



# **DOD Initiatives to Rapidly Transition Advanced Coating and Surface Finishing Technologies for Military Turbine Engine Manufacture and Repair**

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# The PEWG Defined



- The Propulsion Environmental Working Group (PEWG) is an established competency for collaboration within the DOD propulsion community to rapidly transition advanced pollutant free technologies for use in manufacturing, maintenance and rework of gas turbine engines (GTEs).

# Principal PEWG Members



- Military
  - acquisition and logistics representatives of Army and Air Force Materiel Commands, Naval Air and Sea Systems Commands.
- Industry
  - environmental executives, product engineers, and repair development engineers from major turbine engine manufacturers and their major vendors.

# PEWG Management Office



- Anteon Corporation team
- Experienced professionals
  - Program management
  - Project Direction
  - Meeting Management
    - General PEWG Meetings
    - Technical Working Groups
    - Web site maintenance ([www.pewg.com](http://www.pewg.com))

# PEWIG Impact



- Industry is seeing the PEWIG collaboration as a way to develop and transfer advanced technologies across military and commercial enterprise boundaries.
- Objectives:
  - Avoid waste in any form
  - Maximize product value
  - Sustain mission readiness

# Avoid Waste in Any Form



- Waste is any expenditure of money, talent, or time that does not directly add to product or service value
- Forms of waste
  - Corrosion damage
  - Erosion damage
  - Thermal damage
  - Fatigue losses
  - Noxious air emissions impacts
  - Excessive noise impacts
  - HazMat management costs
  - Workplace hazard response
  - Response to toxic releases
  - Fuel waste
  - Facility energy waste
  - Excess inventory management

etc., etc., etc.

# Maximize Product Value



- Safety – Consider safety in every aspect
- Sustainment – Keep engines in service
- Improve capability – Transition new technology to both new engines and fielded engines
- Conserve resources
  - Eliminate waste in any form
  - Recover value at end of product life

***“Make sure business processes are in place to enable all those other goals to be achieved.”***

# Readiness



Sustain mission readiness.....



# Product Stewardship for DoD Propulsion and Power



- Manufacture & field gas turbine engines so that
- (1) the parts do not fatigue, corrode, erode, or wear;
  - (2) engines are manufactured and sustained without reliance on use or generation of toxics;
  - (3) engine designs minimize noise and air pollutants;
  - (4) valuable components are reclaimed and reused when engines are retired.

# PEWG Interfaces for Technology Transition



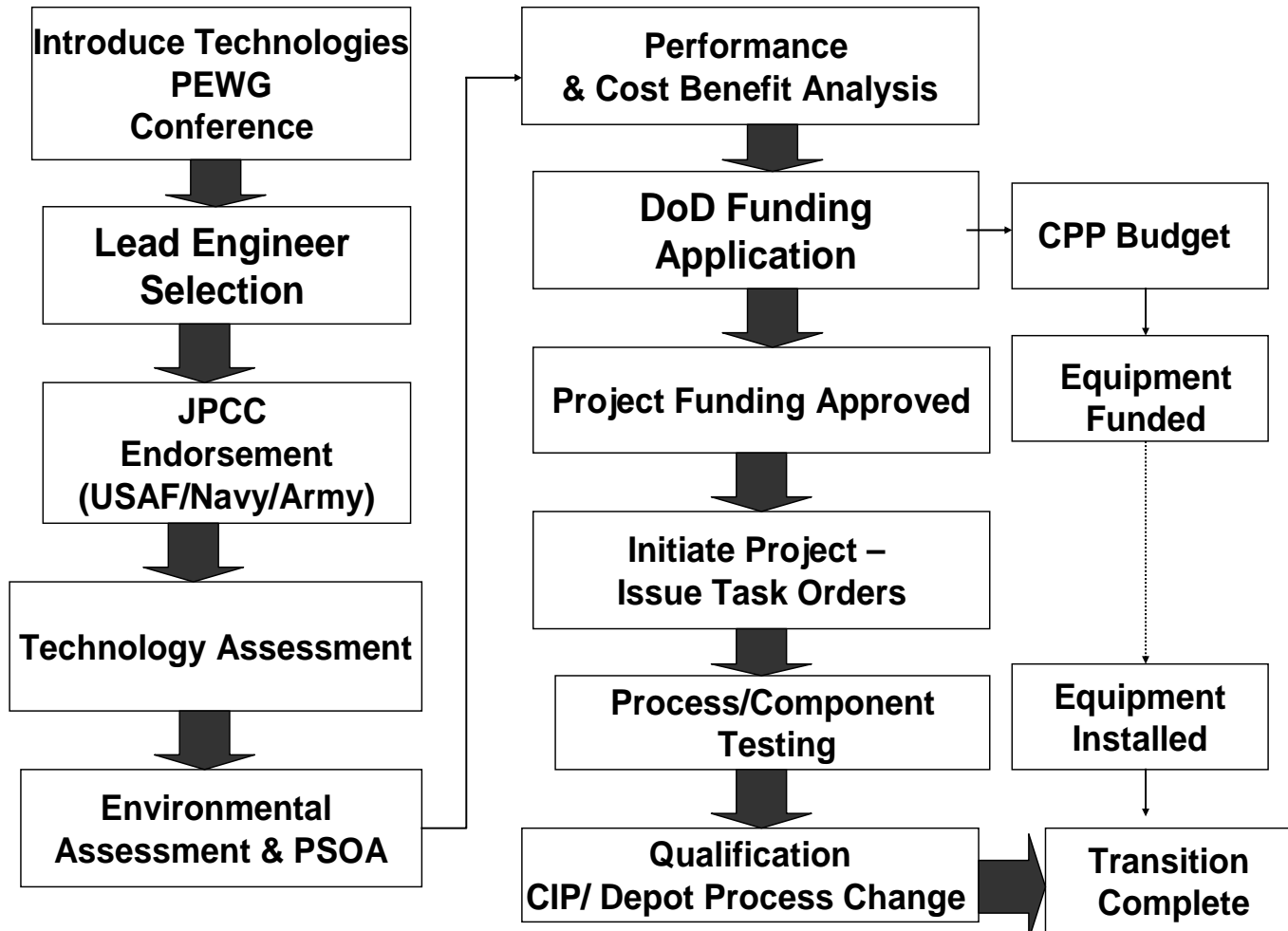
**The PEWG serves the PPGM and JPCC by working with other DoD propulsion technology initiatives**

- Integrated High Performance Turbine Engine Technology (IHPTET) Program
- Versatile, Affordable, Advanced Turbine Engine (VAATE)
- National High Cycle Fatigue Program (Eliminate HCF problems that account for 50% of engine failures).
- Engine Rotor Life Extension (ERLE)
- Service Life Extension Programs (SLEP)
- Depot Technology Modernization Programs

# PEWG Project Methodology



## PEWG Green Engine Project Flow



# Overview of PEWG Projects Involving Plating, Coating, and Surface Finishing



- Advanced thermal spray coatings (HVOF)
- Electrospark deposition
- Laser cladding
- Non-spray alternatives to chrome and nickel plating
  - Powder coating technology for wear, erosion, and thermal damage resistance (Also potential alternative to aluminum-ceramic coatings with chromium content)
  - Alternatives to chrome plate using nickel-based chemistry
  - Alternative to chrome and nickel plate using nanocrystalline Co-alloy pulse plating
- Kinetic (“cold”) spray technology
- High temperature diffusion coatings
- Thermionic cleaning

# Project Fact Sheets

# Advanced Thermal Spray Coatings (HVOF)



PROPONENT(S)	General Electric Aircraft Engines, Pratt & Whitney, Rolls-Royce
PEWEG MANAGER	Chuck Alford, Anteon Corp
TECHNOLOGY OPPORTUNITY ADVANTAGES:	Advanced thermal spray coatings (WcCCo) have superior wear resistance to hard chrome and is more cost effective on a life cycle basis.
CURRENT TECHNOLOGY – DISADVANTAGES:	Chrome electroplating currently in use has environmental hazards and is targeted for elimination. Chrome plate has shorter service life.
APPLICATION	Depot repair, New Part Manufacture
LOCATIONS	OC-ALC, NAVAIR Depots
PROJECT TEAM MEMBERS	Air Force, Navy, GEAE, P&W, RR, Process Vendors,
FUNDING SOURCES	Air Force P2, ESTCP, Navy Affordable Readiness Initiative
STATUS	Funded, Testing complete, Qualification continuing

- Accomplishments
  - Joint Materials Testing completed
  - Full production capability at AF and Navy Depots
  - Qualified for GEAE and P&W Engines
    - Functional test
    - Accelerated mission test
    - Flight test
  - Further implementation planned

# Laser Cladding



PROPONENT(S)	General Electric Aircraft Engines (GEAE)
PEWG MANAGER	Dave Crawford, Anteon Corp
TECHNOLOGY OPPORTUNITY ADVANTAGES:	Qualify laser additive welding (coating/thin) processes to produce near net shape internal/difficult to access features, Restore wear/damage with parent material. AF depot has equipment on site.
CURRENT TECHNOLOGY - DISADVANTAGES:	Hex chrome plating is used to restore dimensional tolerances up to 10mil. Greater wear may result in condemnation of part.
APPLICATION	Depot level repair
LOCATIONS	Oklahoma City Air Logistics Center
PROJECT TEAM MEMBERS	Air Force; General Electric
FUNDING SOURCES	AFMC P2 Funding
STATUS	Approved for FY05

# Alternatives To Chrome Plate Using Nickel-based Chemistry



PROPONENT(S)	Pratt & Whitney Aircraft Engines
PEWG MANAGER	Dave Crawford, Anteon Corp
TECHNOLOGY OPPORTUNITY ADVANTAGES:	Validate and qualify a commercially available electroless nickel boron coating process to restore dimensional tolerance of worn gas turbine engine parts.
CURRENT TECHNOLOGY - DISADVANTAGES:	Chrome electroplating currently in use has environmental hazards and is targeted for elimination
APPLICATION	Depot overhaul
LOCATIONS	OC-ALC; NAVAIR Depots, Corpus Christi AD
PROJECT TEAM MEMBERS	Air Force, NAVAIR, Army, GEAE, Rolls-Royce, Process Vendor
FUNDING SOURCES	AFMC P2 Funding, Navy and Army possible
STATUS	Not currently validated

# Nanocrystalline Co-alloy Pulse Plating



PROPONENT(S)	Pratt & Whitney Aircraft Engines
PEWG MANAGER	Chuck Alford, Anteon Corp
TECHNOLOGY OPPORTUNITY ADVANTAGES:	nCo-P coatings, developed under SERDP project #1152, is a promising alternative to chrome and nickel electroplating for IDs, brush plating, and plating of parts with properties not suited to thermal spray. Process can be implemented by retrofitting electroplating tanks
CURRENT TECHNOLOGY – DISADVANTAGES:	Chrome electroplating currently in use has environmental hazards and is targeted for elimination. Nickel plating may also be targeted for more stringent regulation.
APPLICATION	Depot overhaul, New part manufacture
LOCATIONS	OC-ALC; NAVAIR Depots, Corpus Christi AD
PROJECT TEAM MEMBERS	Air Force, DoD HCAT, NAVAIR, Army, GEAE, Rolls-Royce, Process Vendor
FUNDING SOURCES	ESTCP, AFMC P2 Funding, Navy and Army possible
3/21/2005 STATUS	ESTCP appr FY04-5 req FY06, AF Budgeted for FY06

# Kinetic (“Cold”) Spray Technology



PROPONENT(S)	Pratt & Whitney Aircraft Engines
PEWG MANAGER	Chuck Alford, Anteon Corp
TECHNOLOGY OPPORTUNITY ADVANTAGES:	Kinetic spray technologies deposit thick coatings with a metallurgical quality bond in applications where high temperature spray processes, such as HVOF thermal spray cannot be used. Process also has potential for spray forming on titanium components.
CURRENT TECHNOLOGY – DISADVANTAGES:	Chrome electroplating currently in use has environmental hazards and is targeted for elimination. Thermal spray is not suitable for parts with very low heat tolerance
APPLICATION	Depot repair and new part manufacture
LOCATIONS	Engine depots and part manufacturing facilities
PROJECT TEAM MEMBERS	Air Force, NAVAIR, Army, GEAE, Sandia National Lab, Process Vendors
FUNDING SOURCES	AFMC P2 Funding, Navy and Army possible
STATUS	AF Budgeted for FY06 – ESTCP Funds applied for

# High Temperature Diffusion Coatings



PROPONENT(S)	HITEMCO
PEWG MANAGER	Tom Pagnard, Anteon Corp
TECHNOLOGY OPPORTUNITY ADVANTAGES:	Replace current silicide coating on F100 augments components with a longer life coating.
CURRENT TECHNOLOGY – DISADVANTAGES:	Current coating (PWA 295) is shorter life (2400 hrs versus desired 4000 hrs) which requires more frequent teardown, cleaning, and use of HazMats at engine depot.
APPLICATION	New Part Manufacture
LOCATIONS	Vendor's facility
PROJECT TEAM MEMBERS	Air Force, Process Vendor, Pratt & Whitney
FUNDING SOURCES	RTOC
STATUS	Project in work

# Thermionic Cleaning



PROPONENT(S)	Edison Welding Institute, GEAE, P&W
PEWG MANAGER	Tom Pagnard, Anteon Corp
TECHNOLOGY OPPORTUNITY ADVANTAGES:	Identify applications of a commercially available cleaning technology which uses a reverse polarity welding process to vaporize surface contaminants on turbine engine parts (AKA Cathodic Arc Cleaning). Process does not use water or chemical solvents and apparently generates no toxics.
CURRENT TECHNOLOGY – DISADVANTAGES:	Current cleaning methods generate waste effluents that require management and create potential for uncontrolled releases of hazardous materials.
APPLICATION	Depot and intermediate level repair operations
LOCATIONS	OC-ALC, NAVAIR and Army Depots and repair operations
PROJECT TEAM MEMBERS	EWI, GEAE, P&W, Rolls-Royce
FUNDING SOURCES	RTOC
STATUS	OC-ALC request for FY06 Funding

# Other Technologies

- **Electrospark Deposition for Repair Applications**
- **Powder Coating Technology For Wear, Erosion, And Thermal Damage Resistance**

# In Conclusion



- The PEWG is a trendsetter for collaborative technology transition enterprise within the Department of Defense.
- Technical societies like the AESF are sources for advanced technology discovery and a way to share successes.
- Details on these projects will be available to authorized persons by accessing the project workspace being created on [www.pewg.com](http://www.pewg.com). Interested parties may apply to the author for password access.