

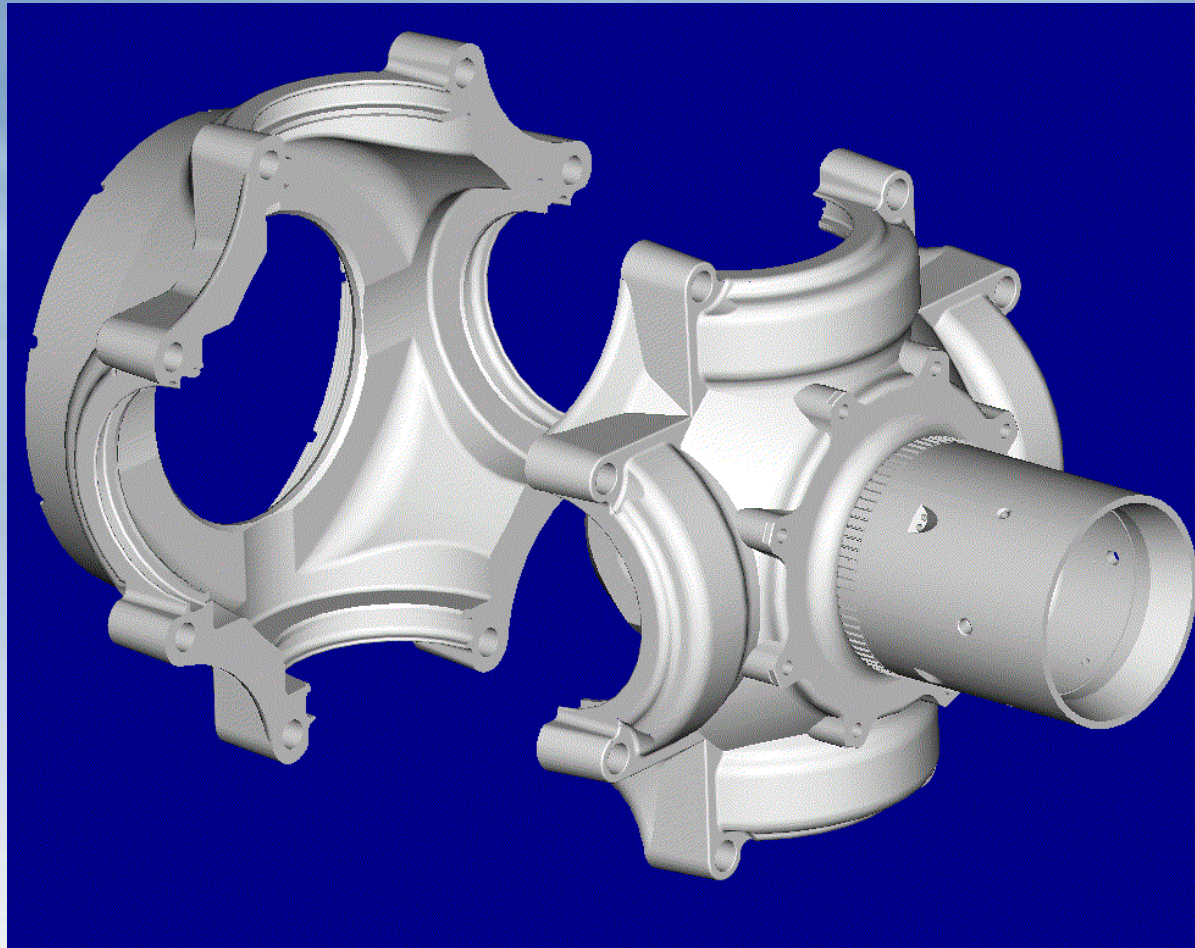
Propeller Component Project Update

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Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE JUL 2004		2. REPORT TYPE		3. DATES COVERED 00-00-2004 to 00-00-2004	
4. TITLE AND SUBTITLE Propeller Component Project Update				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Air Depot Cherry Point,Cherry Point,NC,28533				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES 24th Replacement of Hard Chrome Plating Program Review Meeting, July 20-21, 2004, Park City, UT. Sponsored by SERDP/ESTCP.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 30	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

P-3/C-130 Barrel & Pin Assembly



P-3/C-130

Barrel & Pin Assembly



P-3/C-130

Lever Support Sleeve



Cr-Plated LPSLS

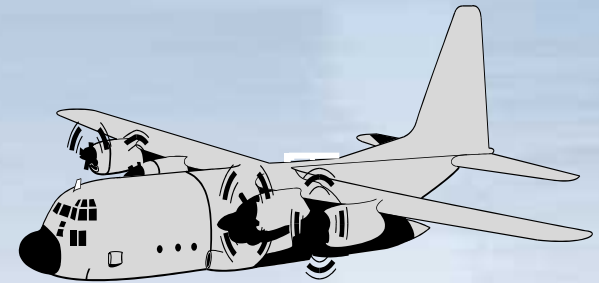


WC-Co Coated LPSLS



Implementation Efforts at Depots

- HVOF systems installed at NADEP Cherry Point
- Warner-Robins ALC installation complete
- Fixtures developed
- Grinding training
- Manual changes
- Joint process instruction



Qualification of Depots

- Process procedures will be submitted
- Each facility submits booth/procedure qualification samples
 - Metallographic samples
 - Almen coupon
 - Tensile bond buttons
 - Bend Test
- Each facility will coat a representative part or shape to be tested for residual stress in coating



NAV  AIR

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HCAT Orlando Meeting

February 2002

HCAT Propeller Hub Team

Hamilton Sundstrand, NADEP Cherry Point,
Warner Robins AFB, NADEP Jacksonville



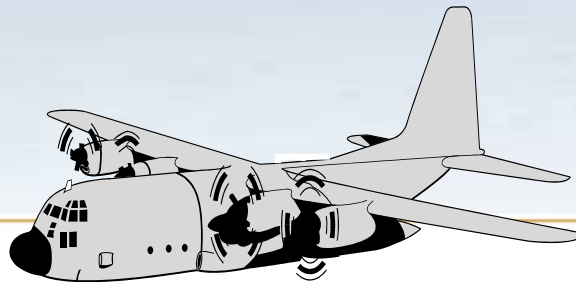
Program Milestones

- ✓ **Fatigue Testing - completed April 2001**
- ✓ **Wear - completed April 2001**
- ✓ **Corrosion - completed January 2001**
- ✓ **TCLP - completed January 2001**
- ✓ **Low Pitch Stop Lever Sleeve Component Test**
 - ✓ **Chrome plated - completed August 2001**
 - ✓ **WC-17Co - completed September 2001**



Future Program Milestones

- Full Scale Engine Test of P-3 Hub at HS - Aug. 2002
- Completed Materials JTR - June 2002
- NADEP JAX based P-3 Operational Test - Nov. 2002
- Developing Joint Depot Operating Procedure - February 2003
- Operational JTR complete - November 2003



Summary Of Fatigue Tests

- **WC-Co exhibited a 10% reduction in strength at low cycle stresses, and a 5% reduction in strength at high cycles stresses when applied 0.010 inches thick to AISI 4340 HRC 40-44**
- **Coatings thinner than 0.010 inches exhibited less fatigue strength debit on AISI 4340 HRC 40-44**
- **WC-Co exhibit superior fatigue properties to both EHC and T-800**
- **Shot peening had a negligible effect on the fatigue strength of WC-Co and T-800**



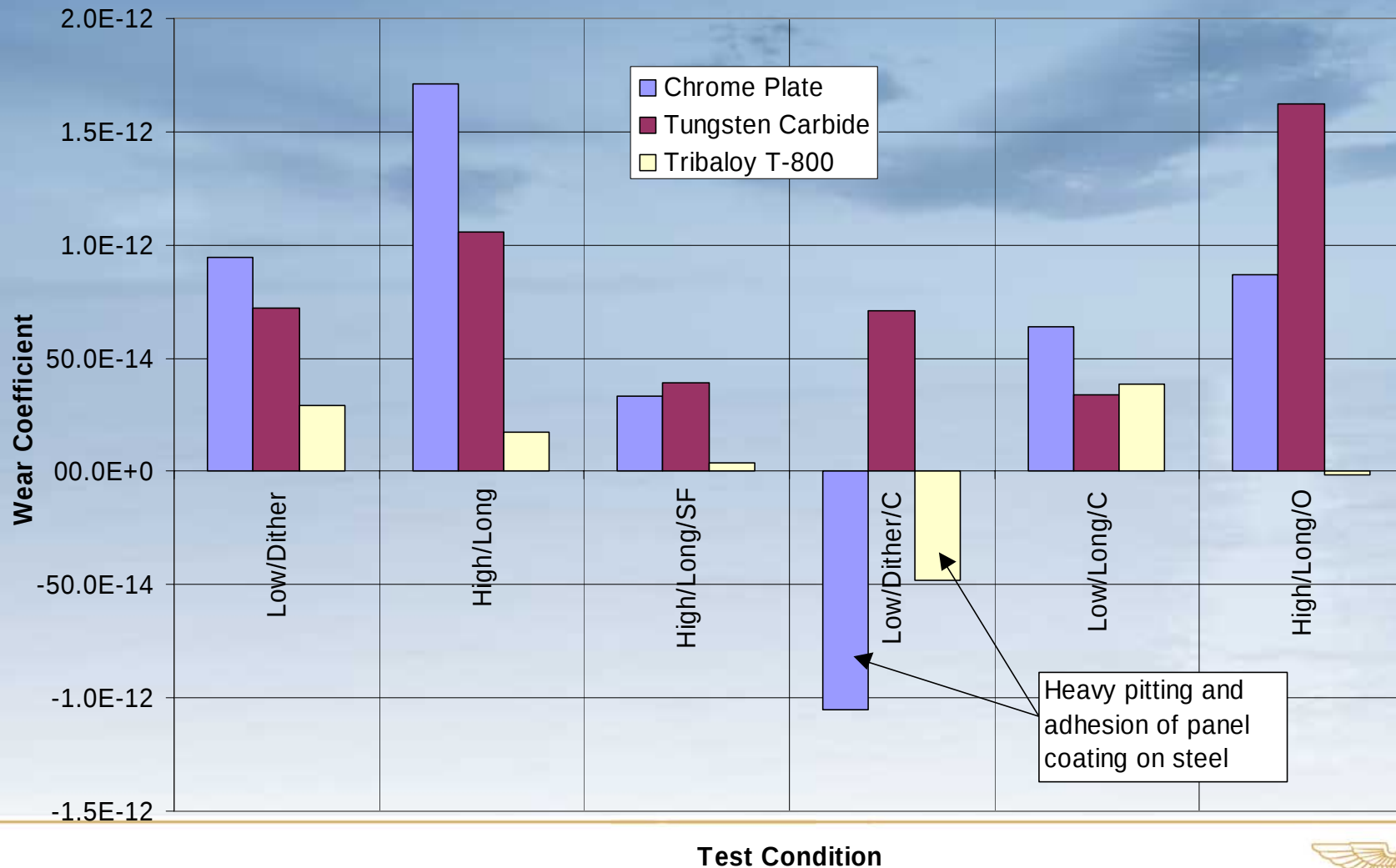
Summary of Wear Tests

- The counterface specimen's wear performance ranking was steel, copper, then Viton based on wear coefficients
- WC-Co coating produced similar or lower wear rates on all counterface specimen materials when compared to EHC plating
- The panel specimen's wear performance ranking was WC-Co, Tribaloy T-800, then EHC plating based visual ranking of coating performance
- WC-Co-Cr coating outperformed Electrolytic Hard Nickel plating in both coating visual ranking after test and counterface wear rate

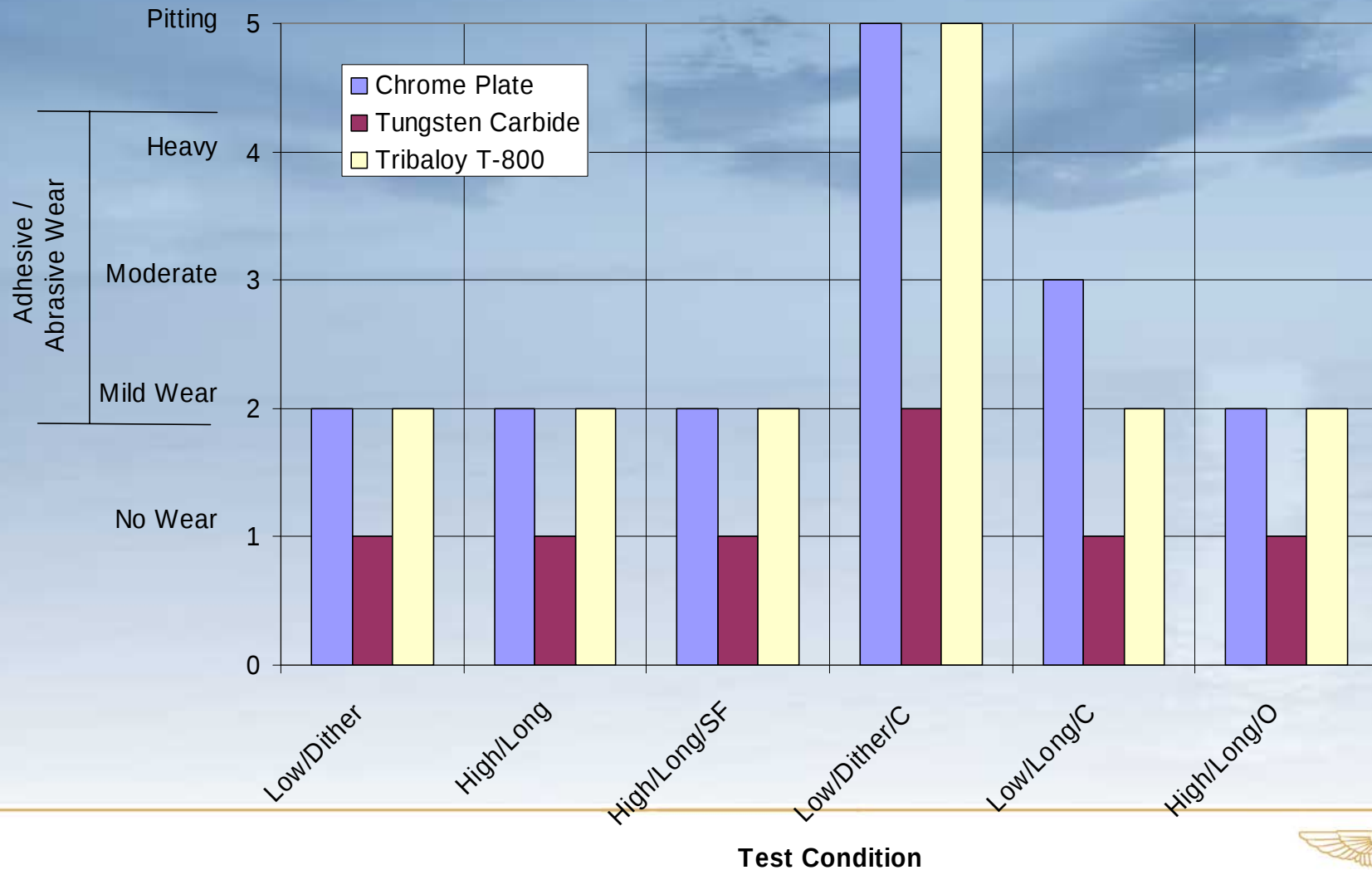


Steel Wear Rate Comparison

Based on Mass Loss Measurements

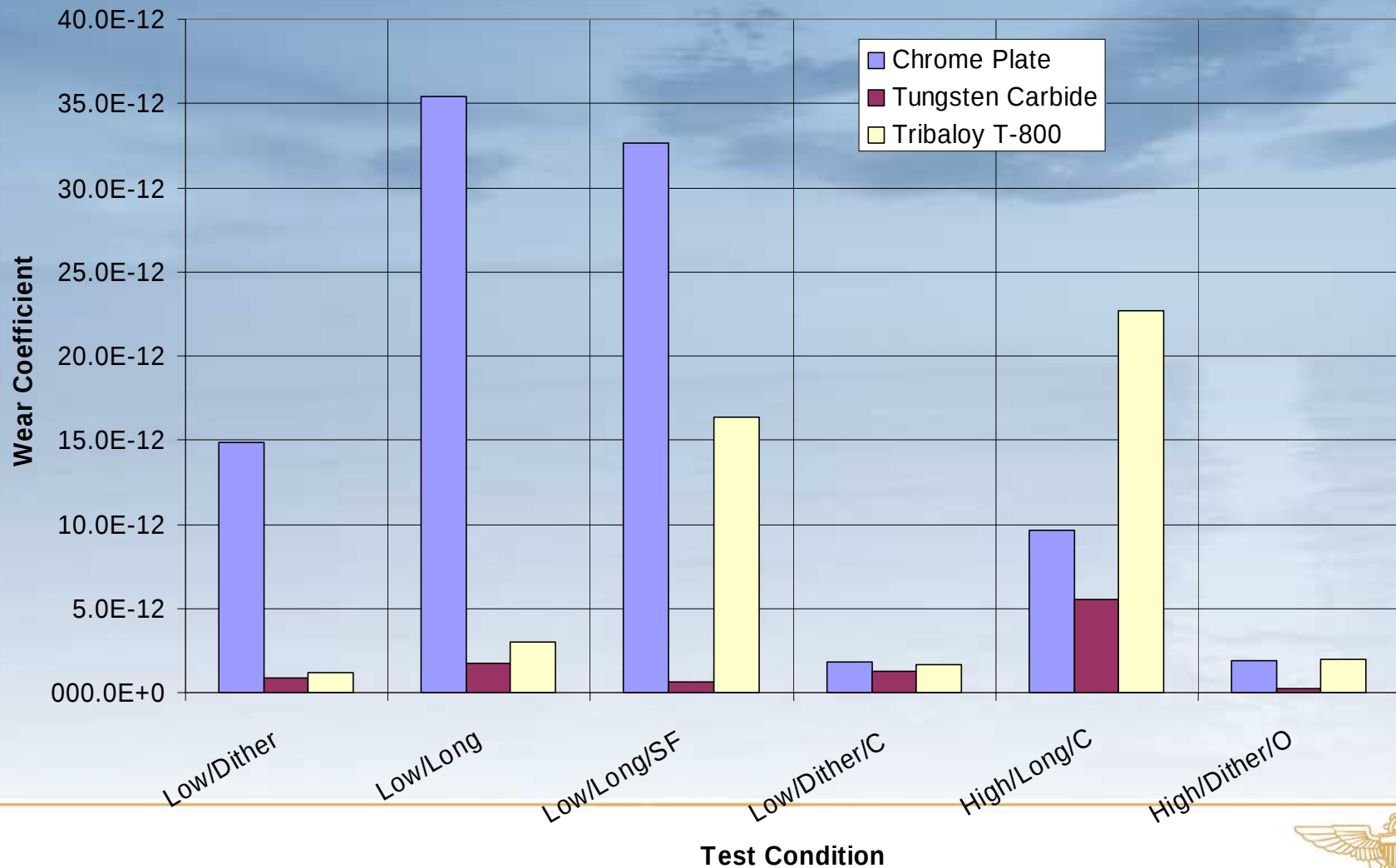


Panel Wear from Steel Specimens

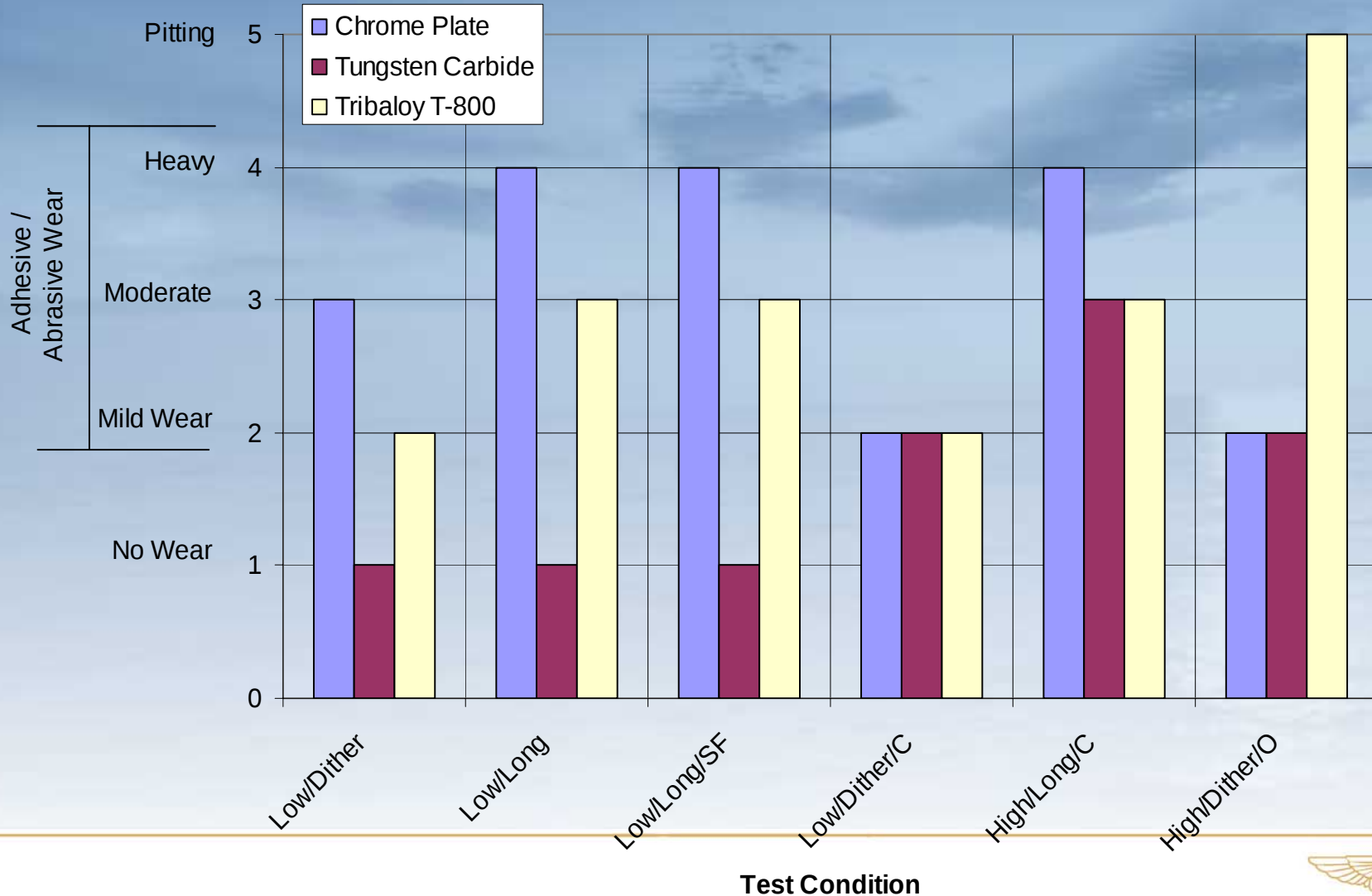


Copper Wear Rate Comparison

Based on Mass Loss Measurements

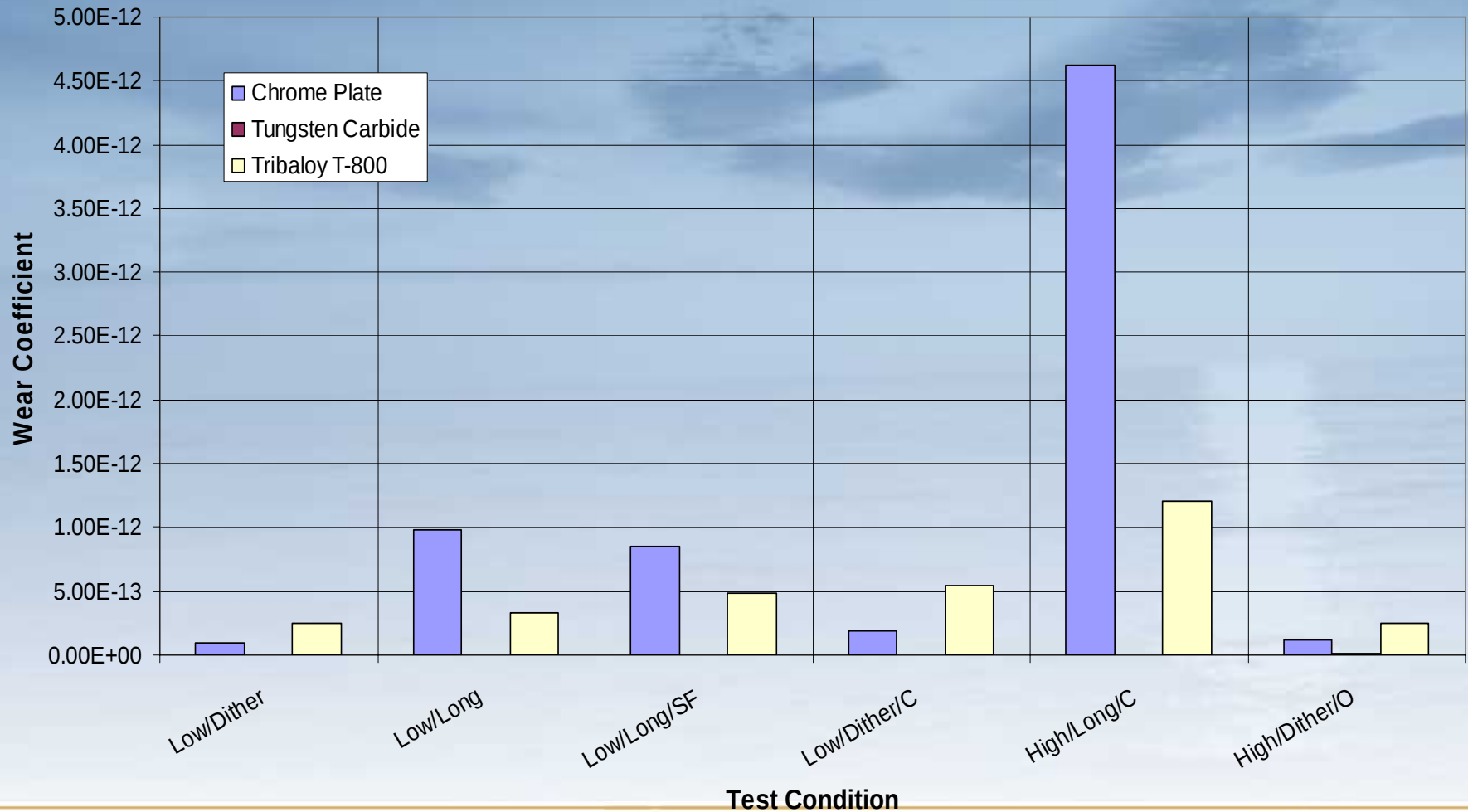


Panel Wear from Copper Specimens



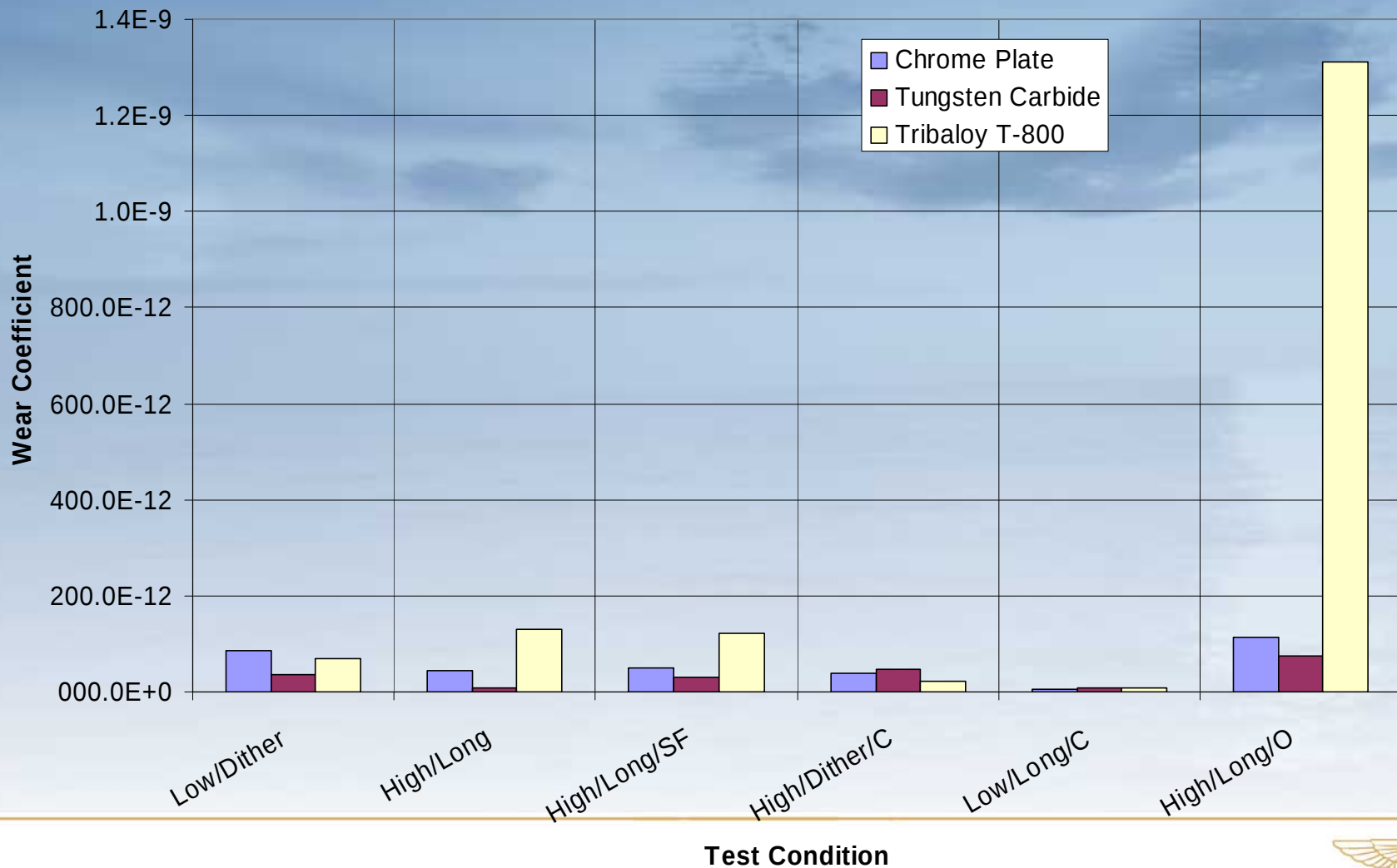
Panel Wear Rate Coefficient Against Copper Counterfaces

Based on Wear Scar Profilometer Measurements



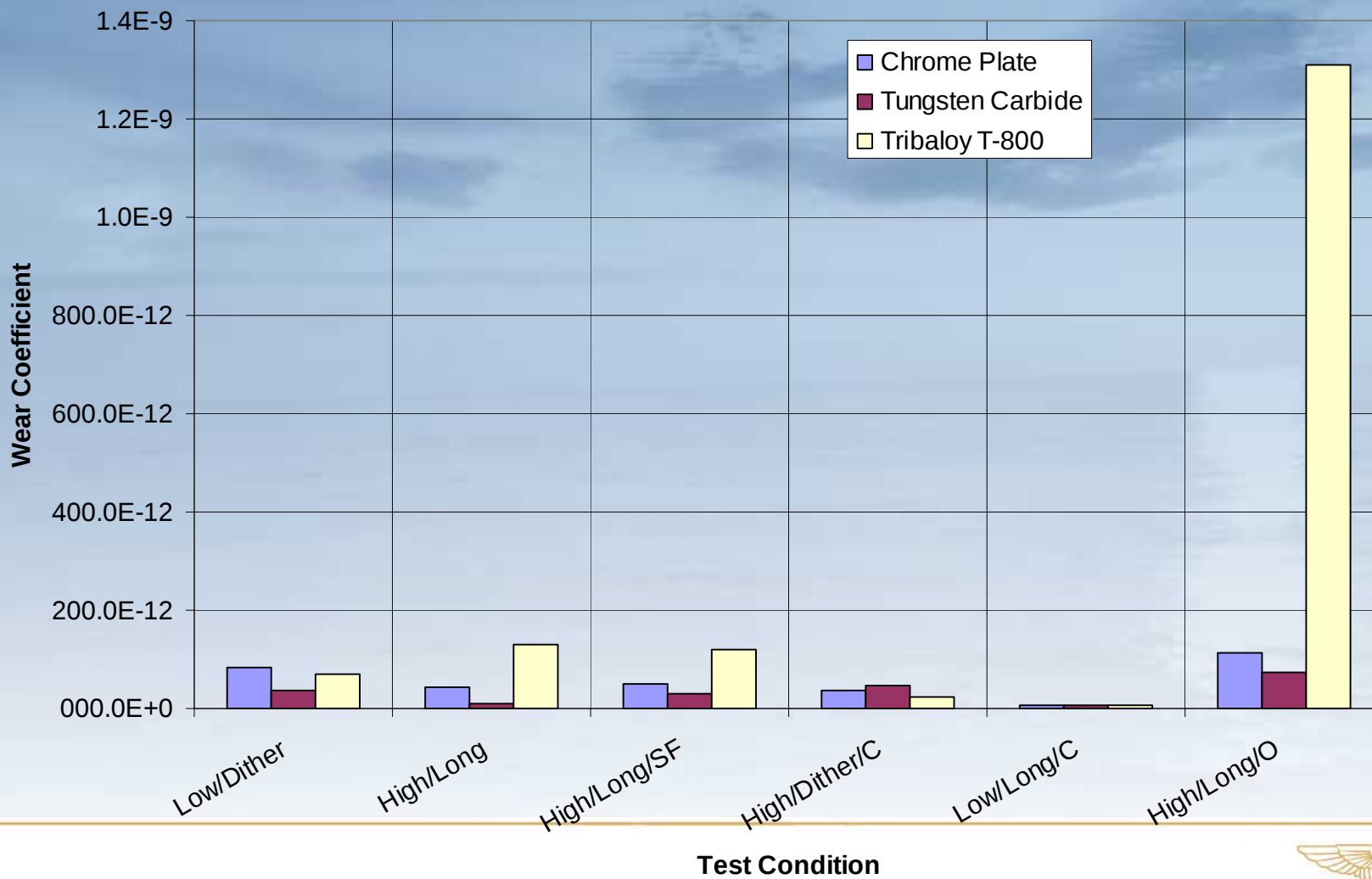
Viton Wear Rate Comparison

Based on Dimensional Wear Scar Measurements

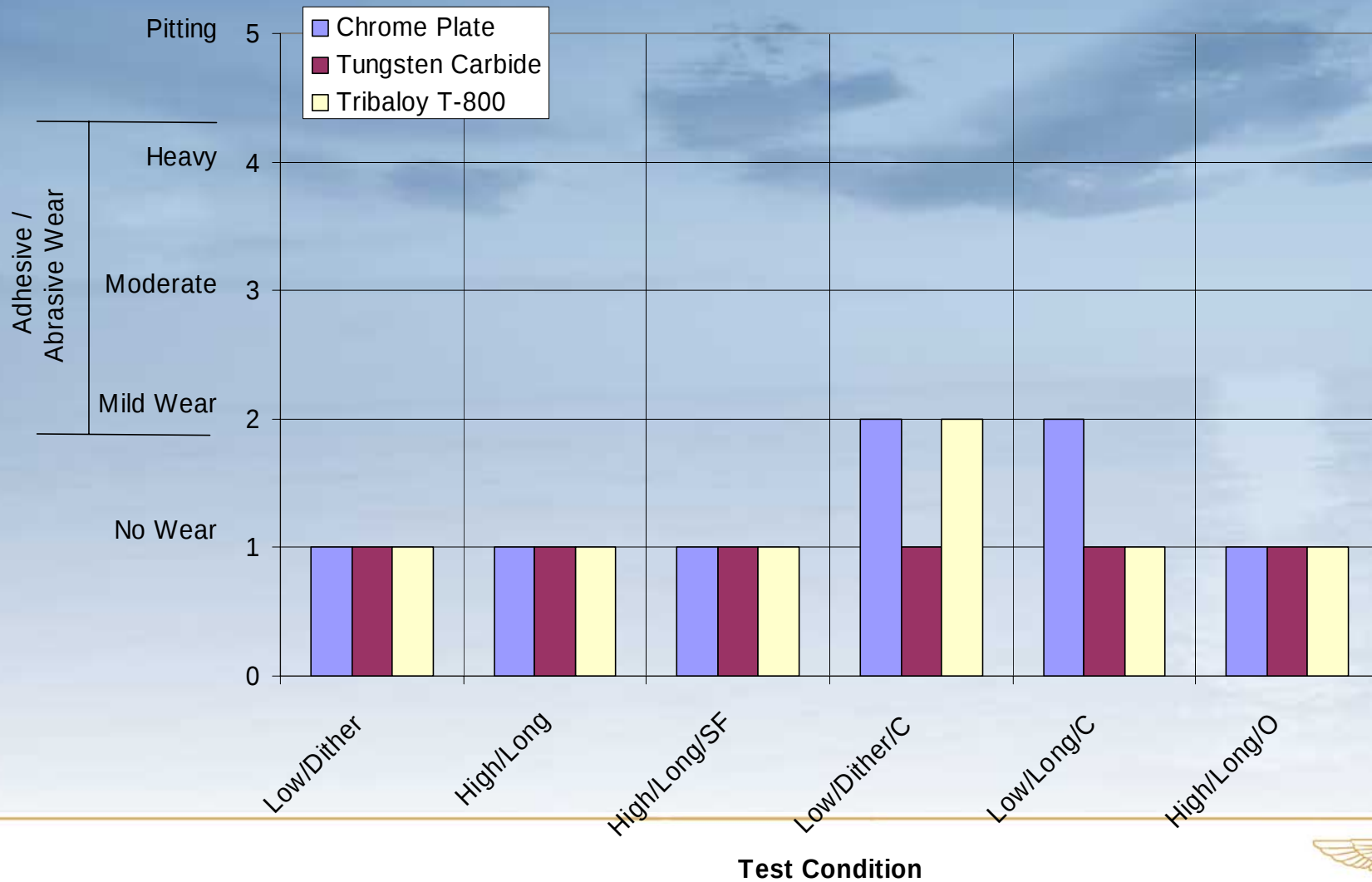


Viton Wear Rate Comparison

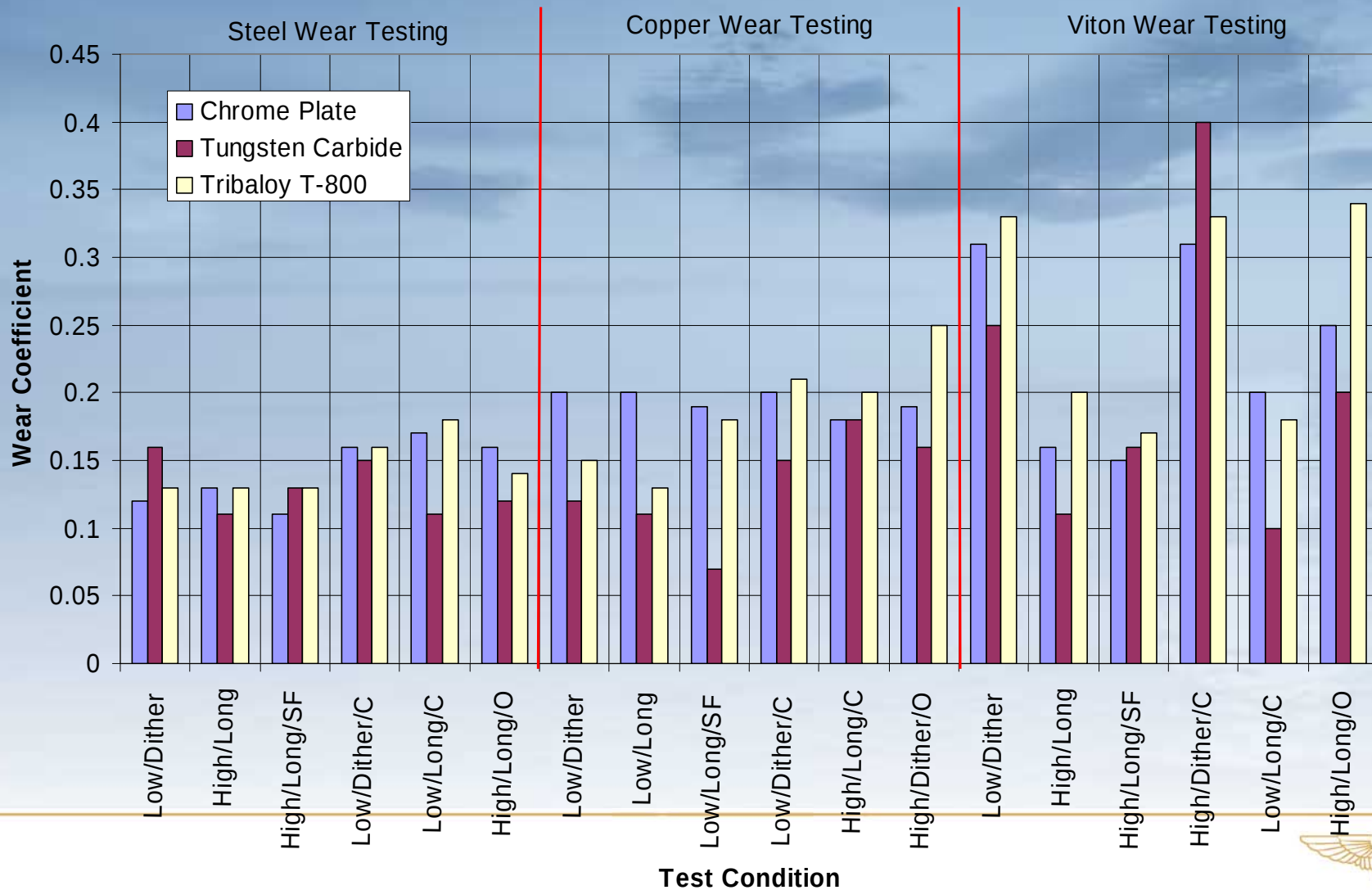
Based on Dimensional Wear Scar Measurements



Panel Wear from Viton Specimens

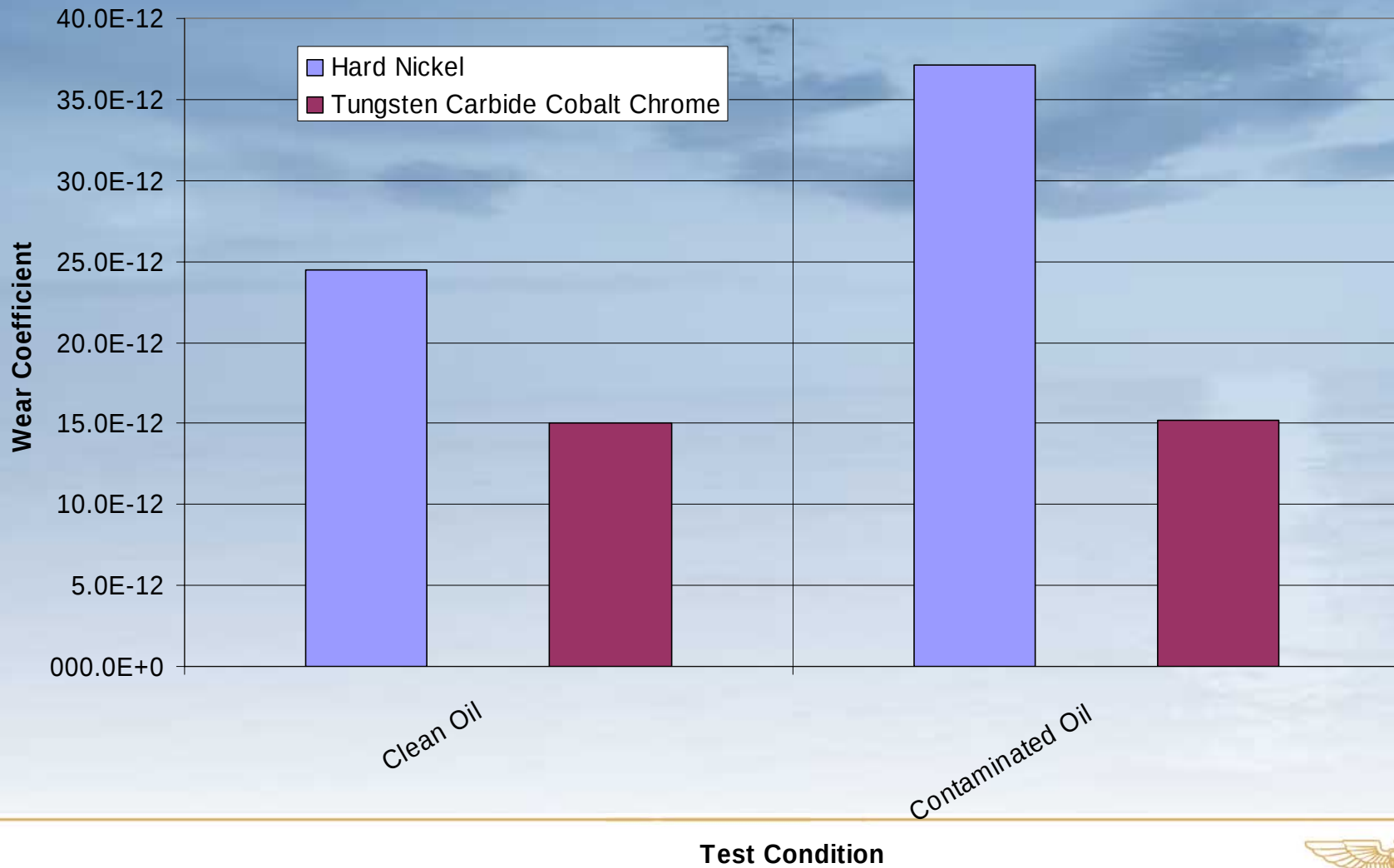


Friction Coefficient

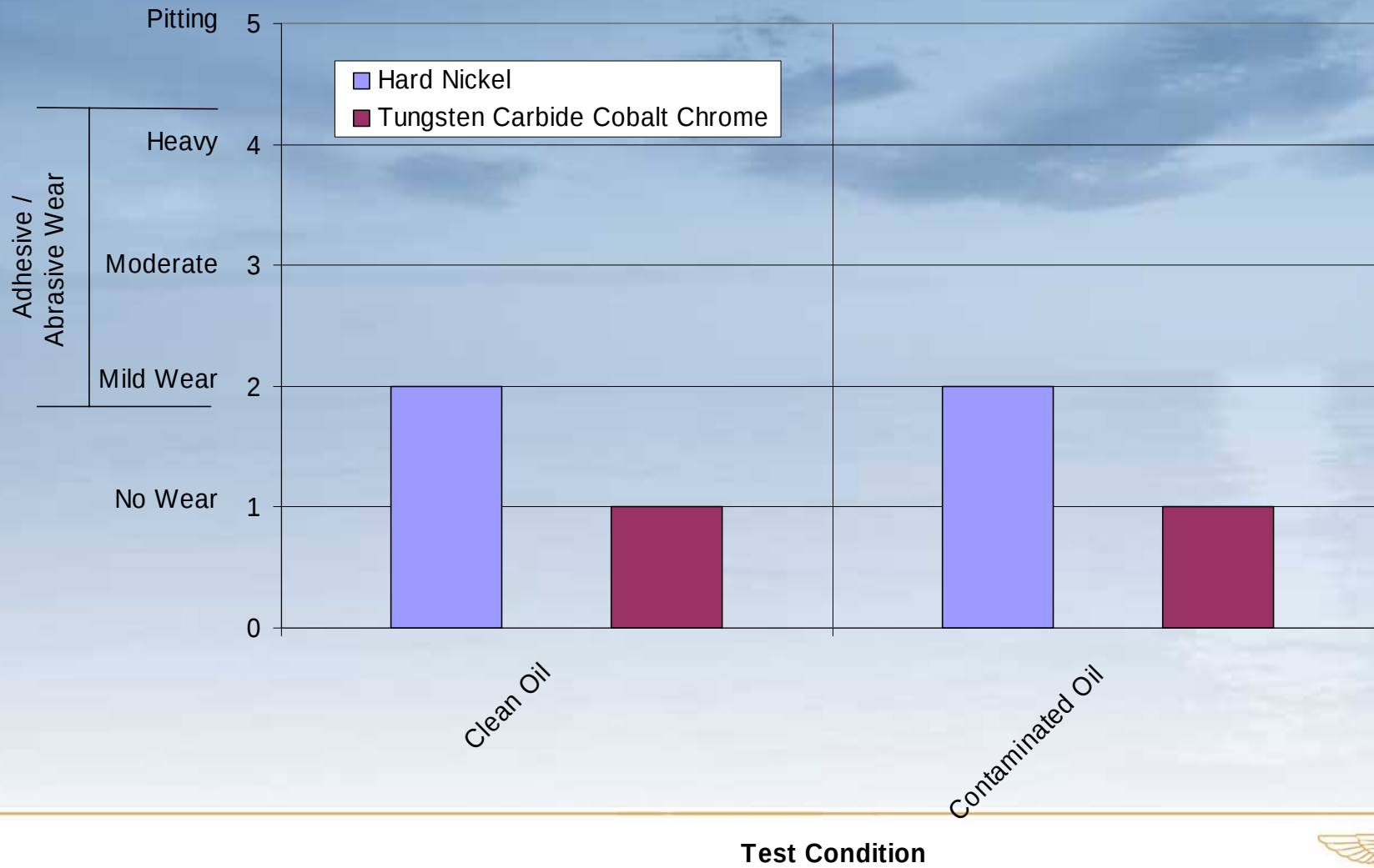


PTFE Wear Rate Comparison

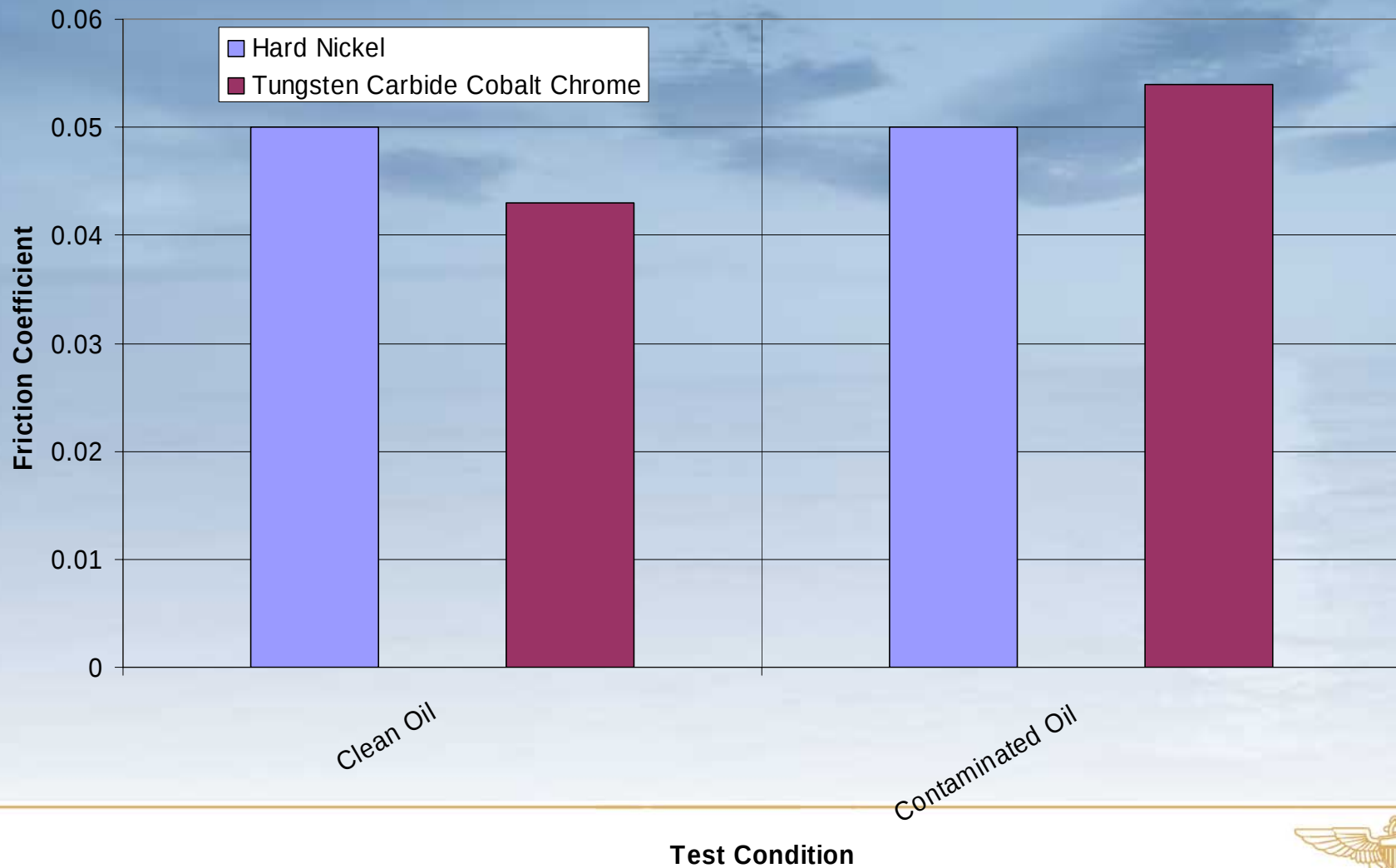
Based on Mass Loss Measurements



Panel Wear from PTFE Specimens

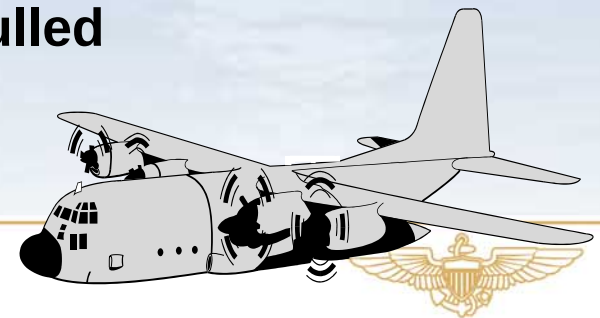


PTFE Friction Coefficient Comparison



Summary of Corrosion Tests

- Nickel Plating was the overall top performer
- WC-Co-Cr was marginally the best HVOF coating
- Quantitative results based on the # of specimens from the B117 cabinet after 552 hours
 - Criteria - visible corrosion exceeding 0.3% of area
 - 66% as coated, 100% machined WC-Co pulled
 - 55% as coated, 100% machined T-800 pulled
 - 55% as coated, 55% machined WC-Co-Cr pulled
 - 22% as coated, 25% machined Nickel pulled



Summary of TCLP Tests

- Spent Material Tested (WC-Co-Cr, T-400, T-800)
- Virgin Powder Tested (WC-Co-Cr, T-400, T-800)
- **NOT HAZARDOUS WASTE**
- In Connecticut Would Be Considered Non-Hazardous Regulated Waste



Low Pitch Stop Specimen

- **Cylinder Coatings**
 - **WC-17Co**
 - **Chrome Plate (AMS 2406)**
- **Piston Ring**
 - **Leaded Tin Bronze**
- **Test Conditions**
 - **75,000 Stroking Cycles = 10/flight, 1hr/flight, 7,500hrs before overhaul**
 - **Hydraulic oil (Mil-H-83282 or similar)**
 - **310 psi oil pressure to accurate piston**
 - **150°F oil temperature**



Summary of Low Pitch Stop Test

- **Cylinder Appearance**
 - **Chrome Plate - Appearance of wear on chrome plate but no significant adhesive wear or scoring**
 - **WC-17Co - Appears untouched**
- **Piston Ring Appearance**
 - **Chrome plate - Signs of use but no substantial wear**
 - **WC-17Co - Signs of use but no substantial wear**



Summary of Low Pitch Stop Test

- **Quantitative Results**
 - **Cr-Plate Surface Finish 2.7 Ra at start, 1.4 Ra at completion**
 - **WC-Co Surface Finish 7.2 Ra at start, 7.2 Ra at completion**
 - **Ring weight loss 3 times higher with Cr plated bore**

