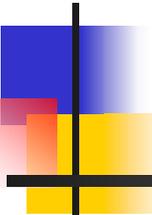


PW Green Engine Program

*Presented to: CT DEP SIPRAC
3/9/2006 Meeting*

**Ray Dimmock
PW Green Engine Manager**



Agenda

- Green Engine Elements (1 slide)
- Striving for Green Products (5 slides)
- UTC Materials of Concern & Technology Plans (3 slides)
- Driving MOC Reductions in Engines (3 slides)

ELEMENTS OF A GREEN ENGINE

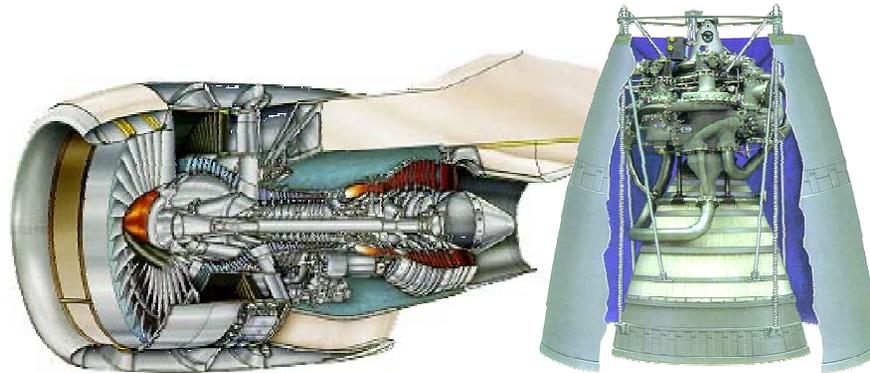
Vision: Pratt & Whitney Sets the Standard for Green

Has the lowest possible
Emission Impact during use

Has lowest possible
Noise Impact

**Manufactured in
Green Factories**

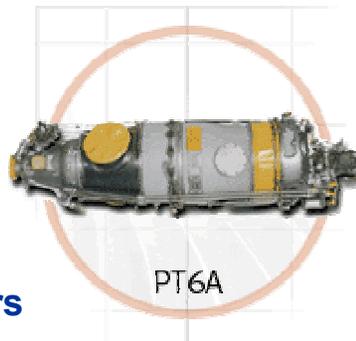
**Material Efficient
(Metal Buy-to-fly,
Propellant Yield)**



**Designed with
Human Factors
in mind**

**Energy Efficient
during use
(Fuel Burn)**

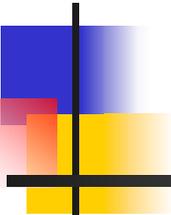
**Contains
Green Materials**



**Maintained with
Green Overhaul and
Repair Processes**

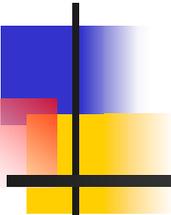
**Involves Green Suppliers
and Partners**

**Designed for
Serviceability, Reusability, Recyclability**



Striving for Green Products

- Engines that burn cleaner
- Engines that operate quieter
- Engines with no materials of concern
 - *Product*
 - *Process*
 - *Original equipment and repair*
 - *During operation by our customers*
 - *At end-of-life*
- Engines 'human friendly' for production and maintenance mechanics
 - *In our shops*
 - *In our customers' shops*
 - *On the flight line*



Eliminating Materials of Concern

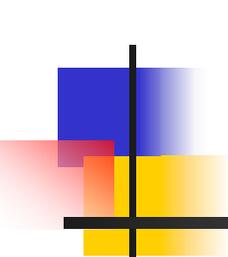
- Identify Materials of Concern
 - *Regulatory bans*
 - *Customer drivers*
 - *Corporate responsibility*
- Identify products containing Materials of Concern
 - *Which engine model, which part number*
 - *Which specifications, which materials*
- Develop & validate alternatives
 - *Specifications without Materials of Concern*
 - *Similar or better performance characteristics (weight, strength, durability)*
- Insert alternatives into products
 - *Validate alternative in target products*
 - *Release to production*



Human Factors Considerations

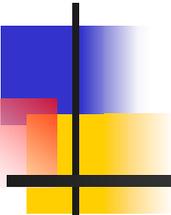
Product Design Considerations:

- Meant to reduce ergonomic stress
- Added benefit - reduce assembly time
 - *Is a bolt easily accessible ?*
 - *Are the part edges too sharp ?*
 - *Are handling provisions in place ?*
 - *Are there blind assemblies ?*
- Human Factors Essential Elements
 - *Accessibility – Ergonomic positioning*
 - *Weight/Center of Gravity*
 - *Fastener Quantity – Standardization*
 - *Force/Torque/Repetition Required*
 - *Assembly considerations – all parts arrive at assembly ready to install*



Environmental Compatibility is a Key Driver for P&W Products

- Engines consume less fuel through higher efficiencies
- Lower emissions address Local Air Quality and Global Warming
 - *Less hydrocarbons, nitrous oxides, carbon monoxide, carbon dioxide and smoke*
- Lower noise creates opportunity to:
 - *Minimize the Noise Footprint around Airports and Communities*
- *Sustain the Growth of the Aviation Industry through increased capacity*
- *Enabling Technologies include Advanced Materials and Aerodynamic Design*
 - Engine architecture
 - High temperature alloys
 - Low weight composites



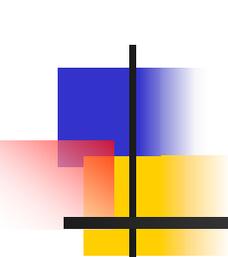
Implementation Complexities

Product-related complexities:

- Jet engine part count typically > 10,000 per engine
- Supplier content typically > 50%
- Domestic and international partners
- Suppliers with 'Design/Make' status

Material of Concern-related complexities:

- Material Safety Data Sheets
 - *Since bans sometimes include trace amounts, MSDS needs to as well*
 - *Need method to overcome Manufacturer claims of proprietary ingredients*
- Product data systems need to be connected to Material of Concern data



UTC Materials of Concern

- History:

- UTC Presidents' Council Approval ('01)
- CEO Public Speech ('03)

- Includes:

- Cadmium, Hexavalent Chromium, Lead, Mercury
- Chlorinated Solvents

NOTE: Does NOT include all PW banned/ restricted MOCs

- Timing for MOC Elimination:

- Passport Gate 4 after 1/1/07 – “New Designs” – subject to 1/1/07 deadline
- Passport Gate 4 before 1/1/07 - “Legacy Designs” – MOC elimination must be considered when redesign is triggered

- *Products & Spares Production*
- *PW Aftermarket Operations*

- UTC Cooperative Efforts:

- Have developed common process listing
- Participating with UTC Green Products Managers to define risk ranking methodology

Baseline UTC MOC Inventory

- Basis for UTC Metrics
- Summarizes MOC uses & replacement status
- P&W/PWC have > 70 MOC identified uses

Example Baseline Inventory Line Item:				Design	Manufacture	Supply	Repair
No.	Material	Process or Usage	Application (Product(s) or Component(s))				
1	Cadmium	AMS 2400 plating, SPOP 21 (PS 211)	Threaded parts (nut, plug, screw, stud)	G	G	Y	Y
2	Cadmium	AMS 2400 plating, SPOP 21 (PS 211)	Non-threaded parts (washer, bushing, bracket)	G	R	R	R
3	Cadmium	AMS 2416 plating; QQ-P-416	Threaded parts (Mil. Std. Fastener, tie-rod, bolt)	G	R	R	R
4	Cadmium	AMS 2416 plating, SPOP 25 (PS 301), SPOP 49, SPOP 315	Non threaded parts (Mil. Std.washer, bracket, seal)	G	R	R	R

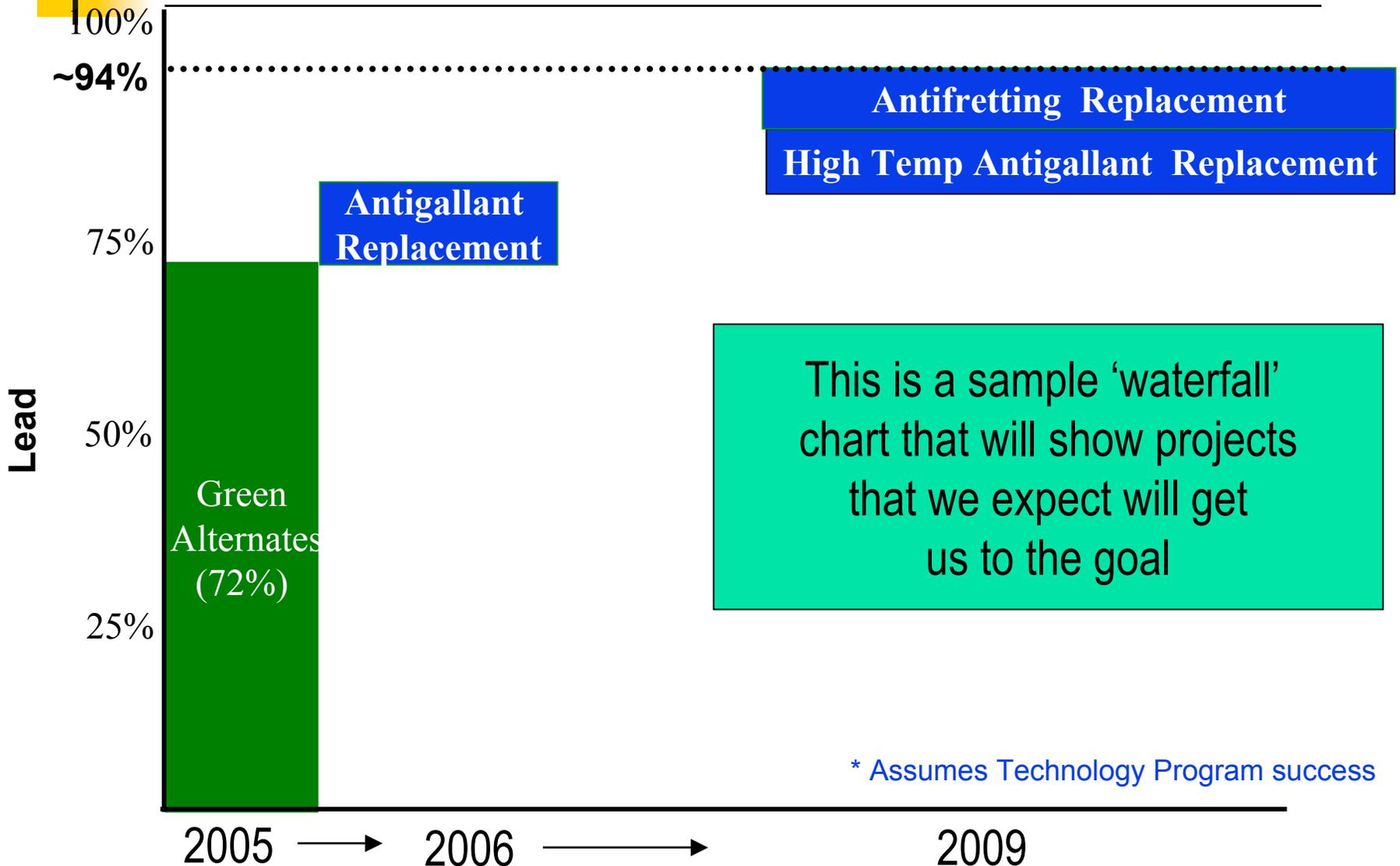
Key:

- G **Eliminated** (Not in use, Usage not allowed)
Y **In Process** (In use, Action initiated to replace MOC)
O **In Use** (In use; alternative not cost effective)
R **In Use** (In use, Action not initiated to replace MOC)
U **Uncertain** (Insufficient data)

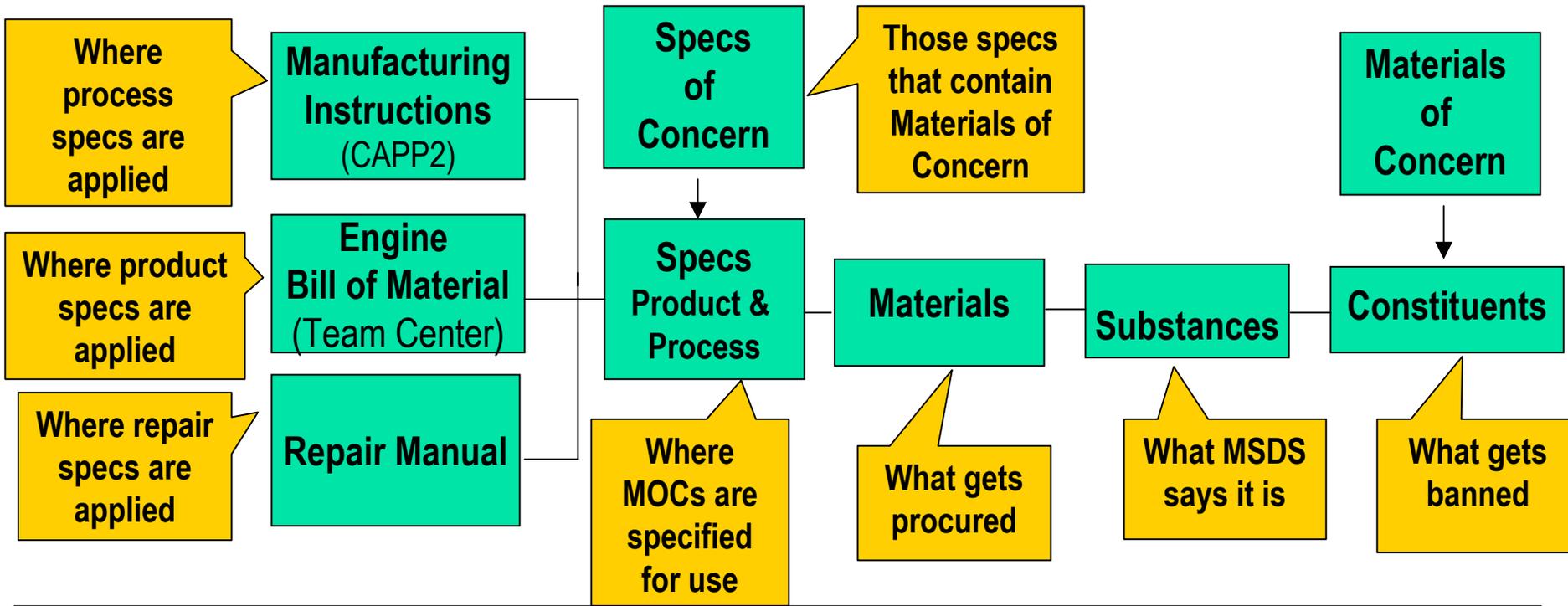
- E **Approved Exception**
GR **Not Applicable**

Lead Reduction (by Application) from New Designs

2006 – 2009 Technology Development Plan

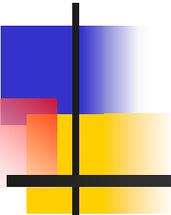


Linking MOCs to Bills of Material



Efficient analysis of affects of potential chemical bans requires:

- All tables above to be complete and accurate
- Appropriate linkage between each table
- Inclusion of partner and supplier information



Implementing Green Alternatives

Key steps to ensure that Green alternatives are driven into products:

- Engineering standard work requires 'Green' alternatives when making material or process changes
- Program chief engineers are presented with target part numbers (those 'brown' parts that have green alternatives – see samples on next chart)
- Passport review process ensures appropriate progress

Samples of Data for Chief Engineers

Spec ID	HMI Percent Contribution	Spec Name	Application
PWA381	12.66%	Shipping Closures	Aluminum caps
PWA333	8.07%	Tube & Flexhose Product Definition	Tubes
AMS2400	6.97%	Plating- Cadmium	All Applications
AMS2416	6.15%	Plating- Nickel Chromium Diffused	Major rotating parts (disk, blade, spacer)
PWA586-3	4.84%	Inactive Components Kaylu	Operating below 700oF
PWA830-1	2.35%	Protective Treatments- AMS 2470 - Anodic Treatment Chromic Acid	All applications except for fatigue sensitive parts and/or parts that may have potential for entrapment)
AMS3110	1.79%	Inactive	

Shows which specs are contributing most to HMI

Shows each part number, the spec, the toxicity value for that spec, and the percent contribution to HMI

Part Number	Spec ID	Spec Level	Toxicity Value	Percent Contribution	Sum of HMI Percent Reduction	Total
11618	AMS2400	1a	114.70	0.08%		
157042	AMS2400	1a	114.70	0.08%		
157042	AMS7252	1a	32.90	0.02%		
184007	AMS2400	1a	114.70	0.08%		
1A6988	PWA586-1	1a	59.0	0.04%	51D473-01	0.24%
1B3559	PWA830-1	1a	40.0	0.03%	58T289-01	0.23%
216741	AMS2400	1a	114.70	0.08%	58T286-01	0.23%
233347	AMS2400	1a	114.70	0.08%	57T529-01	0.23%
233347	AMS7252	1a	32.90	0.02%	56T242-01	0.23%
308031	AMS2400	1a	114.70	0.08%	55T647-01	0.23%

Shows effect on HMI of changing each part number to green