Titanium-Based Alloys

Repair Overview at Delta Air Lines

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Overview

1. Perspective on Delta Air Lines flow of Turbine Engine hardware in the Delta Technical Operations Center (TechOps)

2. Provide an understanding of the range of Titanium-base alloy repairs in turbine engines
Maintenance, Repair, Overhaul (MRO)

1. TechOps performs aircraft and engine Maintenance, Repair, and Overhauls for:

   – Delta Air Lines
   – Regional carriers
   – Cargo aircraft
   – International commercial carriers
Employees

Delta Air Lines employs over 85,000 people; about 24,000 in Atlanta hub

9,600 employees in TechOps; 5500 in Atlanta

Richard Anderson – CEO Delta Air Lines
TechOps Stats

1. TechOps serves over 150 aircraft customers worldwide

2. Annual maintenance performed at Delta TechOps include over 650 engines and 350 APU’s/year
# MRO Engine Lines

1. CFM56          737-800  
2. CF6-80A        767-200,-300  
3. CF6-80C2       767-300, -400  
4. CF34           CRJ-200  
5. PW 4000        767-400  
6. PW 2000        757-200  
7. JT8D-219       MD 88  

8. Back shops adjacent to engine lines support turbine engine repairs and modifications
Light, Medium, and Heavy Maintenance Visits - Work Scopes

1. Light Maintenance – at established cycles general visual inspection of normal wear levels generally at highest level of assembly for major modules unless conditions noted.


3. Heavy Maintenance – at established cycles major engine sections disassembled to the piece-part level for cleaning, visual inspection, and dimensional inspection.
Turbine Engine Component Flow

1. Regular Maintenance
2. Workscope Engineer Determines What Type of Routine Maintenance is Required: Heavy, Medium, or Light
3. Aircraft/Engines Brought to TechOps
4. Engines Broken down and routed to prime shop
5. Parts Inspected
   - Pass Inspection
   - Parts returned as serviceable
6. Fail Inspection
   - Routed for Repair
   - Minor Repair (Handled by Shop Engineer from RPE)
     - Repair Process Developed
   - Sent to Repair Process Engineering (RPE) for Evaluation
     - Major Repair (Requires FAA and/or OEM interaction)
       - Sent to Engine Technologies and Repair Development Engineering
       - Sent for Scrap
MRO Engine Line
Representative Turbine Engine Titanium Alloy Components
Titanium-base Alloy Range of Repairs

1. Electron Beam weld repair of Fan Blades; Long Leading Edge Patch
2. Reforming of Fan Blades
3. HPC Blades and Vanes weld repair
4. Disk and air seal knife edge seal EB weld repair
5. Weld Repairs of LPC and HPC cases
6. Weld and form repair of Turbine Exhaust Duct Assembly (Mixer)
7. Application of enhanced wear resistant coatings
8. Plasma spray repair of compressor cases (Metco 401)
9. Auxiliary tubing - air, oil
9. Blend repairs of blades, vanes, and cases

Primary alloys wrought Ti-6Al-4V, some wrought Ti-8Al-1Mo-1V compressor blades, 1,2 compressor spool wrought Ti -17 alloy (TI-5Al-2Sn-2Zr-4Mo-4Cr)
CP titanium, Ti-3Al-2.5Sn
Engine Test Cell and Repair Shop Areas