NAVSEA
NAVAL SEA SYSTEMS COMMAND

THE FORCE BEHIND THE FLEET

CORROSION CONTROL AND REPAIR TFT

Date:

Presented to:

Presented by:

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INDUSTRIAL OPERATIONS
NAVSEA 04
NAVAL SEA SYSTEMS COMMAND

NAVSEA
NAVAL SEA SYSTEMS COMMAND
EXPAND THE ADVANTAGE

What is CCR TFT?

How CCR TFT Helps

Provides a centralized discussion where stakeholders can share knowledge and act on areas such as:

- TWH approval status and progress
- Standardized equipment and instructions
- Visual aids
- Targeted Availabilities for pilots and implementation
- Safety & Health requirements
- Quality Analysis
- Cost Benefit Analysis
- Concerns and Barriers
- Change Management
- Funding
- Use Cases

Who is Part of the Team?

Team is inclusive and consists of various stakeholder including, but not limited to:

- NAVSEA04 (Facilitator)
- NAVSEA05
- NAVSEA08
- Naval Shipyards (PHNSY, PSNS, PNSY, NNSY)
  - Innovation Managers
  - Product Line Support
  - Paint Shop
  - Engineering
  - Project Engineering and Planning
  - Rad Con Advisors
  - Corrosion Control Manager
  - Safety & Health Office
  - You're also welcome to join or invite others!
- NUWC KPT
- TRF-Bangor
- HII-NNS
- NNL
- NSS-SY
- MDMC
- ONR/NRL
- RMCs
- Coatings and Coverings
- EIB/PICB
- USCG
- GDEB
- MIB

Problem Statement

Background (Maintenance)

Current Operations

Current CONOPS:

Current processes for paint and rust removal include needle guns, grinders, wire wheels, water jetting, abrasive blasting, wire brushes, solvents/chemicals, rotating/vibrating power tools, and even dental picks. Current methods are problematic because:

- Take up pier and dry dock space, requires media collection and disposal, filtration, set-up, and clean-up.
- Hazards to operator health (e.g., nerve damage, hearing, and exposure to hazardous material)
- Noise levels near living quarters on ships or offshore installations. (halt work for quiet periods)
- Hazardous waste generation (containment, collection, and cost for disposal)
- Damage to substrates (physical impact on substrate)
- Require additional time and physical effort to completely strip the surface to substrate level.
- Introduction of contaminants that significantly increase corrosion rates (chlorides) and decreases adhesion (micro dust & debris)
- Consumables wear out quickly and consistently.




How Can Coating Removal and Preservation Tech Help?

Coating removal technologies provide innovative sustainment tools that are easily deployed in austere environments, require small laydown areas, and provide the maintainer and warfighter the ability to decrease repair cycle times. New coating removal technologies will benefit combat and maintenance operations by enabling combat systems to return to field operation faster, whether in new construction, preventative maintenance, or repair and is easily deployed in contested logistical operations among all forces.

CCR technologies can be deployed in all environments; including but not limited to, on-board ship/submarines, tarmacs, hangers, forward operating bases, and facilities.

The benefits of these technologies:

- Non-contact removal (no chemicals, abrasives, grinding, or any physically touching on surface)
- Media and solvent free (minimal HazMat/HazMat labor and cleanup)
- Fast, clean, and safe way to strip coatings (no added contamination from dust/debris)
- Less noise and vibration free application (less worker's comp)
- Light weight and mobile (less time to set up)
- Safer for the environment (requires minimal containment, and clean-up)
- Reduction in resources (manhours)
- All in one systems that are adaptable to robotic and automated operations
- Fast to train, simple to operate, low maintenance requirements

What are some Challenges?

Limitations of these technologies:

- Has potential to alter substrates (Requires specific parameters to limit substrate damage)
- Requires additional safety precautions (Lasers, fume mitigation, barriers, etc..)
- Mobility of equipment (Some are larger than others)
- Limitations with substrates (Organic Substrates require additional settings and setup)
- Can only work on visible areas (Requires additional tooling to completely finish the job)
- There are sometimes trade offs with safety, efficiency, and quality (e.g. more efficient with higher safety risk)
- Industrial hygiene reports are necessary to determine hazards and mitigation
- Environmental reports are necessary to determine hazards to surrounding environment
- Effective area varies with tools and settings (need to determine most efficient parameters)
- In some cases, hot work requirements are necessary (potential for ignition)
- Developing standard operating procedures for new tools (requires engineering bandwidth)
- In some cases, vendors are limited

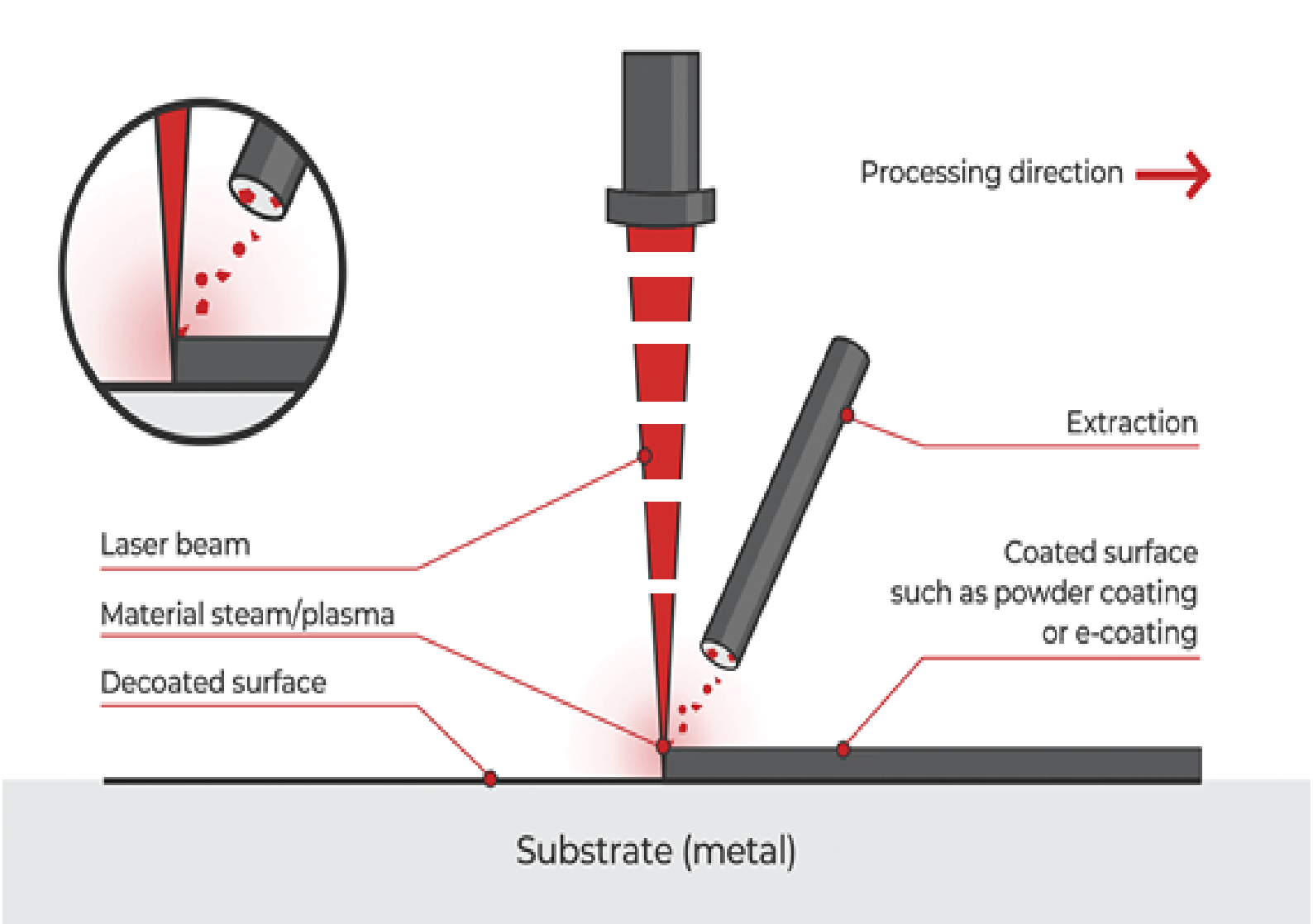
What is Laser Ablation (LA)?

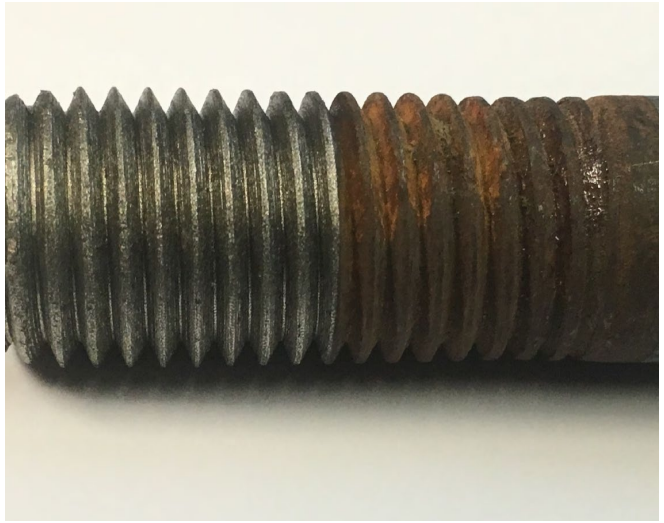
Background on Laser Ablation:

Laser ablation has piqued interest in various communities to remove coatings, organics, and rust in a variety of applications. The Association for Materials Protection and Performance (AMPP) developed two standards for use of pulsed laser ablation called “Pulsed Laser Ablation Technical Guide for Ferrous Metal Substrates” (AMPP SP21611-2024) and “Laser Ablation for Surface Preparation of Ferrous Metals” (AMPP SP21511-2024) approved August 2024.

- Laser ablation systems generate energy dense pulses to break down chemical bonds in corrosion/rust, coatings, carbon, soot, contaminants, grease, grime, thick paint, and more
- Short laser pulses [nanoseconds (0.000000001s), picoseconds, or femtoseconds] are exposed to the surface of the material to form a plasma that breaks down or debonds coatings from substrate and generates a cracking network
- Coating polymers are vaporized and turn into gas, or the shear forces generated from thermal expansion physically dislodges small particles from the surface
- Pulse parameters and other process parameters can be adjusted to limit heat absorption on heat-sensitive material and can be controlled to limit or prevent substrate melting/burning
- Work could expand beyond needle gunning applications and could replace media blasting in certain circumstances or with the right system in place
- The laser pulses allow for the treatment of hard-to-reach areas such as cracks, around corners, and other visible complex geometries. Light will reach into pores that media cannot
- Cleans about a 5” x 5” area (for 1000W system), speed of removal varies with thickness

What is Laser Ablation (LA)?





Adopted from **https://www.laserax.com/blog/what-is-laser-ablation**

What is Laser Ablation (LA)?

What it is NOT:

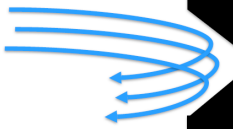
- Laser Welding or Cutting– This is a general misconception when viewing the use of this technology. Not all lasers function the same.
  - For laser welding or cutting to take place a high energy laser beam needs to be intense and focused enough to melt through substrates
- Lightsaber like those seen in “Star Wars” – This type of laser can not sever a finger.

What it IS:

Laser Pulses: Short pulses of laser energy vaporize coatings/rust

- Laser (**L**ight **A**mplification by **S**timulated **E**mission of **R**adiation)
- Power controlled with pulses
- Non-contact Cleaning
- Selective Material Removal

Cleaning Tight Corners and Crevices
With Air Pressurized Media



Deep corners and crevices are hard to reach

Cleaning Tight Corners and Crevices
With Light

Light does not experience back pressure
and airflow resistance.

Laser Ablation(LA)

Laser Ablation Surface Preparation:
Video: https://www.youtube.com/watch?v=-7gdCn6hU9I

The added benefits of this technology:

- Controllable parameters (wavelength, beam diameter, beam quality, focal distance, laser power, pulse length, pulse frequency, scanning speed, # of passes)
- No contamination embedded in surfaces like those from on-contact methods
- Can adjust to control what needs to be removed (color/acoustic sensors/ parameters)
- Cleans metals, ceramics, stone, glass, and other inorganic substrates
- Can be compact and portable and run on standard 120V or 240V (300W laser or less)
- Could replace smaller media blasting applications (e.g. tanks and blasting booths)
- Has a surface profiling capability
- Reaches deep corners and crevices that current methods can’t
- More robust and longer lasting than current tools
- Can be used for radiological decontamination applications

Some limitations of this technology:

- Has potential to alter substrate (requires specific parameters)
- Requires laser safety (enclosures, safety glasses, and interlocks/guards)
- Efficiency is decreases with umbilical length
- Not suitable for organic substrates like rubber or wood
- Can only ablate what is seen by the laser

LA ROIs

Known/Recorded ROIs:

- PSU-ARL report S2823 on LA of PCP from HSLA as an estimated ROI of 2.0, with $19M savings over 5 years with additional anticipated savings with extended use to other steels/coatings. Same study reported injury related savings of approximately $740K and 880 days per year
- PSU-ARL report S3021 on alternative paint removal estimates an ROI of 6.26 and $9.96M savings over 5 years for DDG 51 paint/corrosion removal
- The Environmental Security Technology Certification Program (ESTCP) estimates a total of approximately $550K/year/installation in cost savings resulting from environmental savings per year if chemical stripping was replaced
- NAVAIR found that for support equipment, laser ablation achieves 80% reduction in masking & encapsulation when compared to dry abrasive blasting, decreases hazardous waste generation by 90%, significantly decreases turn-around-time for coating/corrosion removal, and improves surface preparation for weld stripping prior to NDI
- Navy Metalworking Center (NMC) determined a labor cost savings of $17.2/ft^2 and a nondestructive test (NDT) time reduction from days to hours with substantial savings with regard to waste disposal
- NMC determined that laser ablation paint removal rates(125-389 MSI/min) are 2-5 times faster than needle gunning (72 MSI/min)
- GC Laser reported that multi-layer paint and primer could be removed 24x faster than traditional methods, one week of plastic media blasting can be reduced to only 100 minutes and removes 1,400 lbs. of media from the process
- GC Laser also reported additional savings of $126K/aircraft cleaning
- GC Laser reported increased safety with radiation decontamination, and reduced radiation exposure from 298mRem to 1.2mRem or less while maintaining occupational and radiological safety standards

What is Plasma Blasting / Etching (PB)?

Background on Atmospheric Plasma Coating Removal (APCR):

APCR was developed with support from the Small Business Innovation Research (SBIR) program applicable for DoD-wide forward operating usage. The Association for Materials Protection and Performance (AMPP) developed a standard for evaluating the cleanliness of surfaces processed with APCR called “Non-thermal Plasma Surface Preparation of Metals” (AMPP SP21523-2022) that was approved on November 8, 2022

- Uses dry, compressed shop air (80-100 psi // 3.5 cfm) and electricity (220-240 V or 440-480 V) to generate the 4th state of matter, plasma from the air (oxygen and nitrogen)
- A small area is cleaned by using electricity and air to make “reactive” atomic oxygen ions that are ejected from a nozzle.
- When ions contact an organic surface (e.g. paint), they chemically etch the surface into CO_2, H_2O, and inorganic ash
- The oxide layer present on all metal surfaces prevents etching into the metal and the air stream continuously cools the surface
- The topography/surface profile of the substrate is unchanged, and the surface remains below 250˚F
- Reactive chemistries are delivered at high velocity to the surface of the coating to accelerate oxidation and remove organic coatings and loose rust
- Plasma plume can flow (supersonic speeds) into hard to reach areas such as inside cracks, around corners, and other visible complex geometries to react, clean, and prepare surfaces
- The plasma will clean and functionalize surfaces that provides enhanced adhesion of the next coating, especially within the first 2-4 hours of plasma treatment

What is Plasma Blasting / Etching (PB)?

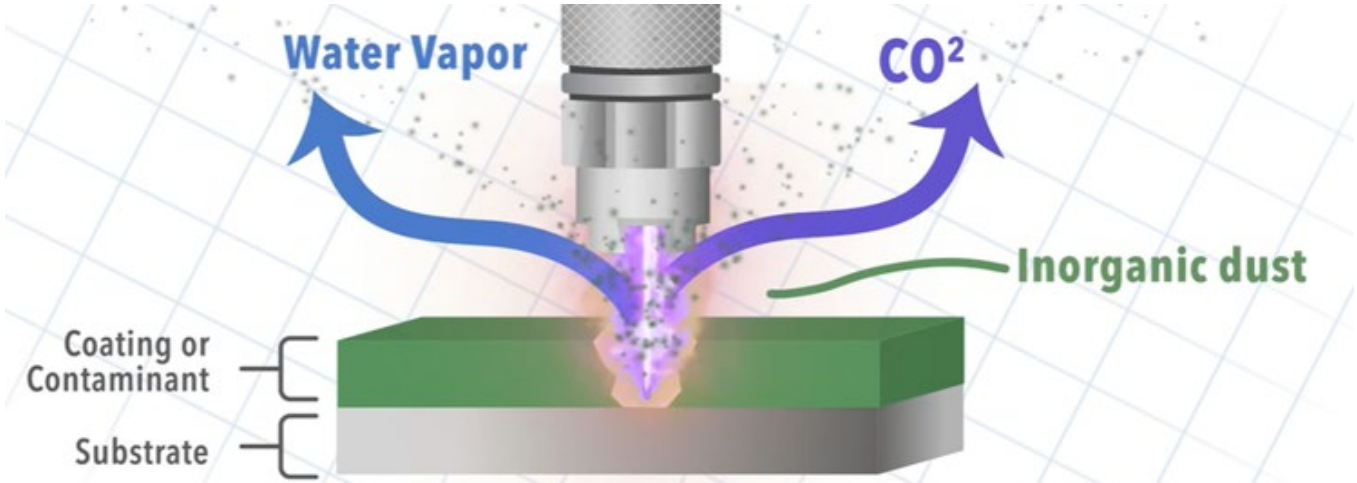
What it is NOT:

- Combustion/Thermal - This is a general misconception when viewing the use of this technology, especially since it appears to be a flame and creates similar by products.
- For combustion to take place:
  - Need high temperatures and heat to “fire point” – PB is low temp (~250 ºF)
  - Reacts with organic substances with heat to form carbon/soot, water, and CO2

What it IS:

Atmospheric Plasma:

- 4th State of matter (after solid, liquid, and gas)
- Non-thermal plasma generated by an electric field that is introduced into an air stream which forms atomic oxygen which is then ejected through a nozzle and onto the substrate.



Schematic representing the use of atmospheric plasma to remove a coating.

Plasma Blasting (PB)

The added benefits of this technology:

- Profile is maintained, no damage to the substrate
- Requires only compressed air and electricity to operate
- Fast to train, simple to operate, low maintenance requirements
- Lightweight (~40 lbs.), 5-minute set-up
- No contamination embedded in surfaces like those from on-contact methods
- Less consumable parts (no chemicals or needles)
- Can be operated by a person or automated with robotics
- Safer for the operator and environment (less noise and vibration)
- Improved worker ergonomics
- Safer for the environment (no hazardous waste clean-up)
- Has capacity to eliminate corrosion-based impurities like rust deposits
- Has capacity to improve adhesion
- Ideal alternative to grinding and chemical washing treatments

Some limitations of this technology:

- Cleans only a smaller sized area (sqft/hour – not for larger area applications)
- Industrial hygiene reports suggest process produces hazardous levels of NO2 (requires additional equipment and resources to mitigate)
- Considered hot work (requires additional resources to mitigate)
- Not suitable for organic substrates like rubber or wood
- Potential for ignition (flashpoints vary with material)

Plasma Blasting (PB)

Plasma Blasting & Atmospheric Plasma Surface Preparation:
Video: apsplasma.wistia.com/medias/0buyo12vqz

APCR applications include:

Fastener Release

Weld Inspection

Pre-Weld Strip Back

Adhesive Removal

Coating removal on delicate parts

Post Media Blast Detail Removal

Difficult to access spaces/locations

Preserving profile on high$ parts

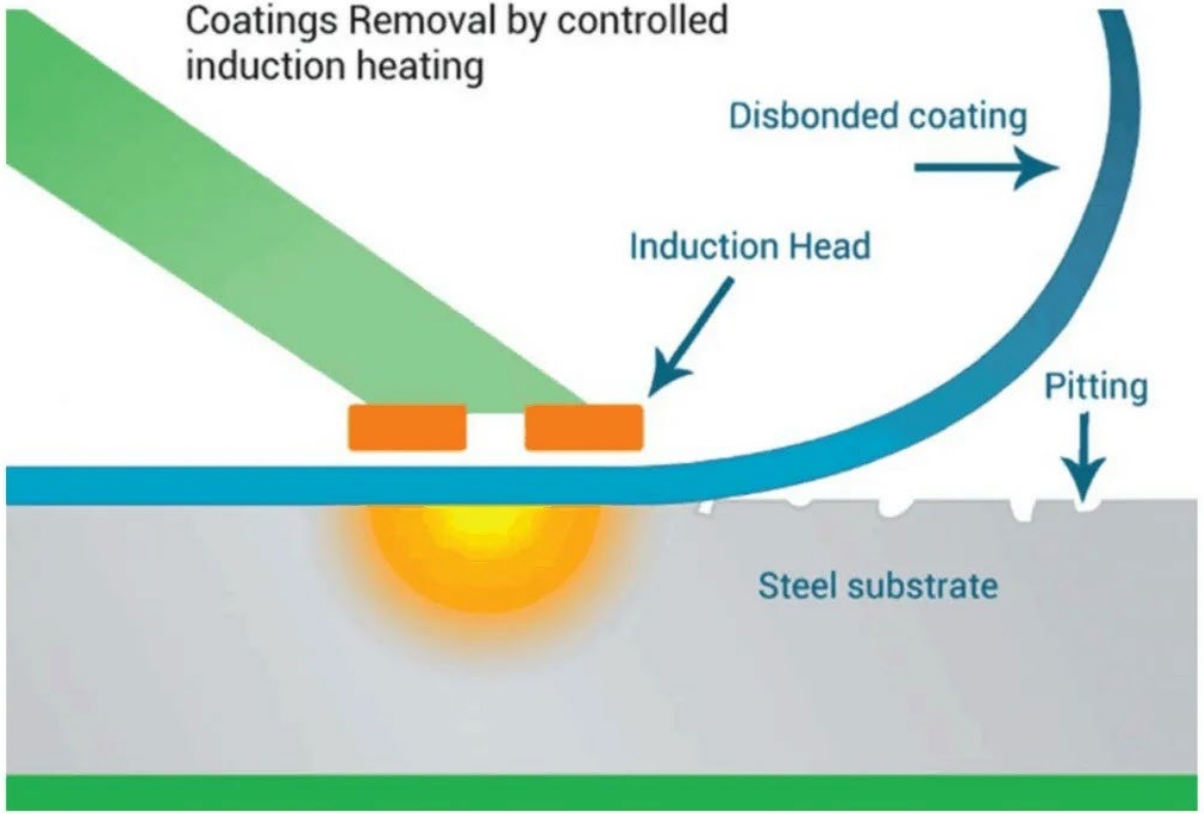
PB ROIs

Known/Recorded ROIs:

- General Dynamics Electric Boat (GDEB) determined that the process for using atmospheric plasma could provide a 94%-time savings over using needle gunning, 75% reduction in process steps, and a 432% ROI
- Norfolk Naval Shipyard (NNSY) study reported plasma blasting as 51% to 291% faster than needle gunning (speed increases as surface complexity increases)
- NAVAIR MALs showed removal of coating for weld NDI inspectiosn from days to hours by eliminating chemical stripping
- Additional 2nd and 3rd order benefits like reduced clean-up, waste disposal, rework, or safety mishaps

What is Induction Heating (IH)?

- Induction heating systems use electricity to generate alternating current through a hand held or robotically held induction coil, which generates an electromagnetic field in the target area (e.g., steel)
- The electromagnetic fields induce eddy currents in the conductive material and the resistance of the substrate causes the currents to rapidly convert into heat (induction heating)
- Heat is generated beneath the coating, causing the coating to peel or dislodge between the coating and the substrate beneath
- Induction heating can be used for paint, non-skid, heavy rust, interior tile and monolithic flooring systems, exterior hull treatments of various thickness, epoxy paints from tanks and bilge spaces, enamel paints, rubber liners, powder coatings, fiberglass, and more



What is Induction Heating (IH)?

Induction heating is gaining acceptance in surface treatment as a valid and safe technique complimentary to media blasting and hydro-jetting methods. Induction Coating Removal (ICR) allows for the removal of old coating that can be disposed of without disturbing the coating material or underlying substrate.

What it is NOT:

- A heat gun (heat applied to surface of material)

What it IS:

- Heating via an induced electromagnetic field to thermally break down the coating bond between the non-conductive coating layer and the conductive base material
- Heat is induced at the surface of the substrate, not in the coating

Induction Heating (IH)

Induction Coating Removal:
Video: https://www.youtube.com/watch?v=qm3tALBpWPc

The added benefits of this technology:

- Significantly reduces fumes and toxic dust
- Reduces steps to perform removal (connect cooling hose, choose coil, use)
- Effectively removes thick coating
- Easy clean up (paint chips vs. dust)
- Less PPE required (safe for the operator and bystanders)
- No open flames
- No special shielding or enclosures required
- Ideal for removing paint, rust, non-skid, fire protective coatings, and tank linings
- Controllable parameters (energy, temperature range, penetration, and speed)
- ~90 ft^2/hour per head

Some limitations of this technology:

- Only works with conductive substrates such as steel
- Has potential to alter substrates if substrate is overheated (needs to be controlled)
- Requires additional processes to completely remove coatings

IH ROIs

Known/Recorded ROIs:

- Cuts coating removal times by as much as 90% compared to alternate methods.
- Greatly reduces waste saving approximately $250k of disposal costs for blasting media
- 107 to 215 ft^2/hr realized on coatings less than 1/8" thick.
  - Up to 20x faster than needle gunning
- The thicker and tougher the coating, the greater the advantage of using ICR over abrasive blasting and hydro-jetting
- Can remove or reduce hazardous waste such as lead paint, polychlorinated biphenyl's (PCBs), or asbestos without mixing with media or water, limiting the volume of hazardous waste
- Significant savings for disposal since material is easily collected, transported, and disposed of
- Exceptional in areas where noise, dust, or water is not acceptable for use
- Superior method in removing thick or touch coatings
- NRL determined that ICR removes approximately 120ft^2/hr of non-skid compared to 50ft^2/hr when using power tools such as needle guns, scalars, sanders, and grinders
- Equipment can resist wear and tear associated with movement, storage, use, or other processes that can cause degradation to the induction equipment. (low maintenance)
- Set up time is a fraction of the time required for media or water blasting

Questions?

DESIGN, BUILD, DELIVER AND MAINTAIN SHIPS AND SYSTEMS ON TIME AND ON COST FOR THE UNITED STATES NAVY

EXPAND THE ADVANTAGE