristics. If you have thick, chunky, loose rust, pitch, paint, scale etc., it is suggested that this surface debris be scrapped off and captured on a tarp or by other reasonable means for proper disposal. LACR on mill-scale will leave an adherent iron oxide on the surface, as was seen in this project. Flash rust and other thin and loosely adhered rust layers are very quickly and efficiently removed using LACR. This scale of interaction with rust and scale is known from prior projects.

Question 13: Can LACR be used in areas that are not flat (i.e., radius area between rolled beam flange and web, bolted splices, bolted connections, etc.)?

Answer 13: Yes, LACR can be used in areas that are not flat. However, using LACR on interior corners and around fasteners requires more care. The laser requires a range of standoff distances to most easily remove coatings. When using the LACR over a non-flat surface, such as an interior corner or around fasteners, it is more difficult to maintain this optimum standoff distance. The laser's ability to clean in tight spaces also depends on the geometry of the laser itself (i.e., it must be small enough to physically fit into the space to provide the correct standoff distance). Overall, it depends on the geometry of the laser system and the area to be cleaned. We've also talked to multiple laser manufacturers who have and are currently developing different head units for the LACR systems to better remove coatings in tight spaces. One manufacturer is developing a 90-degree head unit that can clean coatings on a surface that is 90 degrees to the main axis of the laser system.

Question 14: Has anyone used ICR/LACR for surface prep of weathering steel beam ends?

Answer 14: This project focused exclusively on legacy A36 structural steel beams removed from a decommissioned bridge in Virginia. However, other groups and research has shown that LACR can efficiently be used to clean other types of steel alloys, as well as other structural materials.

Question 15: Could either of these techniques be used to remove pack rust?

Answer 15: Similar to other coating removal methods that require access to the surface being cleaned and as commented earlier in Q18, LACR can remove surface rust but would not be effective removing deeper rust formation that forms in the tight space between the plates or bulk flake rust.

Question 16: Can LACR be used without ICR?

Answer 16: Yes, LACR can be used without ICR without any issues. In total, LACR has been utilized solo to remove a range of coatings. The main downside to using LACR standalone is the slower coating removal rate. LACR is relatively slow in comparison to a commercial scale grit blasting system, and can require more than one pass to totally remove a typical bridge coating. With our research with ICR, it has been shown that it can remove the bulk of the coating, and then minimal passes of LACR are required to completely remove the coating to bare metal.

Question 17: Any chloride measurements taken before and after LACR and/or ICR?

Answer 17: VDOT did not measure chlorides on the surface prior to LACR or ICR, but it is likely given the use of salts for snow and ice control. During coating removal, VDOT did sample coating systems for polychlorinated bisphenols (PCBs) as they may have been used in some coating systems. VDOT coatings sampled did not contain PCBs. After coating removal, laboratory chemical measurements of the uncoated surface showed that after LACR, and ICR in combination with LACR, very little chloride is left on the surface. Through energy dispersive spectroscopy (EDS) measurements, chloride was virtually undetectable on the LACR and ICR plus LACR cleaned surfaces.

Cost/Rate Related Questions and Answers

Question 18: Can you expand on your experience with the equipment costs and periodic maintenance?

Answer 18: VDOT initially investigated purchasing LACR equipment for use by district bridge crews. The unit VDOT was looking at was approximately $500k. As bridge coating removal was a new application of this technology at the time, VDOT instead considered contracts with specialty contractors to perform removal work or renting equipment for state bridge crew work and does not have periodic maintenance information. Rental timeframes depended on the distributer, and some were willing to work with DOTs on one-week, one-month, or 3-month pricing options. At the time, weekly LACR rental rates were approximately $15k with additional costs for items such as safety goggles, suction hoses, and filters. At the time, monthly ICR rental rates were approximately $25k. Again, special DOT rates for initial investigative work.

Question 19: Was there a study on time difference between grit blasting and LACR?

Answer 19: LACR is consistently slower than grit blasting, as shown in prior work. This fact generated a desire to examine the ICR process. ICR, when used in combination with LACR (ICR + LACR) can accelerate the coating removal process significantly. Coating removal rates using LACR depend on the type and thickness of coatings present, with thicker coatings quickly increasing

coating removal time. ICR in combination with LACR was determined to significantly increase coating removal rates as compared to LACR alone due to the ability of ICR to remove the coatings as thick bulk “sheets”, and therefore decreases the number of passes needed by LACR in order to produce a clean, ready to coat surface.

Question 20: What's the cost of using LACR/ICR compared to grit blasting and containments?

Answer 20: VDOT does not have comparable costs between grit blasting and containments currently. LACR/ICR have only been used on portions of VDOT repainting projects where the majority of removal was performed using conventional methods with conventional containment. Also, the pay item for recoating includes removal and recoating (i.e., not broken down separately).

Question 21: The work discussed focuses on coating with lead, would you suggest that other coatings would be removed with similar effort/time?

Answer 21: In this case, there were several layers of paint along with the lead primer. However, depending on the number and thickness of coating systems in question either LACR alone or ICR in addition to LACR can be used to efficiently remove coatings and prepare surfaces for recoating. A range of primers (epoxy, Zn rich) have been shown to be removed efficiently using both ICR and LACR. In this project, a lead primer was present, however ICR and LACR were both successfully used to removed multiple coatings that had been applied on top of the lead primer over the service lifetime of the bridge beams used for testing. The ICR process alone did not remove the lead-based primer, it did however speed up the coating removal process to a final step for LACR.

Question 22: What is the rate of production for LACR/ICR?

Answer 22: Non-VDOT bridge coating removal work (LACR only) resulted in an approximate rate of 1.5 sf per worker hour and involved some hand tooling. VDOT production rates for ICR followed by LACR on potential VDOT work has been estimated at 3.5 sf per worker hour for beam end coating removal including bearing stiffeners, channel diaphragms, and heavy corroded bearings for beam ends with active corrosion on bottom flanges and connecting web areas. Hand tooling for bearings and difficult to reach areas is expected and included in the production estimate.

Question 23: Do you have a ballpark estimate on the costs per square ft for both ICR and LACR methods?

Answer 23: A ballpark DOT pricing could be estimated at about $150/sf for specialty contractor independent work and $100/sf when working under a prime contractor on a portion of a project (i.e., prime providing items like access, disposal, etc.). These estimates derive from a very limited data set and will see variation based on access, detail geometry, beam condition, and other site-specific details.

Industrial Hygiene, Environmental and Training Questions and Answers

Question 24: It looks to me that you still need to have containments.

Answer 24: Use of Class IV lasers requires a laser control area to protect workers/public from laser light within the distance it can damage eyes. Where room is insufficient to establish, laser curtains are required. These curtains can be draped around the area like typical containment tarps or around the manlift or platform work is performed from. A ground tarp can be utilized to capture material removed during ICR or hand tooling where feasible. “Containment” will be dependent on-site conditions and how access will be provided to the areas to be cleaned.

Question 25: Do you still need Lead abatement containment for ICR?

Answer 25: Traditional blasting usually requires a full 100% containment with negative air/mechanical dilution ventilation within the containment. A full containment for achieving zero emission under national ambient air quality standards is not expected for LACR or ICR use. Contact the state or federal agency having jurisdiction for further guidance. However, waste management is still important, which might include tarpaulins or some other method of debris collection to minimize waste falling to the ground or into waterways. Laser curtains are a requirement when performing LACR, although they function differently as compared to conventional bridge containments systems that are used during recoating operations. It is also important to note that after cleaning ICR plus LACR, containment might be a requirement for painting operations, depending on location regulations and the type of painting conducted (airless spraying vs. Brush and roll, etc.)

Question 26: What is the maximum distance that the Air Emission Control System can be from the LACR surface location (e.g., is there a distance vacuum efficiency issue after so many feet)?

Answer 26: VDOT measurements of the fume extractor were collected at 50ft. The contractor stated that they often use up to 150ft of 3” flexible ducting before they notice a loss in velocity. A 3” flexible duct will lose about 0.12 feet per minute per foot of ducting at 1500 fpm.

Question 27: If a structure has lead primer/paint removed by ICR and LACR, can it be considered 'lead free' when paint removal is completed?

Answer 27: OSHA does not have a definition of “lead free” and, where there may be any amount of lead, requires workers be protected according to the amount of lead workers may be exposed to. The EPA has definitions for “Lead Free” for determination of waste, but this is not applicable to OSHA. VDOT’s exposure assessment showed that, for VDOT coating systems, workers were unlikely to be exposed above regulatory limits for hot work conducted after the leaded coating was completely removed using the LACR.

Question 28: With both the ICR & LACR methods introducing heat to the surface, how would an agency be sure that their procedure could be executed by an untrained or beginner-level operator to ensure the surface heating remains superficial (e.g., Official training, job reference standard)?

Answer 28: VDOT’s Special Provision contains several requirements to ensure that surface heating remains superficial including ICR unit, equipment verification, training, on-site test locations, and work monitoring requirements. Work monitoring consists of using a calibrated non-contact infrared temperature gun with temperature thresholds for work stoppage.

Question 29: Were there challenges communicating with project stakeholders (i.e., engineers, project managers, contractors) the occupational needs regarding lead (Pb) - considering the common confusion of EPA requirements versus OSHA requirements (i.e., hazardous-waste disposal, EPA lead Hud vs OSHA)?

Answer 29: The VDOT Bridge Maintenance Program is versed in VDOT’s lead exposure control program and VDOT’s environmental compliance so occupational health and environmental needs were addressed at the forefront of the assessment. VDOT structures do not fall under HUD in Virginia. I recommend reaching out to stakeholders early in the process and making employee health and environmental requirements a focus for any program implementation.

Question 30: May consider AI robot to overcome "trigger fatigue" problem.

Answer 30: Agree, that an AI robot could overcome this issue. While I believe at least one manufacturer is looking into the trigger issue, an engineering control was not available at the time of the study. Other research and programs in the DoD have implemented the use of robotic controls with feedback.

Question 31: All those challenges and problems would have gone away if a well-designed "AI robot" is employed to tackle this LACR work.

Answer 31: A well designed robot would take the employee out of the lead-work and would engineer out the employee exposure hazard. I agree that this avenue should be explored. However, a robot system was not available to VDOT during the LACR and ICR assessments.

Structural Steel Question and Answer

Question 32: Are there any property changes at temperature up to 2000°F.?

Answer 32: Fires under bridges rarely reach 2000°F, which is the temperature most bridge steels experience during the rolling process. Steel properties can change when exposed to heats less than 2000°F. Based on the literature review in this project, high performance steels (HPS) and heat-treated steels, such as high strength bolts, can experience a change in properties around 1100°F.

Standards Question and Answer

Question 33: Are there any groups developing industry consensus surface preparation standards related to laser ablation coating removal?

Answer 33: AMPP is developing industry consensus surface preparation standards related to laser ablation. The documents under development include: SP21511 Laser Ablation for Metallic Surface Preparation, Guide 21611 Laser Ablation Technical Guide, and Guide 21711 Guide and Reference Photographs for Steel Surface Non-Mechanical Cleaning by Pulsed Laser Ablation.