

HCAT Program Overall Objective

Conduct demonstration/validation or research/development on advanced surface engineering technologies that will eliminate or mitigate environmental problems while improving materials performance that will lead to reduced life-cycle costs in military weapons systems

- *HVOF thermal spray to replace hard chrome plating on external surfaces (five projects) (ESTCP w/ JG-PP or PEWG)*
- *Plasma spraying using miniature guns for hard chrome plating replacement on internal surfaces (SERDP)*
- *Electrospark deposition for localized repair of coatings or non-coated components (ESTCP with PEWG)*
- *Nanocrystalline Co-P alloy plating for hard chrome plating replacement on internal surfaces (ESTCP) (FY04 start)*
- *Electrolytic plasma processing for surface cleaning and cadmium plating replacement (SERDP) (Aug 2004 start)*

Program on Qualification of HVOF Coatings as Hard Chrome Replacement

OBJECTIVE: *Demonstrate and validate high-velocity oxygen-fuel (HVOF) thermal spray coatings as an environmentally acceptable and cost-effective alternative to electrolytic hard chromium (EHC) in most maintenance operations at Navy, Air Force, and Army aircraft depots and in manufacturing operations at Defense Department OEMs*

- *Establish superior performance of thermal spray coatings to hard chrome, leading to increased time intervals between required maintenance*
- *Demonstrate reduced turnaround times for repair of components using thermal spray, enhancing weapons systems readiness*

Five projects related to replacement of chrome plating with HVOF coatings

HVOF Projects

Landing Gear:

- *ESTCP funding ended in March 2003*
- *Final Report submitted to ESTCP in 2003; published as archival NRL Report in March 2004 (available on HCAT web site)*
- *Project received ESTCP Project-of-the-Year Award at Annual Symposium on 2 December 2003*

Propeller Hub Components:

- *ESTCP funding ended in March 2003*
- *Final Report submitted to ESTCP in 2003; published as archival NRL Report in March 2004 (available on HCAT web site)*

HVOF Projects

Gas Turbine Engines:

- *ESTCP funding ended in March 2004*
- *Cost and Performance Report (50 page summary of entire project) submitted to ESTCP Program Office in July 2004*
- *Final Report to be submitted in August 2004*

Hydraulic Actuators:

- *ESTCP funding through March 2005*
- *Materials Joint Test Protocol completed; specimens being prepared for coating; testing to begin in August*
- *Extensive actuator qualification testing being conducted by Air Force*
- *Functional rod/seal testing and some actuator qualification testing being conducted by NAVAIR*

HVOF Projects

Helicopter Dynamic Components:

- *ESTCP funding through March 2006*
- *Stakeholders meeting held in mid-March 2004 in Baltimore*
- *Draft Joint Test Protocol completed*
- *Limited component testing being pursued at OEMs*
- *Navy has scheduled rig and flight testing*

Proposed New Hexavalent Chrome Permissible Exposure Limit (PEL)

- *OSHA under court order to issue new hex-Cr PEL under expedited rulemaking schedule*
- *Current PEL is 100 micrograms-per-cubic meter*
- *Although OSHA has not indicated what proposed new PEL will be, metal finishing industry expects PEL in range of 1 microgram-per-cubic meter*
- *Currently going through SBREFA process (obtaining comments from industry)*
- *Publication of proposed new rule in October 2004*
- *Public hearings and comment period from January-April 2005*
- *Publication of final rule in January 2006*
- *New rule will require extensive record-keeping, providing respiratory protection and protective work clothing, segregated work areas and medical surveillance of workers*
- *OSHA estimates total cost to industry will be ~ \$225 million but industry says that is too low*

Components of Rule

- **Dramatically Revised PEL**
- **Action Level**
- **Exposure Assessment**
- **Segregated Regulated Areas**
- **Methods of Compliance**
- **Respiratory Protection**
- **Protective Work Clothing**
- **Hygiene Facilities/Practices**
- **Housekeeping**
- **Medical Surveillance**
- **Hazard Communication**
- **Recordkeeping**

Estimated Compliance Costs in General Industry Associated with the Revised Standard

Cost Category	10	5	1
Engineering Controls	\$10,652,864	\$14,475,735	\$26,474,262
Initial Exposure Assessment	\$15,250,335	\$15,250,335	\$15,250,335
Periodic Monitoring	\$24,605,517	\$30,034,467	\$60,305,070
Respirators	\$29,448,797	\$29,448,798	\$35,361,768
Medical Surveillance	\$21,211,591	\$13,230,302	\$67,359,536
Communication of Hazards	\$21,211,591	\$21,193,263	\$21,881,436

Hexavalent Chrome PEL

Statements by Robert Peters, Director, Environmental, Safety & Health, Aerospace Industries Association:

- *“The OSHA Cr6 PEL proposal is very near the top of the list of environmental issues about which the aerospace industry is very concerned”*
- *“During SBREFA process OSHA used a range of PEL values from 0.025 to 10 $\mu\text{g}/\text{m}^3$. Unlikely OSHA will proposed PEL greater than 10*
- *“Defining issue for aerospace companies will be ‘technological feasibility’ or reaching very low levels of exposure*

Large number of documents related to Cr6 PEL available from AIA

Websites with more information:

www.sba.gov/advo/laws/is_hexrpt04_0420.pdf

www.sba.gov/advo/laws/is_hexjfarpt.pdf

Aerospace EHC Plating Market Segments, 2003

■ *Market Segments*

- *Landing Gear, \$0.35 billion (35%)*
- *Hydraulic Actuators, \$0.29 billion (28%)*
- *Gas Turbines (aerospace and IGT's), \$0.16 billion (16%)*
- *Other (prop hubs, rotor heads, pins, gear boxes, etc.), \$0.22 billion (21%)*
- *Total for aerospace approximately \$1 billion*

■ *Commercial market for EHC: \$0.65 billion (64%)*

■ *Defense market for EHC: \$0.37 billion (36%)*

Source: "Chrome Plating Alternatives," Market Study by Thintri, Inc., October 2003

Market Forecasts for EHC Plating Alternatives

- *Market Study done by Thintri, Inc. “Chrome Plating Alternatives,” published in October 2003*

“In most emerging chrome replacement applications, HVOF will be the method of choice, while other methods will retain niche markets”

- *Interviews with users and suppliers showed general consensus that there will be a 20% penetration of the EHC market within 3-5 years and an 80% penetration in about eight years for applications where HVOF can be used*
- *Compared to oil & gas, heavy machinery and other industries that use EHC plating, HVOF will have largest penetration in aerospace sector*

Other Information Related to HVOF Technology Insertion

- *Thermal Spray Society (sponsored by ASM International) is valuable resource for information; has TSS electronic bulletin board where people can pose questions*
- *Journal of Thermal Spray Technology is valuable source of information; June 2004 issue editorial discussed safety issues associated with thermal spray (metal exposure); special issue of JTST to be published in 2005 will address safety issues*
- *Issue related to quick identification of coatings when they come into repair facility*
 - *Portable X-ray fluorescence analyzer; weight less than 3 pounds, battery operated, uses radioactive isotopes to generate X-rays from material*
 - *Provides rapid quantitative information on elements in material/coating*
 - *Can be interfaced to computer; cost ~ \$30,000*

Other Information Related to HVOF Technology Insertion

- *Thermal Spray Society and NRC Canada hosting Workshop on Sensors and Control of Thermal Spray Processes to be held in Boucherville, Canada, on 26-27 October 2004. Technical sessions will concentrate on following topics:*
 - *Defining needs and expectations of large OEMs*
 - *Applying consistent coatings: A day-to-day challenge for job shops*
 - *Sensors for monitoring gun, particle and coating conditions*
 - *Equipment manufacturers – vision for the future*
 - *Advanced diagnostics and control*

HCAT

Program description, reports, meeting presentations, test data all available at www.hcat.org

Final reports on completed projects available without need to enter username and password

Next HCAT Meeting

*Proposed for
9-10 or 16-17 March 2005
in
North Florida
or
North Carolina*