

Department of Defense Metal Finishing Workshop
Breakout Session 3: Structural (Load-Bearing) Components
May 22, 2006
Washington, DC

Attendees

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Ron Montgomery (Co-Chair), OO-ALC
Chuck Pellerin, SERDP and ESTCP
Steve Gaydos, Boeing
Kevin Kovalewski, Naval Air Warfare Center
Tom Naguy, Wright Laboratory
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1. Current Usage

Landing gear, ground transport vehicles.

2. Requirements

- X To change to alternative materials and processes is very difficult at the depot level. Workers are used to tank processes. They are also afraid new technologies will result in loss of their jobs.
- X In addition, alternatives would require changes at all levels of the organization in terms of process orders and other orders.
- X At some depots with out-of-date shops, all new equipment is required.
- X Magnetron sputter equipment would need expansion.
- X Small shops are reluctant to install zinc-phosphate; they want an easier process.

Exposure takes place not so much at baths but when removing masking or during sanding and grinding.

3. Drivers and Barriers

What are issues for structural components?

- X Use with high strength steel, re-embrittlement, hydrogen embrittlement, single point failures, fatigue.

From the depot point of view, workers are used to tank processes, but HVOF (high velocity oxygen fuel) sprays are line-of-sight only. Alternative materials are designed to work for specific conditions, but there is no way to assure those conditions occur. Depots

often don't know what field repairs have been made. If field repairs are done incorrectly or with the wrong materials, alternative materials cannot be used on top of them. Shops also like to hold onto old materials "just in case." If materials are not used frequently it's not worth it to switch to new materials.

Funding for pollution prevention is a major problem—to get funding you have to show cost savings, but only a subset of costs can be included in the analysis. It's difficult to show environmental payback once low-hanging fruit have been addressed.

Standards

Hydrogen embrittlement testing is a huge issue. There is no good standard for testing—no standard specimen. The current standard uses six specimens. Each vendor is doing the test to its own criteria. People are not necessarily opposed to changing specimens, but they are comfortable with what they use now, along with the fact that they can compare new data based on these specimens to legacy data. Some labs are hesitant to invest additional funding in alternative coatings because after 10 years of testing there is no answer on the hydrogen embrittlement problem. Even if there's a good replacement material, it can't be used until it passes the hydrogen embrittlement test. John Beatty noted that from a coating standpoint, we know what causes embrittlement; we just need to find a way to prove that we have solved the problem.

Even if a substitute meets specifications, there is a concern about whether a material can withstand actual flight, while existing materials' abilities are already known through experience. Specs state that aircraft must have 10E-6 risk of failure; the risk for commercial aircraft is 10E-9. It is difficult to correlate results of hydrogen embrittlement testing with those risk levels.

ASTM is currently developing a new standard (F0704) for re-embrittlement testing (the old standard is from the 1970s and is somewhat arbitrary). Boeing recommends using 1-A-2 buttonhead specimens. Long bars are better for testing but more expensive, and fewer labs are able to test them. They can also only be tested one at a time. Sustained loads are better than rising steploads. The ASTM workgroup is interested in conducting round robin testing with a standard set of specimens and environments (maintenance fluids), but it needs volunteers to conduct the testing.

Fatigue testing is another problem, but there is no standard for that, since each component varies from aircraft to aircraft.

Aside from the new PEL, drivers are usually based on procurement—whether a contract stipulates use of alternative materials. Executive orders on alternative materials are so old no one places much emphasis on them. In some places, active environmental management teams, which focus on process improvement, can be a factor. Procurement is easier because it comes with environmental guidance.

Cost

If cost is an issue, alternatives may be placed on the back burner. Industry tries to stay affordable so it can win contracts, so they avoid switching to alternatives unless it's in a contract. For example, in small diameter bombs, zinc-nickel plating is slightly more expensive than cadmium, so it's not used, even though it meets the specifications for use with low strength steel. Considering life cycle costs can help; but these assessments reflect manufacturing and do not usually include savings in maintenance costs or long term return on investment. Efforts to keep production high also result in continuation of the status quo. Any process that will increase production time is nixed.

The Army has a strategy on reduction in future liabilities but even if cost isn't a factor, this policy is often ignored. If there is no reward, no one is willing to take the risk.

Costs may be a driver when the new PEL is implemented, but this may be facility-specific. The costs of PPE for sanding will increase until chromate is eliminated from primer.

4. Adoption of Alternatives

- X Users want to focus on cadmium replacement.
- X Alternative substrates include magnesium and titanium alloys, high strength aluminum alloys.
- X Tungsten carbide cobalt
- X Alternatives to chromates, where not flight critical. Push for exit pre-coat on cargo planes, non-chromate primer on F-15s.
- X Non-chrome primer is more important than chromated pre-treatment.
- X Need to eliminate chromate wash primer. Small shops are resistant to installing zinc-phosphate and want another easy process for low strength steel. This could just be pretreatment.
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5. Remaining Needs

- X Funding for pollution prevention is a major problem—to get funding you have to show cost savings, but only a subset of costs can be included in the analysis. Need to change the way costs are calculated. Need to determine life cycle costs for alternatives.

- X Congress could reverse the failure to reward, and could provide a driver to make such changes even if cost is an issue.
- X Funding for seed programs, such as the MAI program on hybrid structures, would be useful.
- X Funding is needed for implementation. The estimated cost of a new shop for HVOF is \$50 million.
- X Existing processes need to be improved until new technologies are implemented. Best management practices are not followed everywhere.
- X Switch to dry processes—it's easy to switch out materials there. Why keep using 19th century processes?
- X Avoid coatings altogether. Use titanium and composites.
- X New technologies should be systems-based. Eliminate grind damage, sanding, and corrosion, not just cadmium.
- X Switch to trivalent chromium, although some are concerned that it still contains hexavalent chromium. Others are concerned that trivalent is not much safer.