Boeing Technology

Maintenance Program and New Materials on Boeing Commercial Aircraft

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Seattle, WA

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Report Documentation Page

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Agenda

- **Summary of Maintenance Program**
- **Drivers for implementing new materials**
- **Replacement of Alodine 1000**
- **B787 Finishes**

BCA Maintenance Program

- **Well defined program for all models**
- **Old system used letters**
  - **“A” check -- intended to disclose the general condition of the aircraft**
  - **“C” check -- greater depth of inspection throughout the airplane to ensure continued airworthiness**
  - **“D” check – Major systems/operational/functional checks, aircraft modifications, cabin refurbishment, painting, structural inspections, etc.**
- **Operations based system has layered inspections**
  - **based on flight hours or calendar**
  - **Varies by aircraft and operator**
  - **System maintenance**
    - **Lubrication, operational/functional,**
  - **Zonal Inspection**
    - **Combines general inspections and CPCP**
  - **Structural maintenance**
    - **Detailed and special detailed inspections**
    - **Musst maintain a “damage tolerance rating”**

Fleet Average Intervals (hours)			
model	"A"	"C"	"D"
737	~400	~5000	~20000
767	~200	~5000	~28000
747	~600	~5000	~48000

- **Military usage of airframes will not match commercial service**
  - **Maintenance intervals and practices will need to be adjusted**

“Operations” Maintenance Program

B747 Structural Program

STRUCTURAL MAINTENANCE PROGRAM

MPD NUMBER	AMM REFERENCE	PGM	ZONE	ACCESS	INTERVAL THRESHOLD	INTERVAL REPEAT	APPLICABILITY APL	APPLICABILITY ENG	MAN-HOURS	TASK DESCRIPTION
XX-XXX-XX										AIRPLANE MAINTENANCE MANUAL PROCEDURE (CHAPTER, SECTION, SUBJECT) WHICH SUPPORTS THE MPD REQUIREMENT.
										MPD Sequence number
										MPD Sequence number
										First two digits = ATA Chapter
		S								Maintenance Program Type (C = Corrosion, F = Fatigue, S = Structures)
53-501-00		S	112	112AL NOTE	16000 FC 3000 DY NOTE	0 FC 0 DY NOTE	ALL	ALL	1.30	INTERNAL-GENERAL VISUAL: AREA FORWARD OF NOSE LANDING GEAR WHEEL WELL LOWER LOBE SKIN PANELS-FORWARD OF BODY STATION 246. LONGITUDINAL SKIN LAP SPLICES. FORWARD ACCESS HATCH-CUTOUT STRUCTURES including skin within 20 inch periphery of cutout. FORWARD ACCESS HATCH-CUTOUT STOP FITTINGS AND BACKUP STRUCTURE. FORWARD PRESSURE BULKHEAD BODY STATION 132.5. NOSE GEAR WHEEL WELL-FORWARD BULKHEAD. FLOOR BEAMS. INSPECTION NOTE: 126.5 to 180.5 "ONLY" INTERVAL NOTE: Whichever comes first. Repeat interval satisfied by corrosion Items 3-653 and 53-65. ACCESS NOTE: Insulation blanket removal/displacement required.

EXAMPLE

EXAMPLE ILLUSTRATING FORMAT

RAM

MPD Sequence Number

First two digits = ATA Chapter

EXAMPLE

EXAMPLE ILLUSTRATING FORMAT

B737 Zonal Program

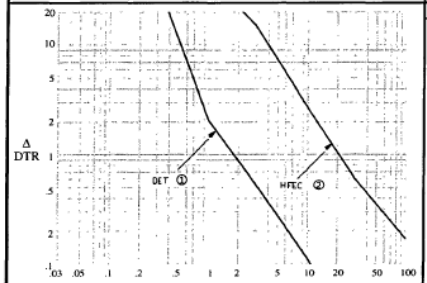
53-806-00		112	112AL	4000 FC 750 DY NOTE	4000 FC 750 DY NOTE	ALL	ALL	0.70	INTERNAL-ZONAL (GV): AREA FORWARD OF NOSE LANDING GEAR WHEEL WELL Perform an Internal Zonal Inspection (GV) of the Area Forward of the NoseLanding Gear Wheel Well. INTERVAL NOTE: Whichever comes first

DTR CHECK FORM ITEM: **F-25H** MODEL - SERIES: ALL 747 AIRCRAFT

TITLE: SKIN LONGITUDINAL LAP SPLICES

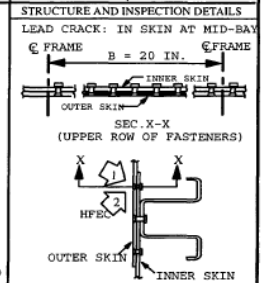
LOCATION: SPLICES BELOW S-38 / BS 140 - BS 2360 (A)
OUTER SKIN - UPPER ROW OF FASTENERS

OPERATOR(S) | NO. ELIGIBLE A/C



STRUCTURE AND INSPECTION DETAILS

LEAD CRACK: IN SKIN AT MID-BAY



NOTES:
(1) IF DAMAGE IS DETECTED WHILE CONDUCTING DETAIL VISUAL INSPECTION, USE HFEC INSPECTION TO INSPECT THE TWO ADJACENT BAYS.
(2) AREAS INSPECTED PER SB 747-53A2267 POST MOD INSPECTION PROGRAM MEET REQUIRED DTR.
(3) INSPECTIONS AND FREQUENCY PER SBs 747-53A2312 & 53-2367 (ON SPECIFIED LAPS) MEET THE REQUIRED DTR.
(4) F-25H INSPECTIONS ALSO BENEFIT F-25A AND F-25B.
(5) SEE 747 REPAIR ASSESSMENT GUIDELINES DOCUMENT (D6-36181) FOR INSPECTION REQUIREMENTS IF AN EXTERNAL SKIN DOUBLER IS INSTALLED.
(A) SEE F-25 LAP SPLICE IDENTIFICATION DIAGRAMS FOR DEFINITION OF SPECIFIC LAPS TO BE INSPECTED

STRUCTURE DETAIL	INSPECTION PROGRAM DETAILS: JOB CARD	DIREC ⇨	CHECK LEVEL	METHOD	%SAMP R_0	FREQUENCY F-FLIGHTS	$N = \frac{100F}{R_0}$	DAMAGE DETECTION PERIOD N_0 FLIGHTS	Δ DTR
OUTER SKIN		1		DET				3080	
		2		HFEC				7640	

			REVISED	DATE
ENGR				
CHECK				
APR				
APR				

FUEL LEAK DTR —
TOTAL DTR
REQUIRED DTR 10

Drivers for change in aerospace finishing technology…

Safety / Environment

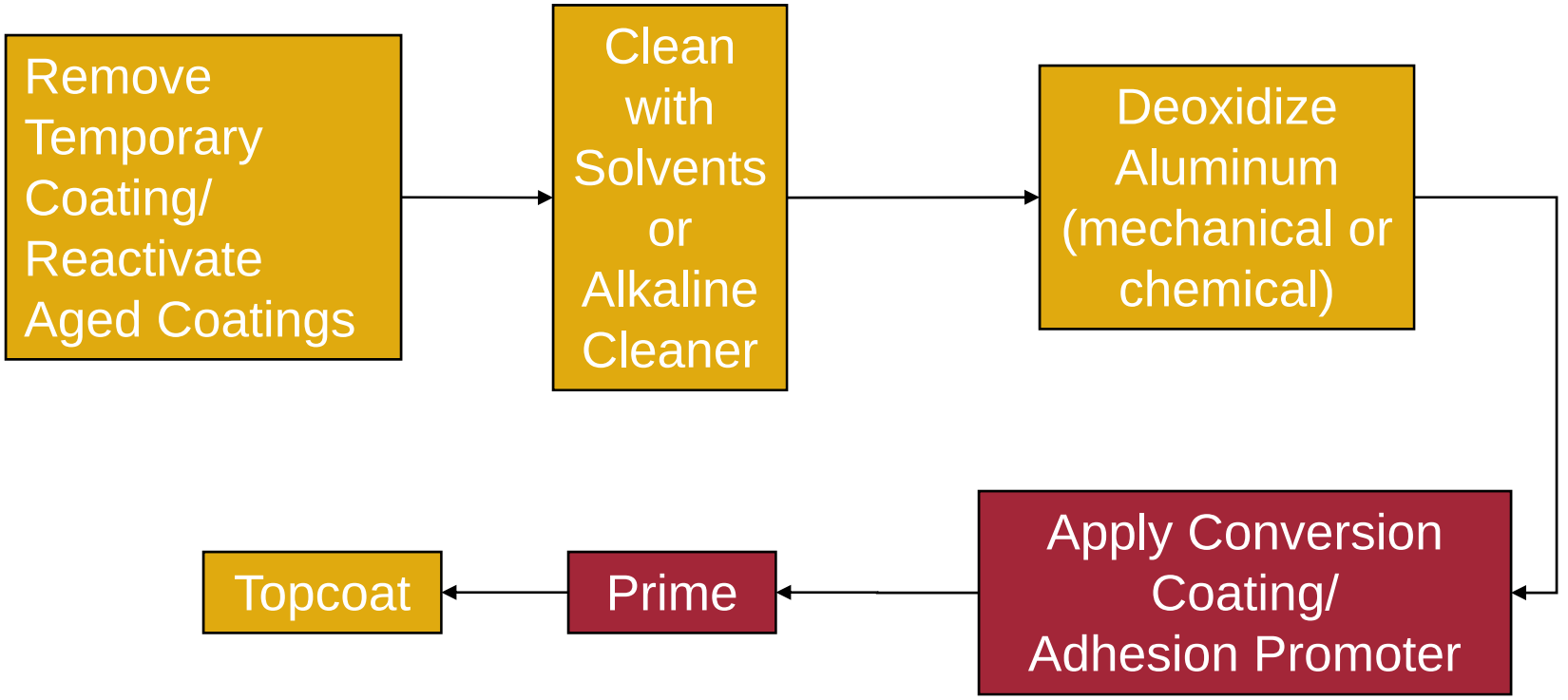
Performance

Process

When does “change” occur?

- **Technologies introduced with new models / major redesign**
  - **Need to meet engineering performance requirements and have production volume capability**
    - **New Substrates**
      - High strength steels
      - Light metals
      - Composite structure
    - **Chromium plating replacements**
      - Most models now have HVOF
    - **Chromate conversion coating replacements**
      - Need to maintain or improve performance
    - **Chromate corrosion inhibitor replacements**
      - Nonchromate systems not yet as capable
    - **Cadmium replacements**
      - Alternatives moving toward implementation
    - **Repair/Maintenance of new materials is important**
- **Technologies introduced for significant performance or process improvement**
  - **Replacement of Alodine 1000 for aircraft painting operations**

Exterior Finishing Process

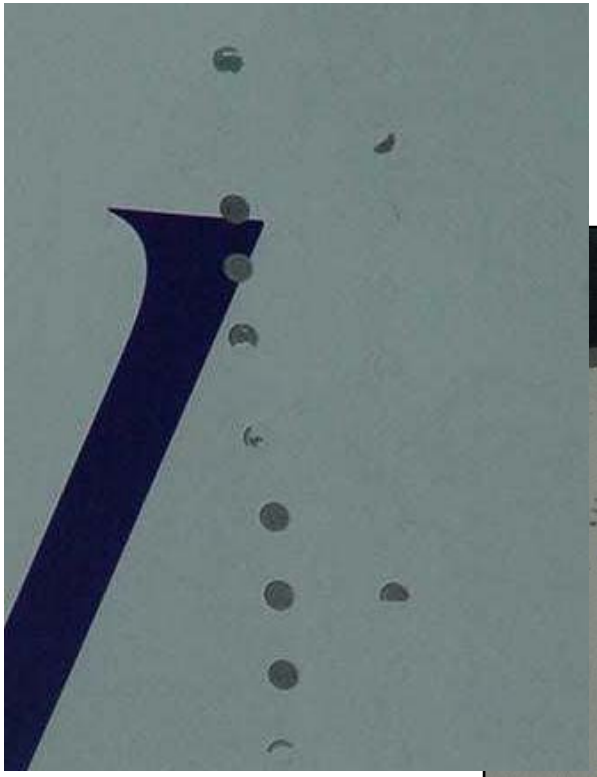


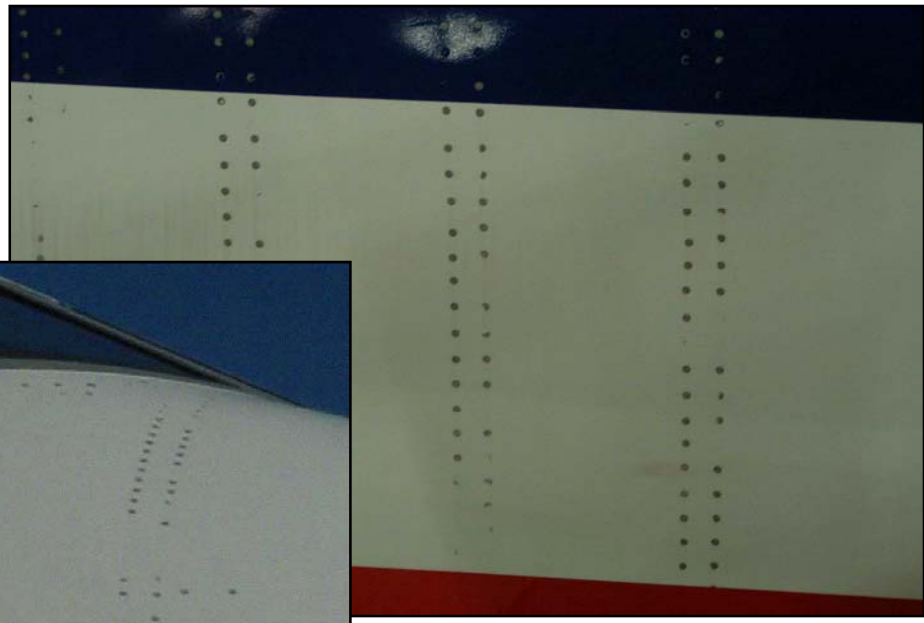
- **Each process and material in the exterior coating system is critical to ensure overall durability**
- **Changes require careful consideration….and a lot of testing and verification**

Performance Driver - Rivet Rash Reduction

Paint delaminates from rivets but not fuselage skins

- Affects all models and decorative paint systems
- Conventional conversion coating identified as contributing factor





In-Service Data – Production Trial Airplane

Comparison of two 777-200LRs with different pretreatments

Rivet Rash on First 777-200LR (**conventional conversion coating**) <400 Flight Hours

No Rivet Rash on 2nd 777-200LR (**AC131-CB / Boegel EPII**) <400 Flight Hours

Depainting – Production Trial Airplane

4-12 mils of paint

1st Strip Coat
6.5 hours dwell

1st Strip Coat
8 hours dwell + squeegee

2nd Strip Coat
6 hours dwell + squeegee

4th Strip Coat
8 hours dwell + squeegee

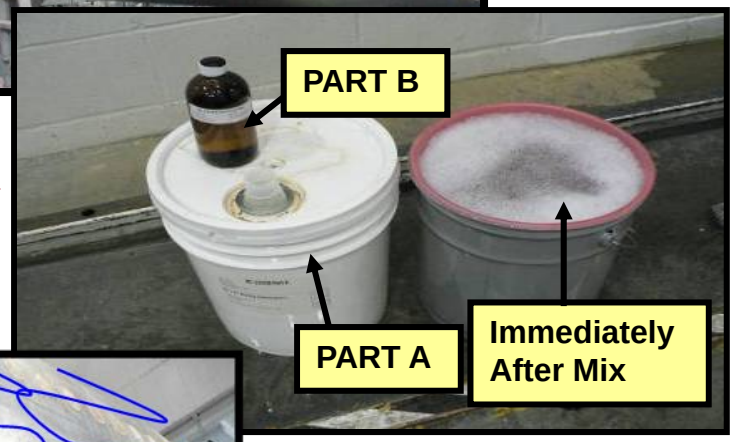
Abrade and rinse

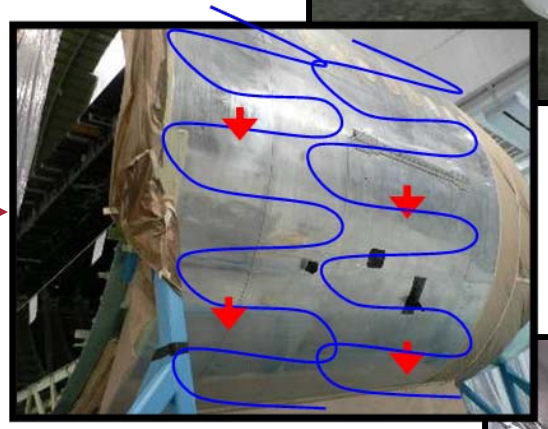
Process Optimization

- Solvent clean
- Deoxidize (chemical or mechanical)
- Water break free check
- Mask for Prime

1. Mix 2-part kit & shake 5 Min
2. 30 minute induction time
3. 24 hour pot life
4. Apply with air-assisted airless paint gun with small fluid tip
5. Spray top down
6. Apply minimum amount to wet surface
7. Allow 10 minutes drip
8. Wipe off excess, if necessary
9. Tape after dry, 1 hour min

- Complete mask for prime





Implementation

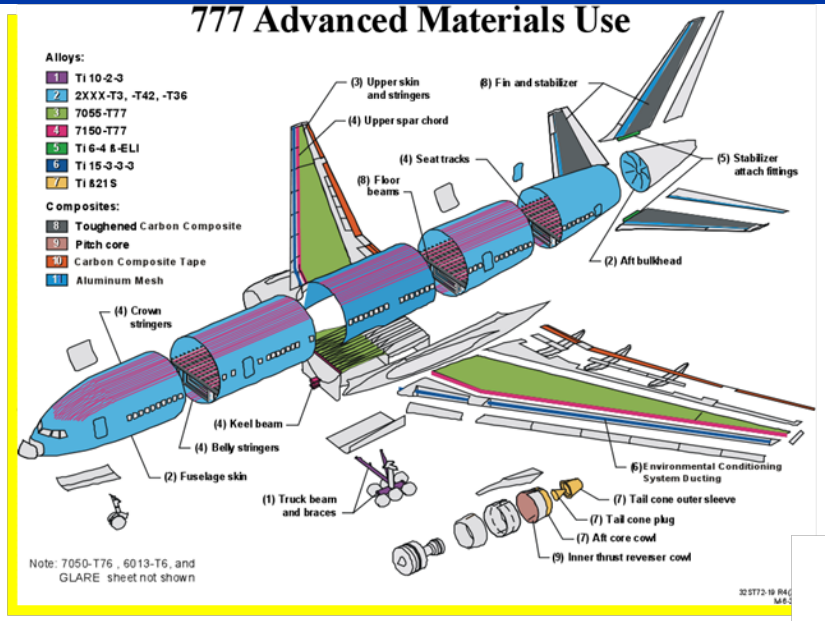
Everett Decorative Paint Operations implemented AC131-CB/Boegel EPII for 777s in March 2007

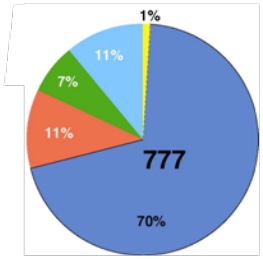
Elimination of ~ 400 gallons of chromated pretreatment and wastewater material per 777

Impact to Boeing

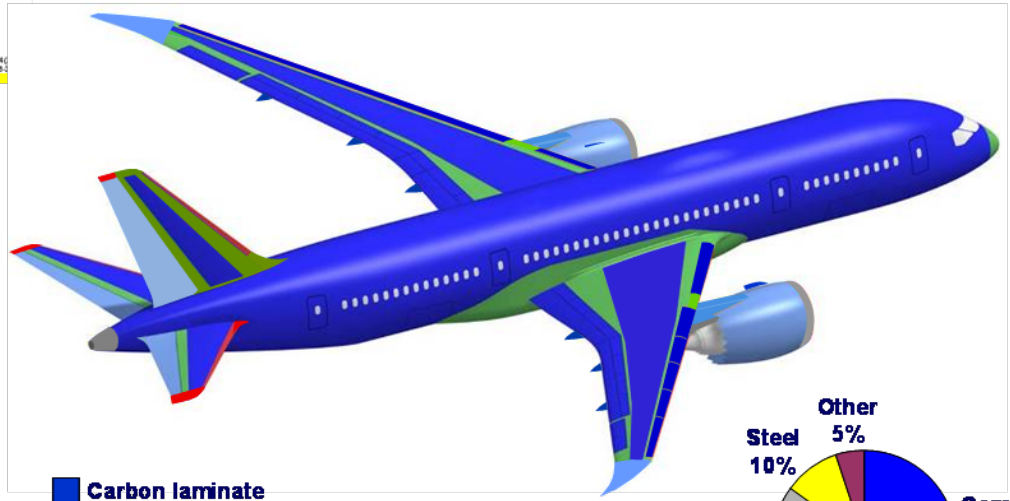
	Conventional	AC-131-CB / Boegel EP-II
Health & Safety	Contains Hexavalent chromium pH = 2.1	No Hexavalent chromium pH= 6
Environmental Impact	Volume of chromated coating: ~100 gallons/twin aisle ~25 gallons/single aisle Rinse water that requires remediation: ~300 gallons/twin aisle ~75 gallons/single aisle	Volume of chromated coating: None Rinse water that requires remediation: None
Durability	Rivet Rash is Problematic	Reduces Rivet Rash

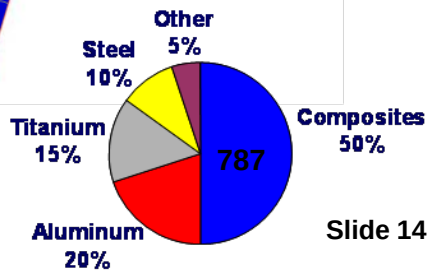
Advanced Materials Usage





787 Composite
Primary Structure





Selectively Strip-able Topcoats

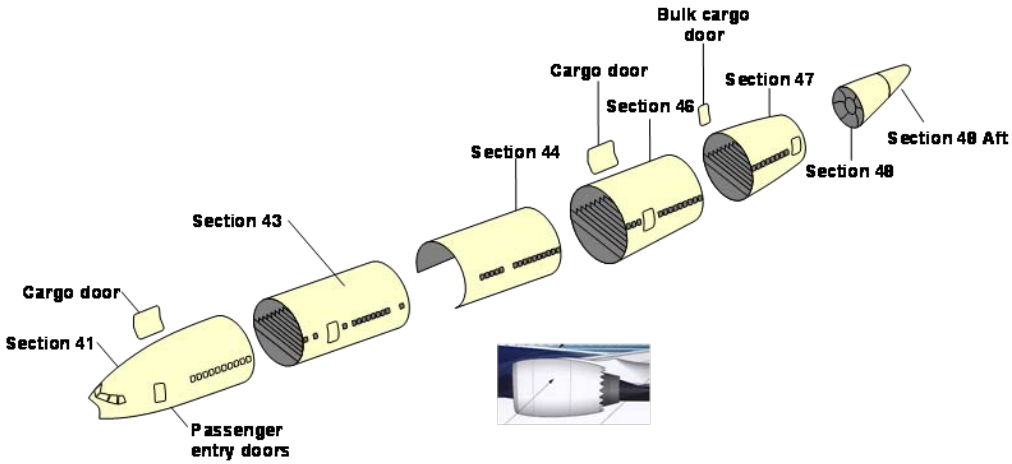
BMS10-13 paint stripper is applied to the paint system

Decorative colors (BMS10-125)
Initial topcoat (BMS10-126)
Intermediate coating (BMS10-120)
Exterior primer (BMS10-118)
Co-cured surfacing film (BMS8-341)
Graphite Skin (BMS8-276)

Over time, the paint stripper swells and delaminates the BMS10-120 intermediate coat from the BMS10-118 primer, removing the topcoat and most of the intermediate coat

Exterior primer (BMS10-118)
Co-cured surfacing film (BMS8-341)
Graphite Skin (BMS8-276)

Substrates Approved for Chemical Stripping



During repaint, a thin layer of primer, the intermediate coat and the decorative paint is applied

Decorative colors (BMS10-125)
Intermediate coating (BMS10-120)
Exterior primer (BMS10-118)
Co-cured surfacing film (BMS8-341)
Graphite Skin (BMS8-276)

Summary – Opportunities and Challenges

- **Maintenance program is based on operations experience**
  - **Manual has sections for all models and operators**
- **New materials must meet performance requirements**
- **Must meet OEM production and sustainment cost objectives**
- **Need to facilitate new technologies to production ready status**
- **Overall objective is to produce a safe vehicle that is economical to acquire and operate**

Questions?