



“Olive Drab, Haze Blue and Jet Black:” Camo for WWII US (USAAF) Aircraft



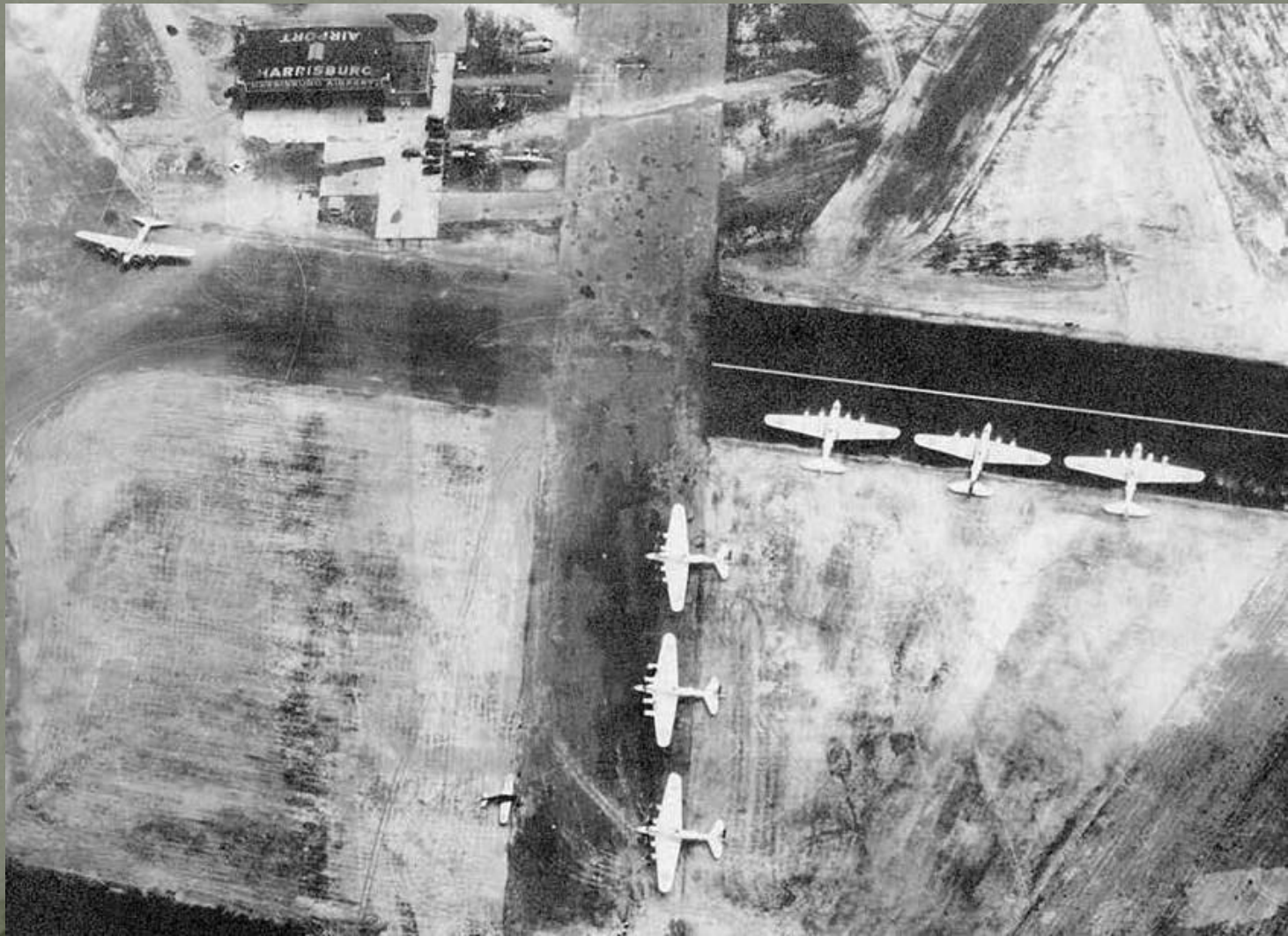
BRIAN DUDDY
WRIGHT FIELD SCALE MODELERS

US Aircraft Camo in WWII

- The Problem, The Science, and Camo Principles
- Pre-War Trials and Testing
- Army and Navy at Beginning of WWII
- Special Finishes – Anti-Submarine, Photo Recon, Night Fighters
- Wartime Changes, Postwar Standards

Aircraft Camo Principles

- It's all about visual detection.



Camo Principles

- Camo is used to prevent or delay *visual* detection through :
 - **Shape** – break up or conceal
 - **Color** – blend with background(s)
 - **Contrast and Shadow** – reduce or eliminate
 - **Movement** – disguise or delay detection
- Camo is a tradeoff; it has to be both *Effective and Suitable*
 - Ground vs. Air Detection – no one “best scheme”
 - Day vs Night, High Altitude vs Low Altitude operations
 - Patterns vs Single Color; Flat (“Non Specular”) vs Gloss
 - Paint Cost, Sources, Application, and Field Maintenance
 - WWII-era aircraft shifting from wood/fabric to aluminum
 - Standards for Industry, Time and Production Schedule Impact
 - Weight Penalty for paint and a performance tradeoff
 - Corrosion Prevention Properties for metallic structures, esp. harsh environments – shipboard operations

Early Experimental Camo - 1938



*Early B-17 in
multi-color
scheme*





Pre-War display at Bolling Field, DC, showing experimental camo

Problems addressed by War Dept.

- Now had to plan for a world-wide Air Force!
- Paint must be readily available from US sources, must be operationally suitable as well as technically effective. (*Can't rely too much on ingredients scarce in wartime.*)
- Extensive testing was done on all sorts of paints and finishes by the USAAF Air Materiel Command during the war.
- The Army and the Navy joined their efforts and also included the UK.

*P-51s in USAAF and
RAF camo:
Same aircraft,
different approaches*



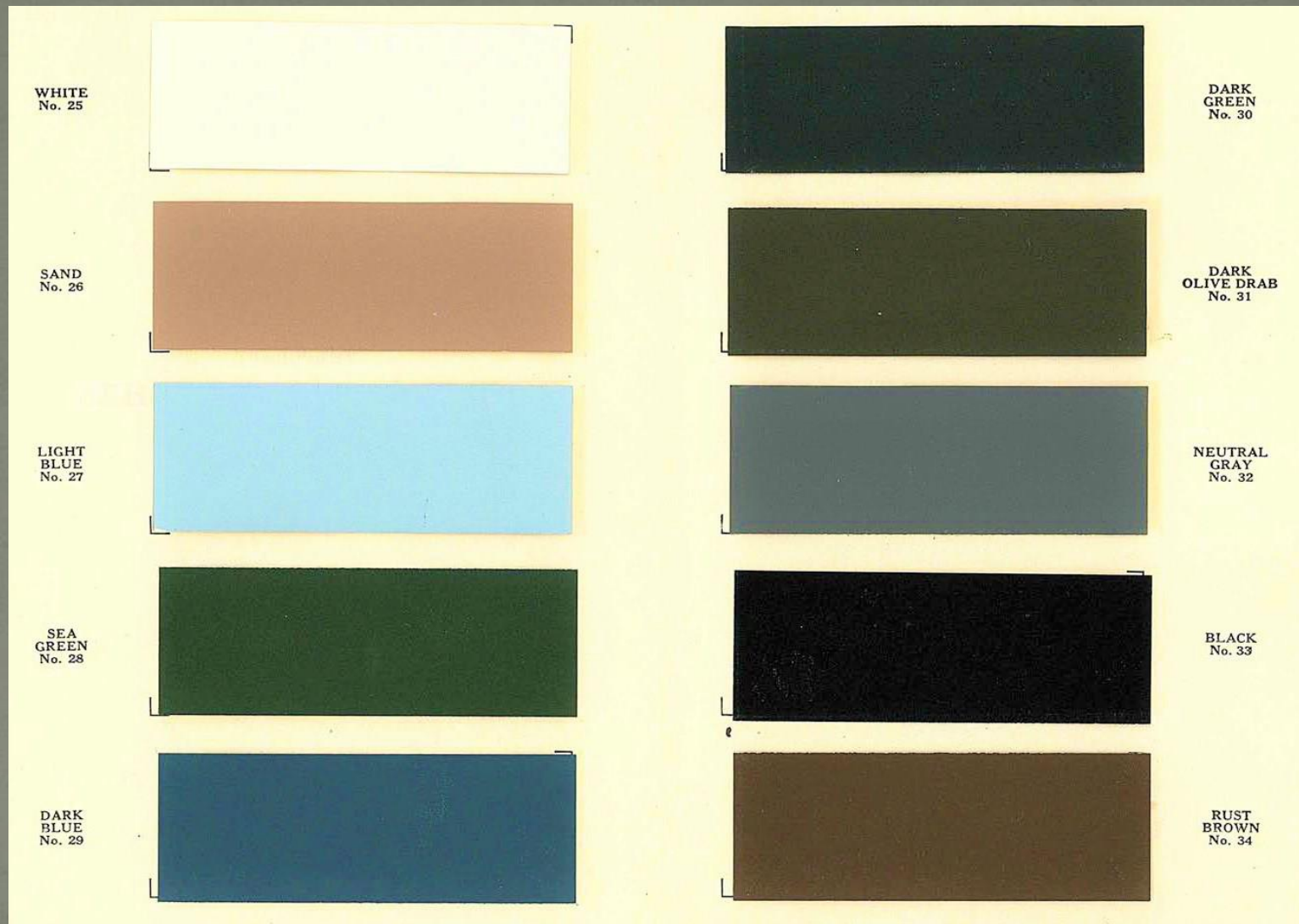
1942 Army-Navy Standards

- The Army standardized to Dark Olive Drab #31 upper, and Neutral Gray #32 lower surfaces – standard for most of the war.
- The Navy initially standardized to Medium Blue-Gray upper and Light Gray lower surfaces.
- This applied to all tactical and strategic aircraft, except for trainers and other aircraft based in the ZI (CONUS.)

P-40s in OD and Neutral gray in the final assembly stages at the Curtiss plant in Buffalo, NY



USAAF Standards: April-May 1942



The first appearance of standard paint finishes for Army aircraft and their corresponding numbers issued by Air Materiel Command – AAF Bulletin Number 48: May 26, 1942.

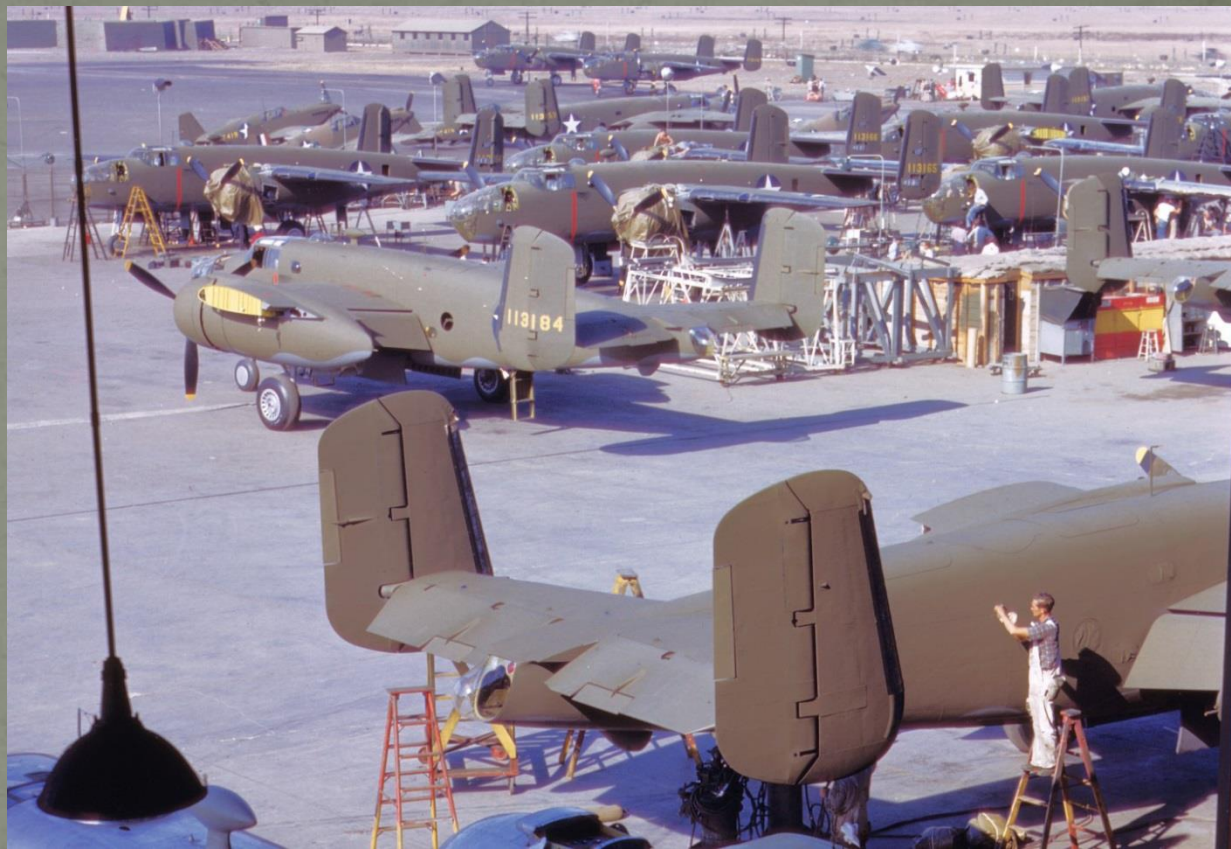
- Apr/May 42: Joint Aircraft Committee standardizes colors for USAAF/USN/UK including Dark Olive Drab and Neutral Gray for USAAF (Medium Green could be substituted locally depending on terrain.)
- Specs were produced based on that, but, *“General requirements for paint relate only to the physical properties of the paint as airplane finishes and do not deal with the manner in which the color is secured.”*
- May 1942: AAF directed that to camouflage aircraft for desert use, a coat of permanent Sand-colored enamel could be applied over the Olive Drab while the undersurface remained Neutral Gray.
- Jul 42: AAF decides to pursue infrared reflecting paint with chromium oxide.
- Aug 42: USAAF standardized to OD, Black, Sand, Medium Green, color card issued
- UK standardized to Azure Blue, Dark Sea Gray, Middlestone, Dark Earth and Sky Type S Gray.

*C-47 at Patterson Field
(now Wright-Patterson AFB)*



“Olive Drab”

- There is probably no more hotly-contested issue in IPMS than “what color is Olive Drab?”
- Technically, it is NOT *Green*. It is a mixture of **Yellow** and **Black**!
- The USAAF started the war using and specifying Dark OD No. 31, but that changed in the latter half of the war for technical reasons.
- The Army Ground Forces also applied OD to vehicles, but it was a different shade and formula than the USAAF.
- In December 1943 ANA Standards began to be used with earlier OD 41 to specify paint colors.



B-25s in production at the North American plant in fresh OD and NG



*Examples
of OD over
Neutral
Gray*

OD and Medium Green

Fabric Control Surfaces
slightly different shade

OD has now faded to a medium brown

Medium Green overpaint

Neutral gray retains its color

- Wartime OD faded very fast, and took on several shades...
(Note absence of “Pre-Shading.”)
- Throughout the war, manufacturers delivered the aircraft painted, but they were repainted by subdepots and in time were no longer in standard finishes.

Wartime OD and Medium Green C-47...

Dark patches are Med Green,
Also for repairs and damage

“Invasion Stripes” painted
over



OD and Medium Green



OD and Medium Green – Memphis Belle B-17F



See it in person at the NMUSAF, Dayton Ohio!

Even more exotic schemes were tried...

- P-51A at Eglin Field FL, 1943. After extensive tests, this 'dazzle' scheme proved not only ineffective but enormously labor-intensive to apply!

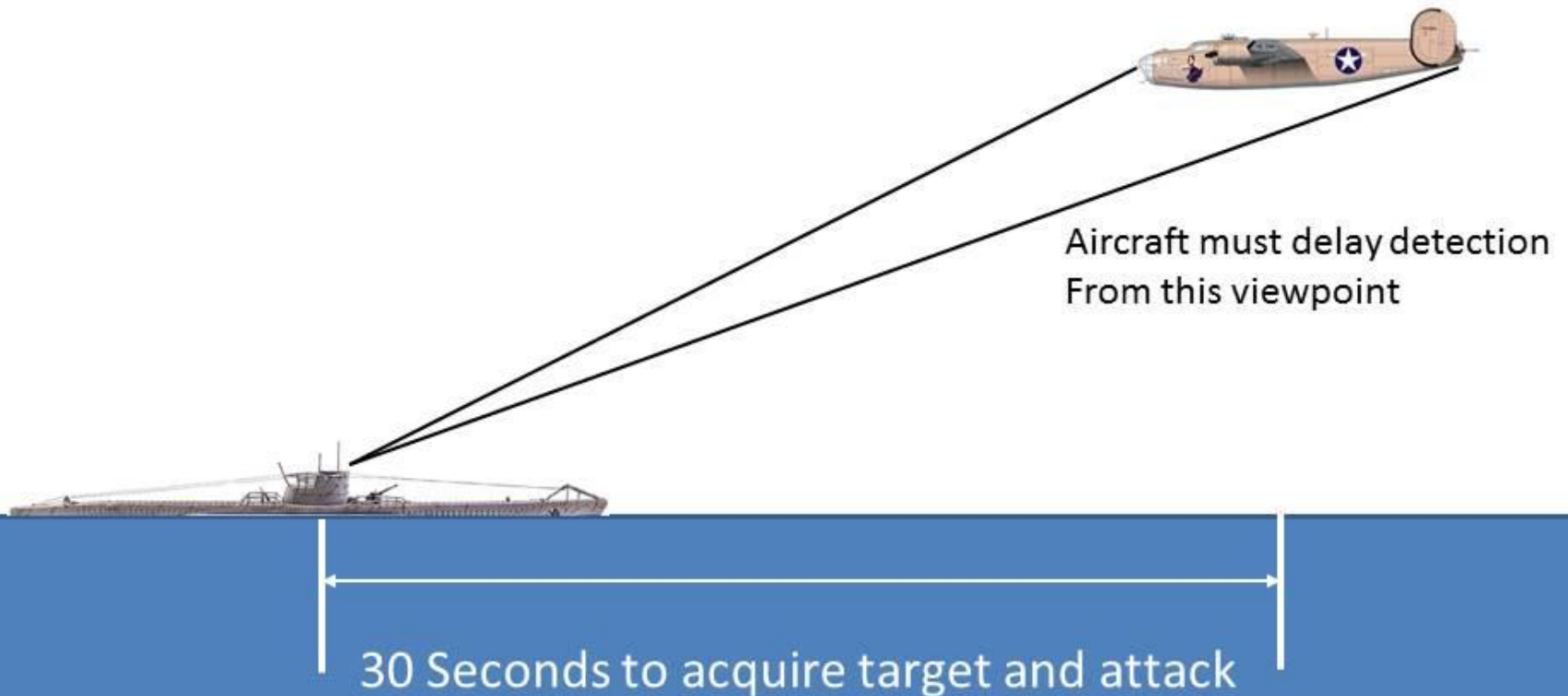
This required approximately 6000 rolls of Tamiya masking tape!



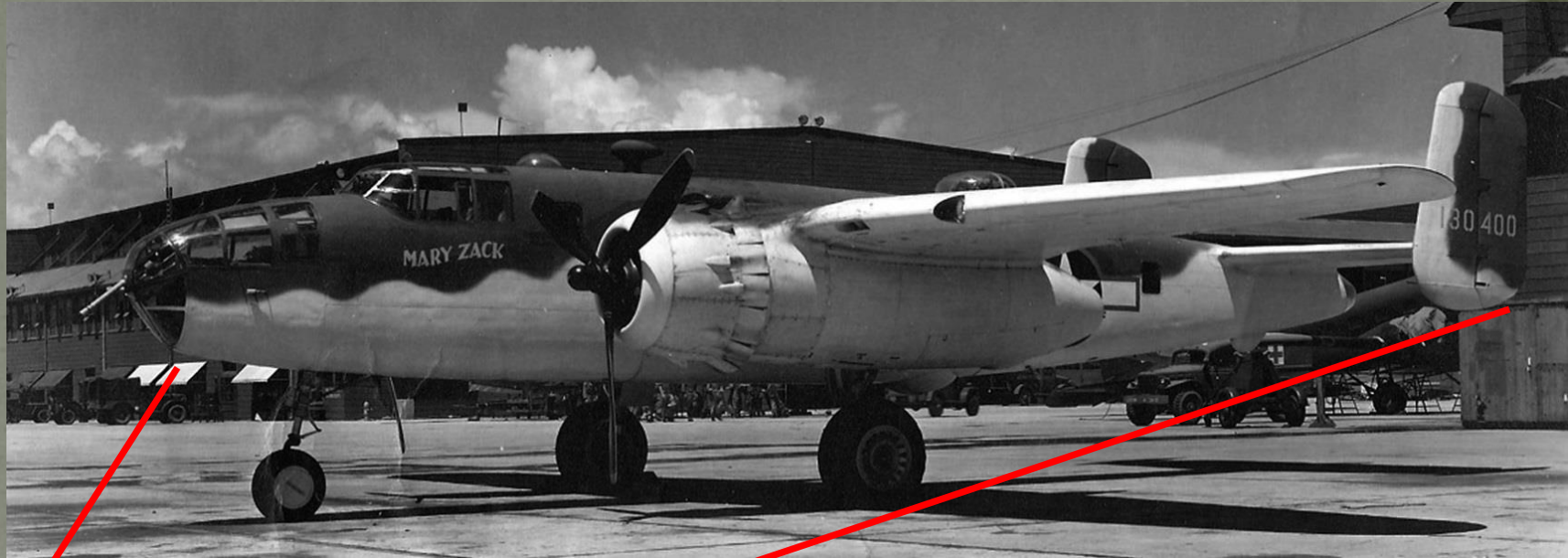
Special Finish: Anti-Sub Aircraft

- German U-Boats were a serious threat in the Atlantic for most of the war – the US/UK explored all countermeasures.
- Early air operations against subs on surface were unsuccessful due to detection and escape by U-Boat crews.
- Research and data indicated aircraft had only 30 seconds from moment of detection until the crew would “crash-dive” the submarine – very narrow attack window.
- Extensive experiments and research in shades and weather conditions to develop new camo schemes to hide the aircraft and delay detection.
- Results indicated Pure White or “Oyster White” undersurfaces were the most effective, with either Olive Drab or Neutral Gray on top.
- Actually made a huge difference in the Anti-Sub Campaign.
- This was NOT recommended for use where there would be air opposition to the sub-hunting aircraft!

Anti Submarine Camo Study Applied to both Army and Navy Aircraft

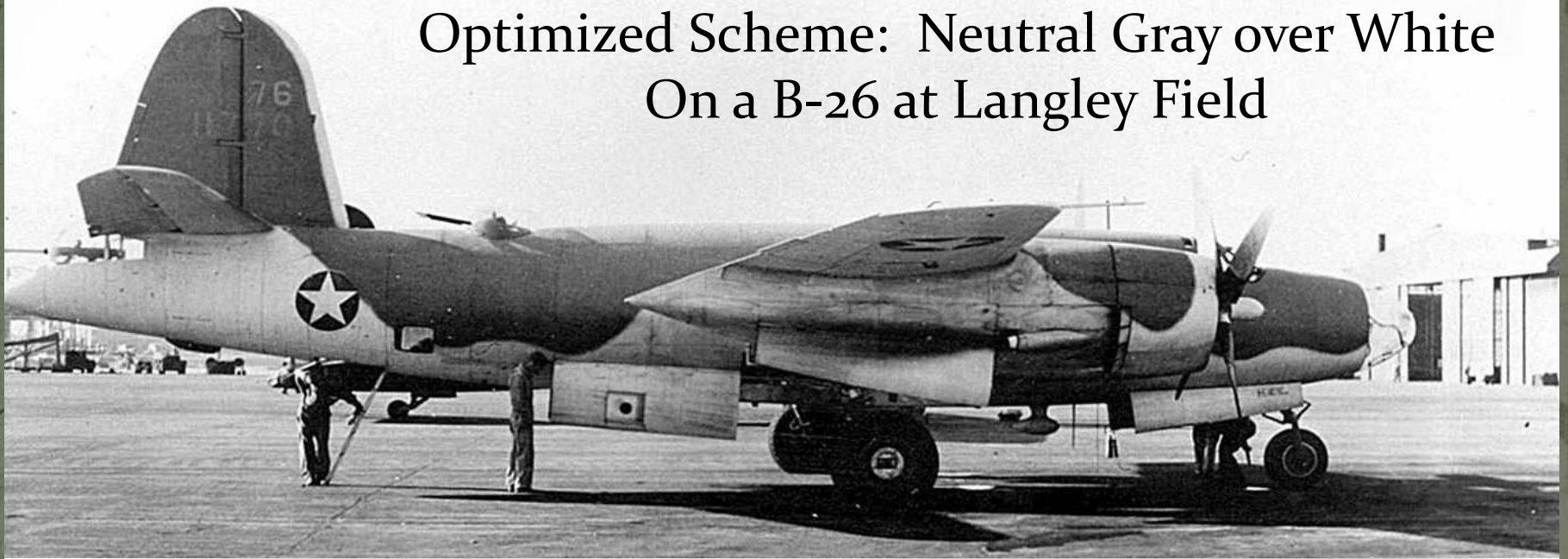


Optimized Scheme: Neutral Gray over White
Next Best: OD over White



Note from this vantage point
(front & below,)
the observer only sees the white
on the underside

Optimized Scheme: Neutral Gray over White On a B-26 at Langley Field



Navy SBDs in
Anti-Sub
(Anti-Ship) Scheme



Variations of the scheme on RAF and US B-24s



Special Finish: Photo Recon Aircraft

- Photo Recon (PR) aircraft usually operated alone, at high altitudes, and on predictable flight patterns.
- A new camo was needed to disguise them at altitude.
- This problem had more study than any other finish during the war – trials by both industry and military.
- So-called “Haze Paint” was developed initially for Lockheed F-5 (P-38) PR aircraft. Later changed to *Synthetic Haze Paint*.





The Haze finish did work very well to conceal the aircraft at altitude, however...

- It required considerable skill to apply properly and maintain, *and*
- It highlighted the fact that the PR aircraft lacked the armament of the basic P-38, so the Haze Paint idea was dropped May 43.



Special Finish: Night Fighters

- The third problem also studied extensively was how to hide aircraft at night – mostly from searchlight beams.
- Obvious solution: “Flat Black”? But testing proved otherwise.
- Gloss Black or standard Olive Drab was more effective.
- New Gloss scheme – “Jet Black” #622 developed for night fighters: P-70, P-38M, P-61 and tested in December 43.



Night Fighter Finishes

- Jan 44: All night fighters were to be painted glossy black.
- Mar 44: Navy Light Gull Gray, Navy Dark Gull Gray, Glossy Jet Black #622 were added to the color chart.
- Although effective, the Gloss/Jet Black finish required more continuous maintenance in the field.
- Some P-61 units stayed in OD for that reason.
- The Jet Black finished lasted into Korean War era.



Changes to Olive Drab

- The formula for Olive Drab was modified during the war to address the emergence of infrared photography for detection – aircraft can now be ‘seen’ by their IR signature.
- New shades were developed that allowed better concealment and resistance to IR photography.

*Late war B-24
in Dark Olive
Drab*



Wartime Changes in Finishes

- In the second half of the war, the USAAF philosophy of camo changed significantly.
- The primary driving factor was: existence of RADAR.
- The secondary factor was: SPEED.
- Radar detection was now more of a concern than visual, so the USAAF reduced or eliminated camo altogether.
- Fighter aircraft in ETO needed highest top speed possible to deal with German jet threat = reduce weight by eliminating camo.
- Camo ordered removed in November 1943, although some commanders in the Pacific felt it was still useful.
- By 1945 complete air supremacy rendered camo unnecessary.

Tech Order 1-1-7, April 1944: Removal of Camo and First appearance of “ANA” shades

2. AUTHORIZED FINISHES.

a. DAY CAMOUFLAGE. - Standard day camouflage for liaison aircraft, helicopters, and gliders consists of upper surfaces olive drab, shade No. 41, Bulletin 41 or AN Bulletin 613; and lower surfaces neutral gray, shade No. 43, Bulletin 41 or Army-Navy sea gray, No. 603. (See AN Bulletin 157A.)

b. NIGHT CAMOUFLAGE.

(1) GENERAL. - Special black camouflage paints, color designation, “Jet No. 622,” have been developed for use in minimizing visibility of airplanes at night. The estimated quantities of materials required will be found in table I.

By the end of the war, it was pretty much left up to the local commander...



Post-Script, Post-War Colors:

- ANA Standards were used briefly until superseded by the Federal Standard (FS) colors.
- The FS 595 colors that were in use (5-digit color numbers) did not become official until the mid-1950s. That standard has gone through several revisions (A,B,C) since then. (Now SAE)
- FS numbers are often specified on model paint and painting instructions in an attempt to give some type of standard reference.
- However, *specifying FS numbers for WWII aircraft or equipment, therefore is a “best guess.”* FS numbers only apply to post-Korea era finishes. – there is no exact FS number for wartime Olive Drab for example, although FS34087 is quoted.

ANA - FS Equivalents

COLORS; LIST OF STANDARD AIRCRAFT CAMOUFLAGE

1. Contents. This bulletin contains the list of names and numerical designations of the Air Force-Navy standard low gloss colors for aircraft, camouflage.

Color name	Color standard to be employed		Superseded ANA Color standard
	Fed. Std. No. 595	ANA color No.	
Instrument Black	1/ 27038	---	514
Insignia White	37875	---	601
Light Gray	36440	---	602
Sea Gray (Replaced NG)	36118	---	603
Black	37038	---	604
Insignia Blue	35044	---	605
Semi-Gloss Sea Blue	25042	---	606
Non-Specular Sea Blue	35042	---	607
Intermediate Blue	35164	---	608
Azure Blue	35231	---	609
Sky	34424	---	610
Interior Green	1/ 34151	---	611
Medium Green	34092	---	612
Olive Drab	2/ X 34087	---	613
Orange Yellow	33538	---	614
Middlestone	30266	---	615
Desert Sand (formerly Sand)	30279	---	616
Dark Earth	30118	---	617
Dull Red	30109	---	618
Bright Red	31136	---	619
Light Gull Gray	36440	---	620
Dark Gull Gray	36231	---	621
Seaplane Gray	26081	---	625
Semi-Gloss Insignia White	27875	---	626
Desert Drab	30219	---	628
Field Green	-----	627	---
Light Green	-----	630	---
Shadow Green	34079	---	631
Olive Green	-----	---	624

FS 595C Replaced by SAE Standard

- FED-STD-595 Rev C, dated 16 January 2008, and all associated slash sheets, was cancelled as of February 2017.
- SAE-AMS-STD-595, “Colors Used in Government Procurement,” supersedes FED-STD-595C.
- This document, and all new SAE-AMS-STD-595 color standard products such as fan decks and color chipsets, may be obtained from Society of Automotive Engineers at www.sae.org.

Is it Olive Drab, or Dark Blue?



Only The Rivet Counters know for sure!



Go forth,
and
PAINT!!!

