



## Background

The C-17 Pollution Prevention Integrated Product Team (IPT) is headquartered at Wright-Patterson Air Force Base (WPAFB), Ohio, and lead by Major Carolyn Jacobson (MSW/C17 SG), but the team spans across the country. The more than 60 member IPT includes bio-environmental, safety and maintenance personnel at current C-17 bases – Altus, Charleston, McChord, and McGuire AFBs, Jackson Air National Guard (ANG) and March Air Reserve Base (ARB), as well as engineers from the C-17 home in Long Beach, Ca, and representatives from the Air Force Research Laboratory (AFRL), the Air Force Corrosion Office, Air Mobility Command (AMC), Air Force Materiel Command (AFMC), Air Education and Training Command (AETC), Boeing Logistics Support Systems in San Antonio, Texas, and elsewhere.

In the past two years the IPT has initiated a dozen major projects and numerous smaller

ones with a budget of \$12 million. The team deals with maintenance, engineering, contracts, Systems Engineering, Environmental Safety and Occupational Health (ESOH) and sustainment aspects of the C-17 plus production, bed-down, and demilitarization for the 140 aircraft in service in the United States and also supports four planes in the United Kingdom.



▲ The C-17 Bases & Headquarters (Bases in green have not yet received aircraft)

### Awards & Services

- Instructed the Air Force Institute of Technology's (AFIT) Acquisition P2 Distance Learning Course reaching students at installations worldwide
- Briefed at the Joint Services Environmental Management (JSEM) conference in 2005, chaired the ESOH weapon system acquisition session in 2004
- McChord maintenance received Boeing's prestigious C-17 Moose award
- Charleston AFB earned P2 Champion recognition for roller-applied paint from the Air Force's Environmental Protection Commission
- Runner-up for National Registered Environmental Professionals Education Award
- 2004 Aeronautical Systems Center (ASC) ESH Management Award winner
- Winner of the 2004-2005 Air Force Thomas D White Pollution Prevention Acquisition Team Award

### Accomplishments

Within the past two years the C-17 Pollution Prevention (P2) IPT has made significant gains in all aspects of weapon system acquisition. The team's success was noteworthy enough to be labeled the "model for establishing funded pollution prevention projects and active user participation in prioritizing projects" by the Air Force Environment, Safety & Health group for acquisition programs. These are just a few of the many accomplishments that were completed.

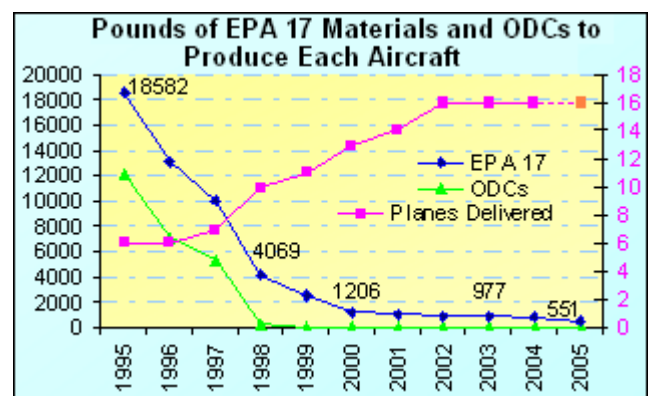
### Weapon System Acquisition Program

The P2 IPT's mission is to eliminate or reduce the use of hazardous materials on the C-17 Globemaster III weapon system and to initiate proper management of hazardous materials throughout the system's life cycle. The P2 program strives to integrate pollution prevention

into the systems engineering and product design processes to ensure the minimization of hazardous materials in the earliest phases of a program. All this is accomplished while minimizing cost and risk to system performance.

Since 1994 the C-17 Pollution Prevention IPT has been an integral part in eliminating hazardous material from the weapon system. The program focuses on over 100 'Chemicals of Concern'. This list consists of the Environmental Protection Agency's (EPA) list of 17 toxic industrial chemicals, ozone depleting chemicals identified by the Montreal Protocol and numerous other chemicals branded for their carcinogenic, mutagenic or otherwise hazardous nature. The program's success at eliminating these materials can be attributed to a strong relationship between the bases, depots and the C-17 manufacturer, Boeing. Key projects have dealt with the elimination of hazardous materials (hazmats) and waste through green alternatives, material recycling techniques and improved processing methods intended to eliminate excess waste. Studies from other weapons systems, such as coating evaluations from KC-135 transports or F-16 fighters, have also been leveraged in order to maximize benefits to all.

### Incorporating ESOH Analysis in Acquisition



▲ The C-17 P2 IPT's hazmat elimination success since aircraft delivery began

In order to proactively address many pollution prevention opportunities, the C-17 P2 IPT prepares semi-annual Pending

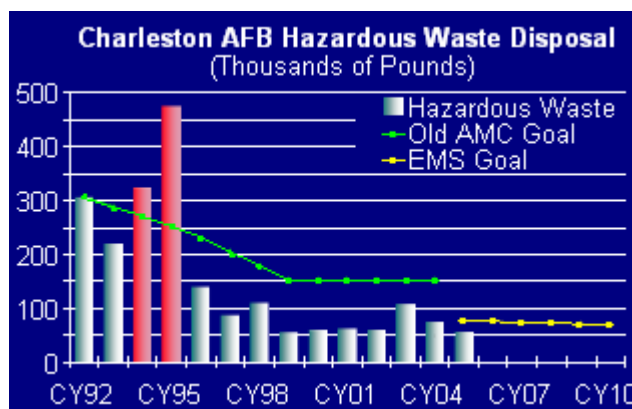
Environmental, Health & Safety Regulatory Changes reports. These reports review conceptual, proposed and final ESOH regulations issued by the U. S. EPA and federal OSHA. On several occasions, chemicals of concern have been identified by the regulators as requiring further emphasis and focus. This was the case with hexavalent Chromium and OSHA's plan to review the existing exposure standard in 1995. This led to the proposed Chromium regulation, issued in October 2004, which would significantly lower the standard. Therefore the P2 IPT had nine years of advance notice to analyze potential risks and focus its resources to reduce or eliminate hexavalent chromium in as many material acquisitions and applications as possible.

The program has integrated DOD 5000.2 instructions into its mission. The team regularly updates the Programmatic Environmental Safety and Health Evaluation (PESHE) for the C-17, which establishes the overall guidelines for the program. From this, the P2 IPT has developed the C-17 Pollution Prevention Strategic Plan, a comprehensive \$80 million plan over seven years, which outlines future goals of the program in order to identify potential regulatory hazards and minimize future risks. Roadmaps for both Cadmium and hexavalent Chromium elimination can be found in the Strategic Plan. These focus on elimination of the two hazardous chemicals through alternative materials and processes. As part of the chrome study, a three year field evaluation, stemming from the Joint Group on Acquisition Pollution Prevention (JG-APP), is ongoing to demonstrate the capabilities of a non-chromated primer on a C-17 at Charleston AFB.

Systems Engineering has become an important part of the acquisition phase of the P2 program. Twice a year the ongoing projects are reviewed and the associated risks are assessed to determine the continuation of each project. Risks and Key Performance Parameters for each project are also tracked in the Systems Engineering Application & Management System

database so that they may be reviewed at any time.

The primary focus of the C-17 program has always been quality, and the P2 IPT is no exception. Over the past two years, the C-17 P2 IPT is proud of each of the bases for having zero right-to-know violations. In the FY04/05 time period alone, the use of EPA-17 chemicals in production was reduced by 175 pounds per aircraft; this was an 18% reduction compared to 2003 and an astonishing 95% cut vs. 1995! The 'greener' production aircraft have translated into tremendous savings in waste disposal at the base level.



▲ Charleston AFB Hazardous Waste Disposal; CY04 disposed of 76,000 pounds of material

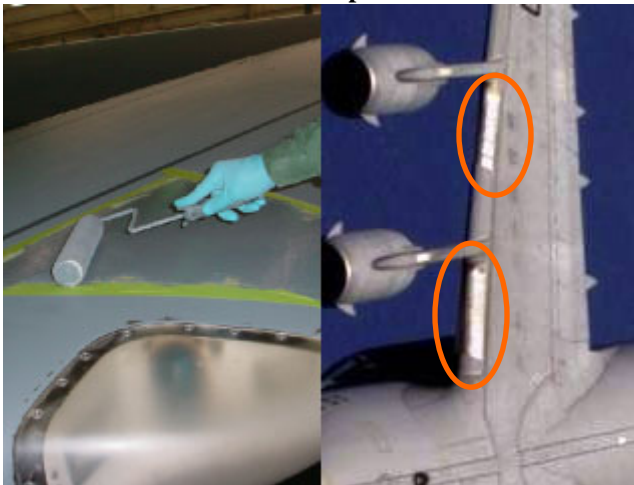
### ESOH Integration

Pollution Prevention concepts are integrated into the early stages of engineering design and manufacture as part of the Producibility Enhancement and Performance Improvement (PE/PI) guidebook. This manual also instructs P2 to review all engineering changes. The P2 Team is active in finding replacement materials for hazmats that are found in the Time Compliance Technical Orders (TCTOs). These documents are generated when aircraft modifications are necessary to meet mission and maintenance objectives. A common P2 recommendation occurs when a hazardous solvent is called out and an environmentally alternative is readily available. Approximately 45 TCTOs and 250 material and process

specifications are analyzed each year. In 2005 alone, over 1,100 draft engineering drawings requiring Project Level Review (PLR) were examined for ESOH impact.

Currently, the shiny, unpainted Titanium slats on the wings make the C-17 vulnerable to attack. As a benefit to weapon system operations, the team has developed a heat resistant, environmentally friendly, Sol-Gel coating to protect the Titanium. The product was field tested at both Altus and Charleston AFBs and should be ready to implement in 2006. This coating will address a major operation-survivability issue against hand-held rockets and the war on terrorism.

Unpainted Titanium slats ▼



▲ Paint being rolled on to the wing tip of the C-17

One of the biggest innovations for the team was in the area of logistics support. Over 250,000 pounds of tires have been recycled at Charleston AFB in the past two years. Charleston's paint group also found that rolling paint, as opposed to the traditional spray method, increased the transfer efficiency, reduced the amount of paint used and reduced air emissions by 50 percent. Workers also enjoyed ergonomic benefits from not having to use heavy spray equipment or full respiratory protection. In the first half of 2005, Charleston saved over 1,500 pounds of hazardous waste. Based on the very positive findings of Charleston, the roller process is being optimized and will be incorporated into

maintenance procedures at future C-17 bases, such as Hickam AFB in Hawaii.

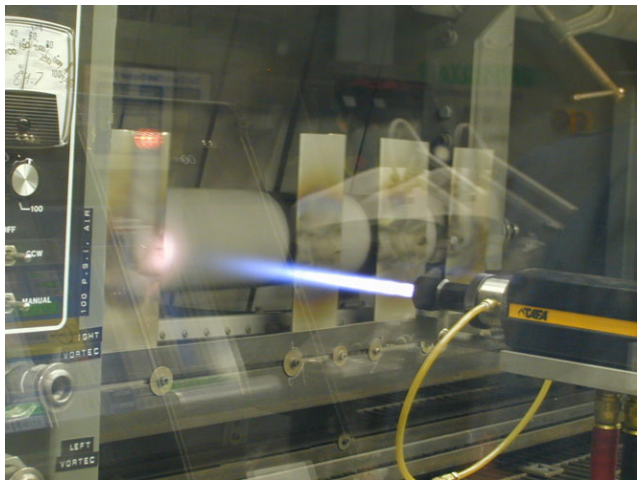
The C-17 is leading the way in the Air Force for planning for the end of their aircraft's lifetime. The newly developed deactivation, demilitarization and disposal (3D) plan addresses hazardous materials such as Cadmium, Chromium, Aluminum-Lithium, Beryllium and composites. Significant opportunities for material recycling were identified, particularly with carbon composites, resulting in huge potential savings for the weapon system. Over 1,000 Beryllium parts were flagged in the 3D plan as specialty metals, with instructions on how to manage and dispose of them. An exposure-free retrofit program for Beryllium containing seat tracks will begin next year. In August 2005, a hard landing overseas led to premature demilitarization and disposal of some parts. The IPT worked with the C-17 Crisis Management Team on the handling of Beryllium bearings in the landing gear to prevent worker exposure and safely recover the parts. This was a great early demonstration of the value of the 3D plan. The C-17 3D plan will become a guidebook for any weapon system facing demilitarization.

#### *Material Substitution/Hazmat Elimination*

The C-17 Pollution Prevention IPT is out in front for reductions of hazmats through alternate materials. The P2 program was able to eliminate the solvent P-D-680, and replaced it with aqueous and bioremediation cleaning compounds for use in aircraft wash-rack cleaning, parts washers and hydraulic cleaning – this resulted in a significant decrease in Volatile Organic Compound (VOC) emissions. The IPT also approved a recyclable solvent for engine part cleaning, completely eliminating another waste stream.

Through the use of high-tech coating techniques, such as Aluminum Ion Vapor Deposition and Tungsten-Carbide Thermal Spray coatings, the IPT is working to eliminate

Cadmium and Hard Chrome plating on the landing gear. Team members have worked extensively with the Ogden Air Logistics Center to qualify them as a supplier and hopefully bring the technology to future weapon systems. The new coatings show superior performance and are environmentally friendly – the next generation coating will greatly enhance part life and cut field maintainer exposure to Cadmium! A brush plating solution has even been developed for immediate field repair of damaged plating. All of these new procedures are being added to production specifications.



▲ High Velocity Oxygen Fuel (HVOF) coating process eliminates the need for Chrome plating on the main landing gear axle

Erosion protection tape usage was implemented in 2004. The tape is applied to the leading edges of the tail and areas of the main landing gear to enhance protection of the aircraft from foreign object debris and erosion damage and minimize the need for frequent touch-up of those areas. The previous spray-coat technology greatly exceeded VOC regulations and contained hazmats such as toluene and xylene. The tape provided enhanced performance and minimal maintenance in a hazmat-free product. The success of the tape led to a field evaluation of erosion protection applied to other areas of the plane, including the leading edges of the wings.

The P2 team also made improvements in air emissions and engine maintenance. By

inserting a thermal stability additive into regular jet fuel a new fuel was created, JP-8+100. The enhanced fuel halts the formation of varnishes and deposits on the engine, allowing for longer periods of time between repairs. Occupational Health studies showed no added health effects from the +100 formula. The additive also lowered particulate emissions for increased survivability and environmental compliance.

▼ IPT members apply erosion tape to the leading edge of the C-17's right wing

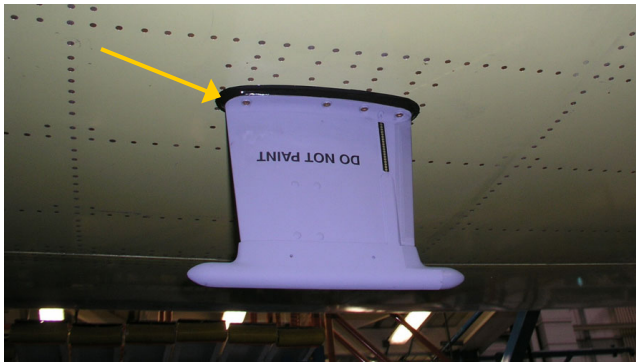


▲ Aircraft awaiting deicing

A few years ago, C-17s began experiencing corrosion of electrical components in cold weather as well as failures of sensory systems. The malfunctions were attributed to corrosion from the de-icing fluid used. The P2 program stepped in, seeing an opportunity to not only stop the corrosion, but replace the glycol-based de-icing fluid with environmentally friendly, low Biological Oxygen Demand alternatives that would be less harmful to lake and stream ecology. The IPT is working with de-icing fluid suppliers to create the next generation of deicers. These materials should be field tested in early 2006. In the interim,

McGuire AFB has adopted a policy of runway glycol recycling so that zero contamination is released into the water supply. In the past two seasons they have captured and recycled over 50,000 gallons of glycol contaminated water.

When maintenance personnel bring up environmental issues, the P2 IPT springs into action. Workers reported difficulties in meeting mission capability requirements using the current cure-time sealants. The P2 team tested and approved a Skyflex non-chrome sealing material, eliminating the need for a 24 hour cure time and reduced hazardous materials by ten pounds per plane. A quick curing sealant was also approved for antennas, windows and lights which cut the cure time on the affected areas by 40 hours and further reduced sealant hazardous waste by ten percent.



▲ Quick cure sealant applied on antennae

The success of the C-17 P2 IPT has carried over to other weapon systems. By sharing lessons learned with the C-130 avionics modernization program, design engineers were able to implement hazmat reductions up-front; the greatest decrease being in ozone depleting chemicals. This led to an estimated \$10 million savings over the lifetime of the C-130J.

### *Education & Outreach*

The C-17 Pollution Prevention IPT has excelled at creating an open environment between all members of the team and educating the community on the value of Pollution Prevention.

The team held the 17<sup>th</sup> and 18<sup>th</sup> C-17 P2 Expanded IPT symposiums. These events included over 20 briefings and 50 attendees and provided a great cross feed of information between the technical and field communities. Representatives of related organizations, such as Safety, Health and Environmental Affairs (SHEA), also attended to share their experience with the value of pollution prevention.

Weekly telecons are held to provide a free flow of information on everything from field issues to technical progress. The C-17 IPT website contains environmental assessments, regulatory reports and over 70 technical reports of past projects. McChord AFB prints an environmental newsletter and Charleston AFB maintains a recycling website. For three years, the C-17 assembly plant's Environmental Affairs department has sponsored a career day, attended by over 150 high school students annually. SHEA develops displays which educate students on the effects their lifestyle choices make on the environment. Students worldwide were instructed by the AFIT P2 Acquisition Distance Learning Course. All of these items promote team involvement and access to information.

The IPT also contributes to the Air Force and defense community. Teammates have participated in and presented papers at Air Force Deicing conferences and Air Force Materiel Command ESOH working groups. The IPT is represented at the Hard Chrome Alternatives Team (HCAT) and the Joint Cadmium Alternatives Team (JCAT); both interact with all defense branches and industry representatives. C-17 findings have been presented for the Society of Automotive Engineer's (SAE) G-12 committee on de-icing materials. In 2004, the IPT presented at the Air Force Corrosion Conference to reach out to the maintenance community and chaired the weapon system acquisition session at the JSEM conference. Over 60 technical transition reports and C-17 requirements have been provided to the ASC P2 Solutions & Needs Databases.