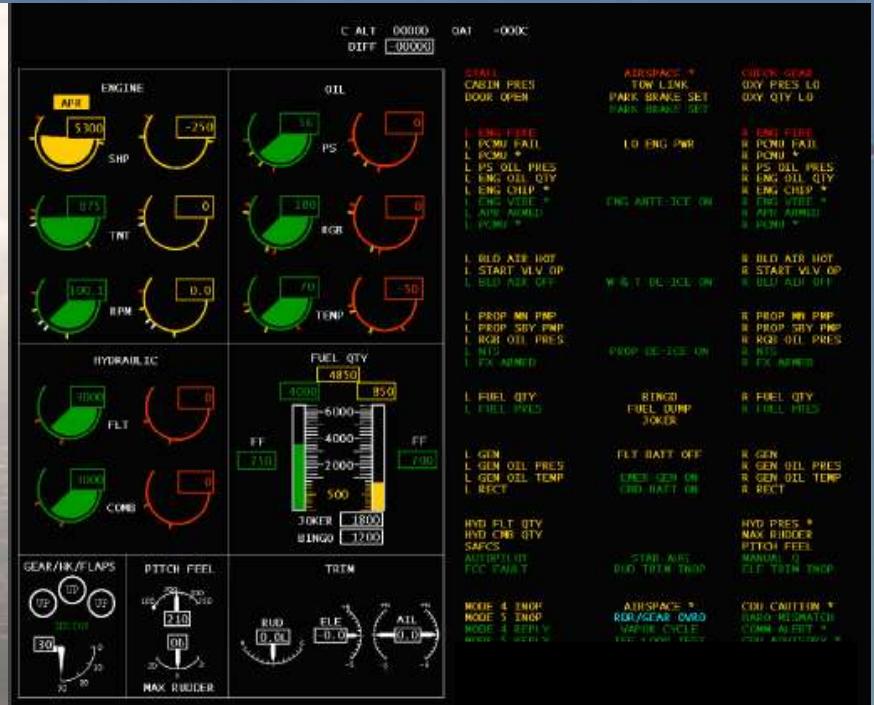




TOO MUCH OF A GOOD THING



A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

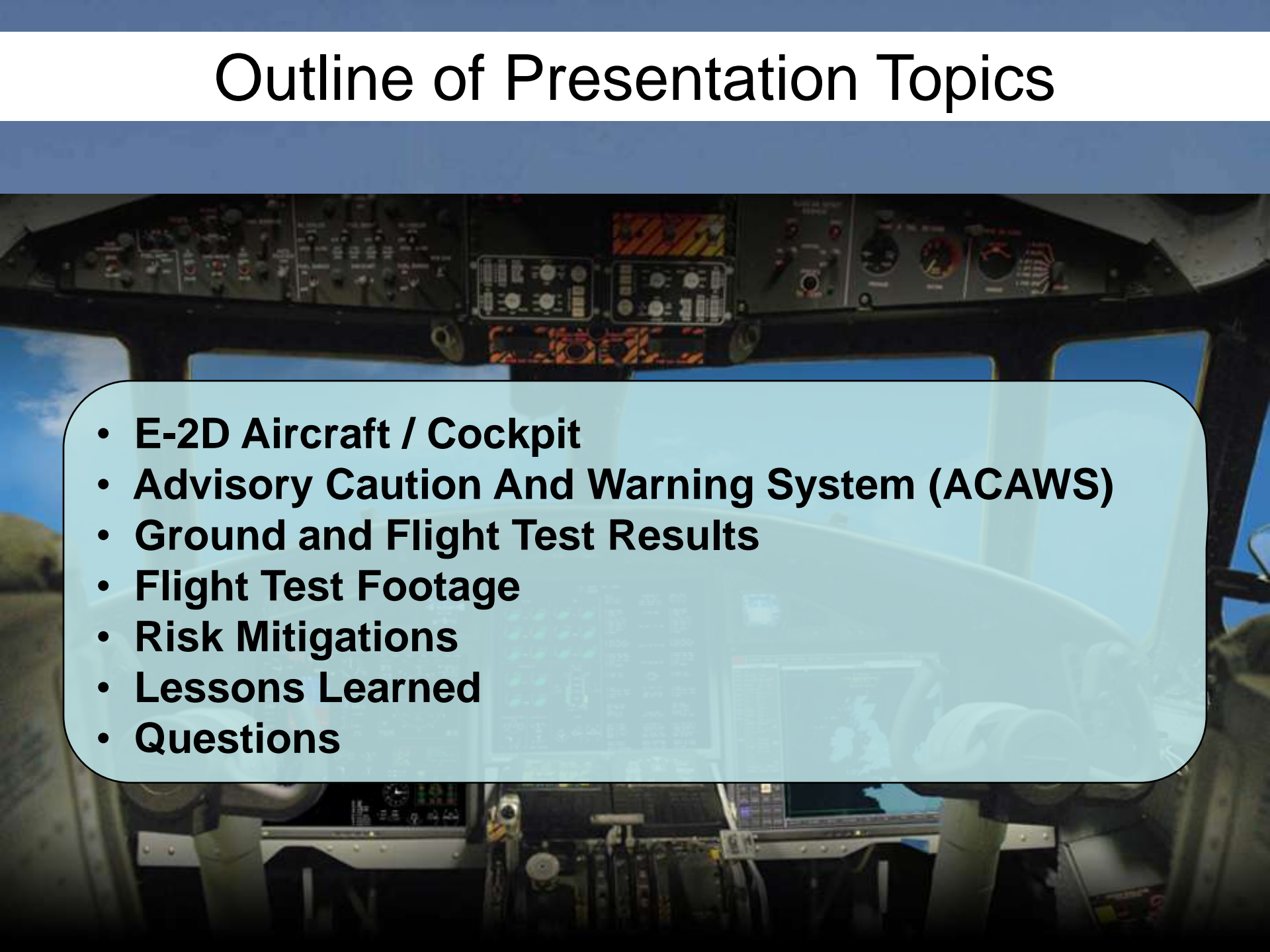


LCDR Lawrence Nance (M)
 E-2D Project Test Pilot
 Air Test & Evaluation Squadron Two Zero

Mr. Pat Svatek (SFTE)
 E-2D Air Vehicle Test Lead
 NAWCAD

April 2009

Outline of Presentation Topics

- 
- The background of the slide is a photograph of the cockpit of an E-2D aircraft. The cockpit is filled with various instruments, including multiple large display screens showing flight data and maps, numerous control panels with buttons and switches, and two yokes (steering wheels) for the pilots. The overall lighting is somewhat dim, typical of a cockpit environment.
- **E-2D Aircraft / Cockpit**
 - **Advisory Caution And Warning System (ACAWS)**
 - **Ground and Flight Test Results**
 - **Flight Test Footage**
 - **Risk Mitigations**
 - **Lessons Learned**
 - **Questions**

Too Much of a Good Thing

A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

MISSION: Provide Airborne Early Warning (AEW) and Command & Control against projected 21st Century threats



Major Updates:

- Glass Cockpit
- Smart Air Data system
- Interconnected Avionics
- Propulsion Control and Monitoring

Too Much of a Good Thing

A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

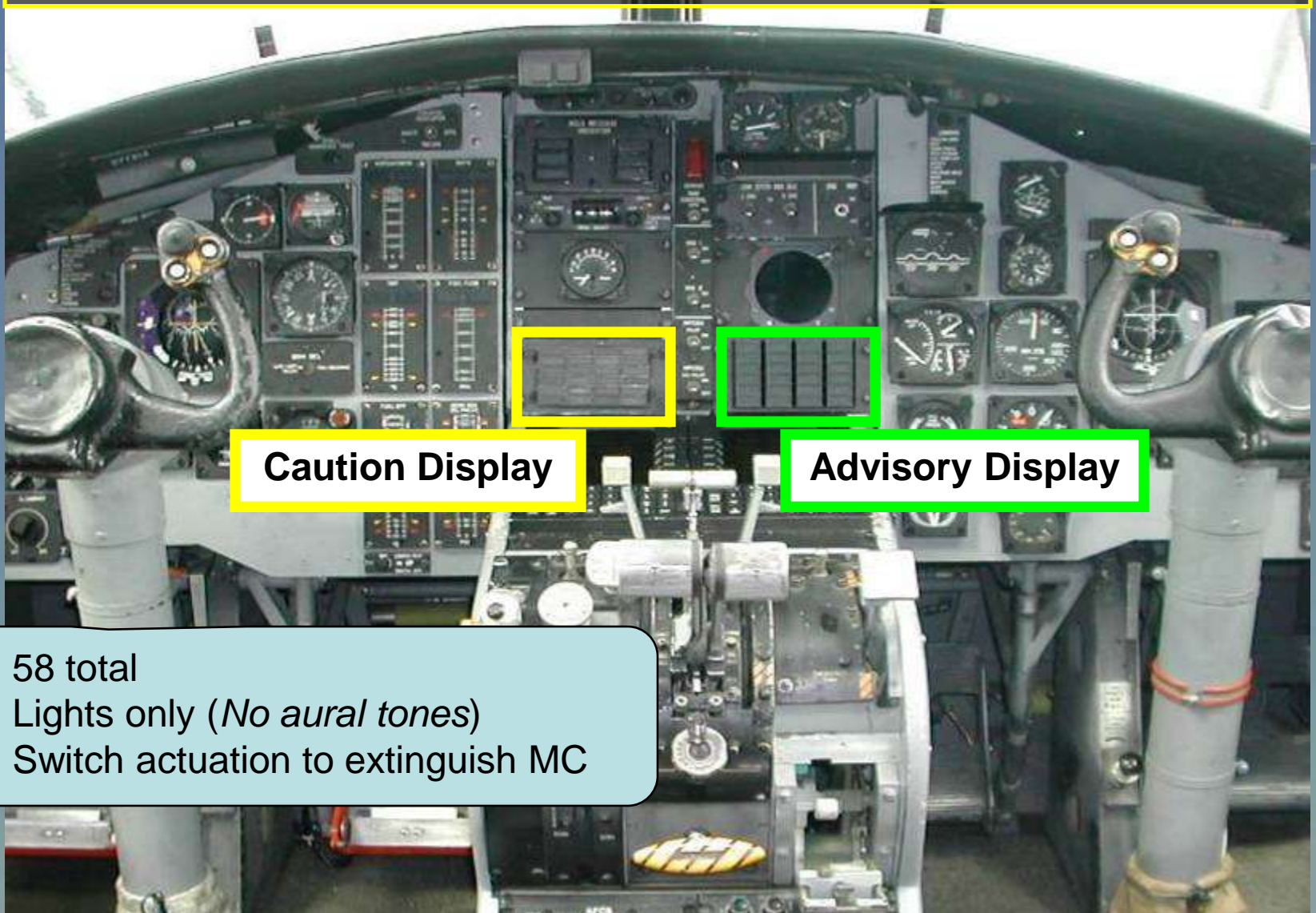


Cockpit Modifications (E-2C vs E-2D)

Too Much of a Good Thing

A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

E-2C Cockpit



Caution Display

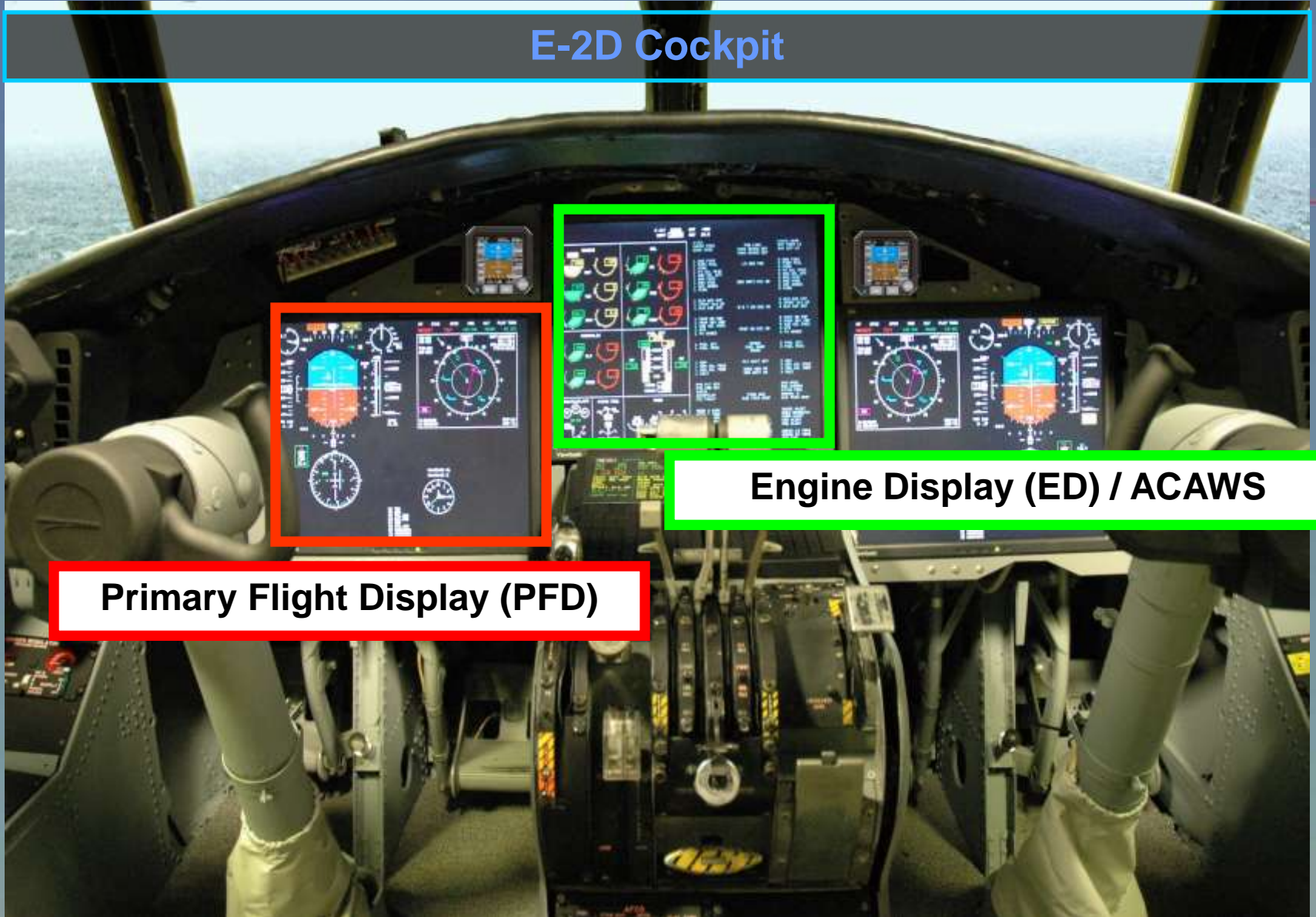
Advisory Display

- 58 total
- Lights only (*No aural tones*)
- Switch actuation to extinguish MC

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A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

E-2D Cockpit



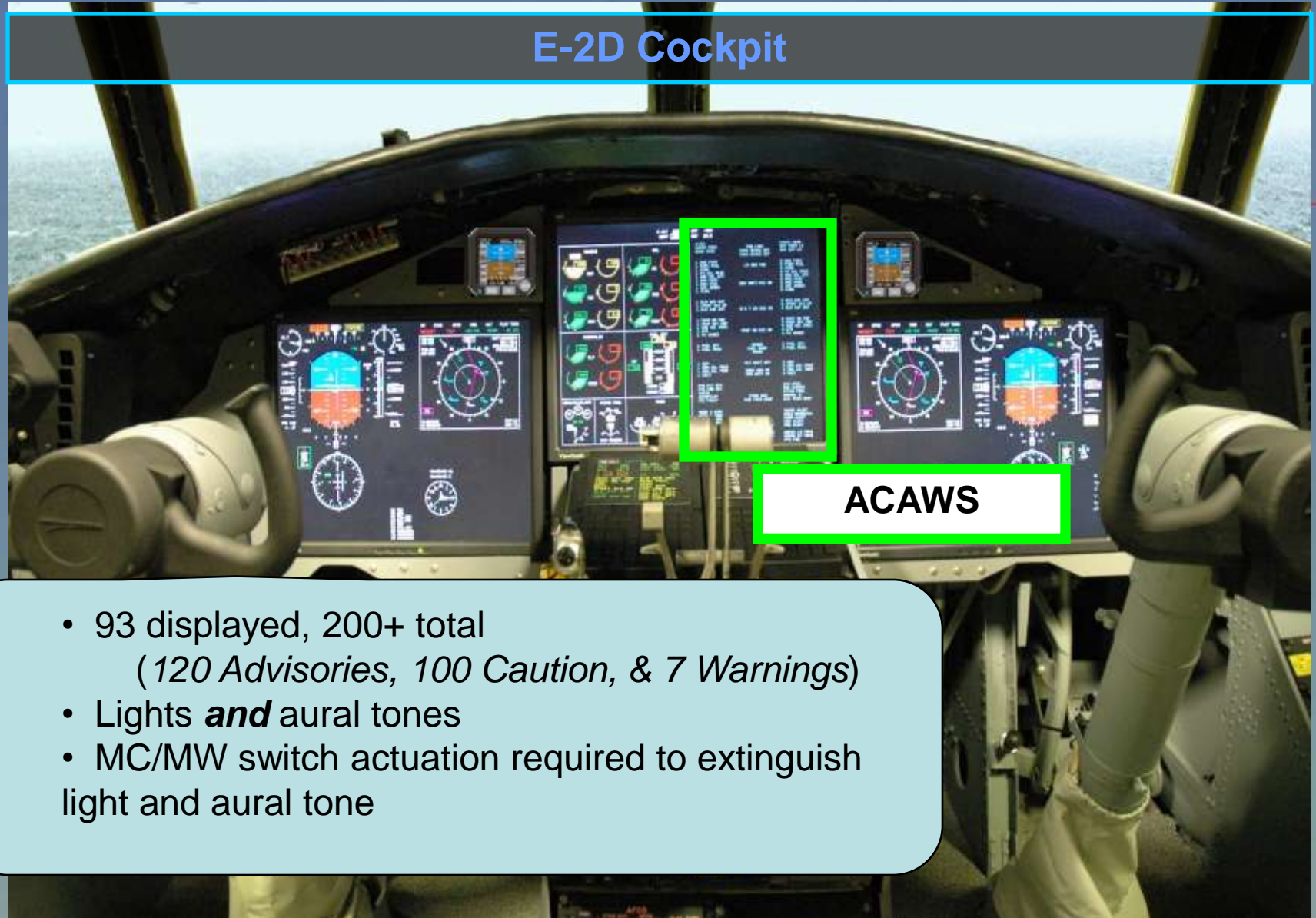
Primary Flight Display (PFD)

Engine Display (ED) / ACAWS

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A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

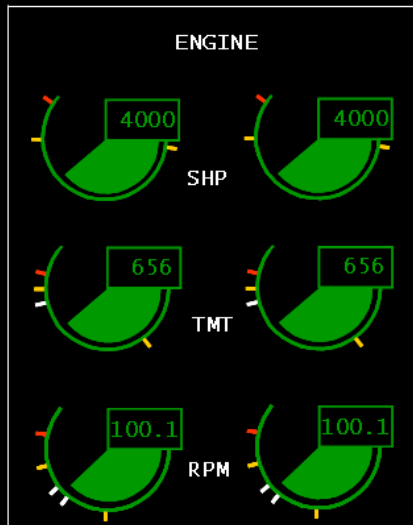
E-2D Cockpit



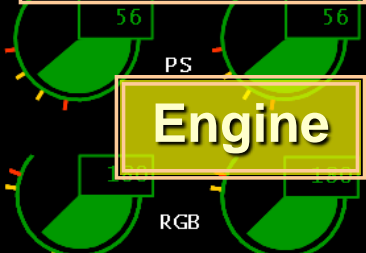
- 93 displayed, 200+ total
(120 Advisories, 100 Caution, & 7 Warnings)
- Lights **and** aural tones
- MC/MW switch actuation required to extinguish light and aural tone

Engine Display (ED) / ACAWS

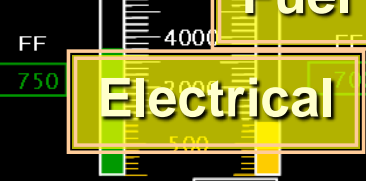
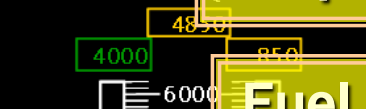
C ALT 00000 OAT -000C
DIFF -00000



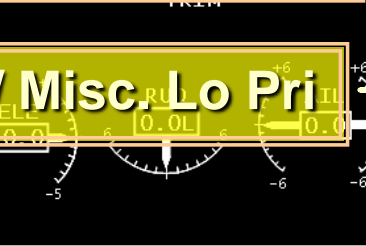
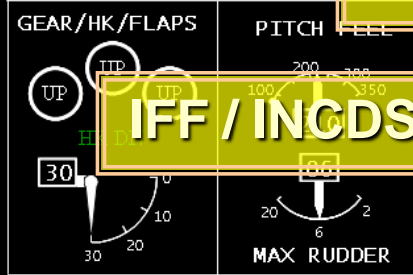
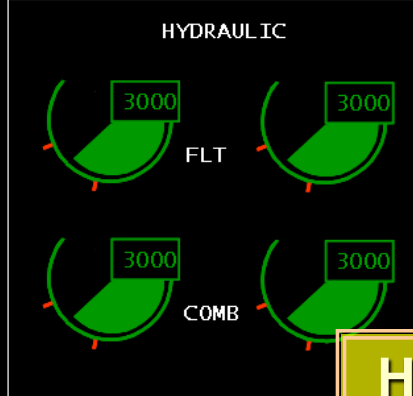
Misc Hi Pri



Bleed Air



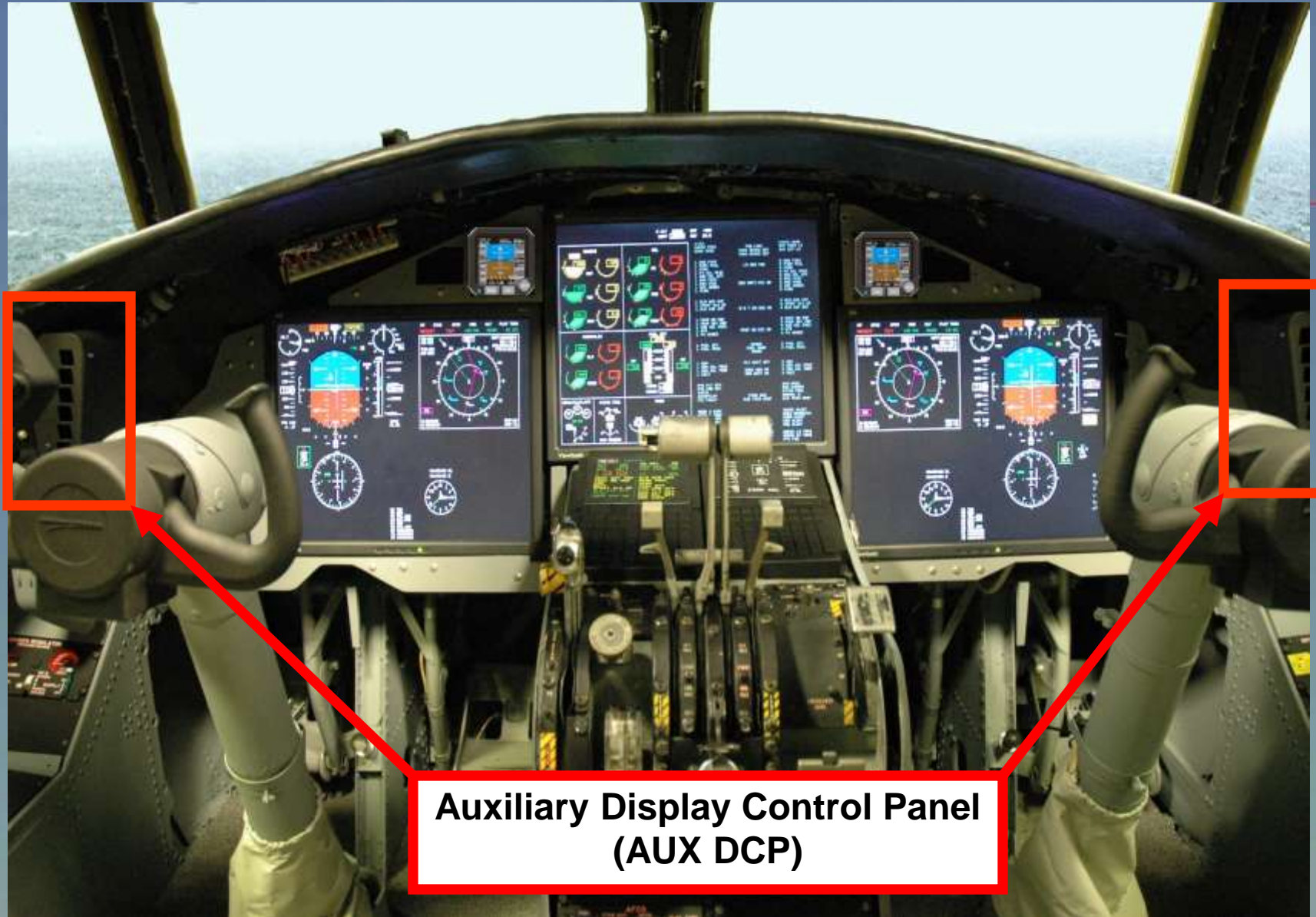
Hyd. / Autopilot



- STALL
- CABIN PRES
- DOOR OPEN
- AIRSPACE *
- TOW LINK
- PARK BRAKE SET
- PARK BRAKE SET
- CHECK GEAR
- OXY PRES LO
- OXY QTY LO
- L ENG FIRE
- L PCMU FAIL
- L PCMU *
- L PS OIL PRES
- L ENG OIL QTY
- L ENG CHIP *
- L ENG VIBE *
- L APR ARMED
- L PCMU *
- LO ENG PWR
- R ENG FIRE
- R PCMU FAIL
- R PCMU *
- R PS OIL PRES
- R ENG OIL QTY
- R ENG CHIP *
- R ENG VIBE *
- R APR ARMED
- R PCMU *
- L BLD AIR HOT
- L START VLV OP
- L BLD AIR OFF
- W & T DE-ICE ON
- R BLD AIR HOT
- R START VLV OP
- R BLD AIR OFF
- L PROP MN PMP
- L PROP SBY PMP
- L RGB OIL PRES
- L NTS
- L FX ARMED
- PROP DE-ICE ON
- R PROP MN PMP
- R PROP SBY PMP
- R RGB OIL PRES
- R NTS
- R FX ARMED
- L FUEL QTY
- L FUEL PRES
- BINGO
- FUEL DUMP
- JOKER
- R FUEL QTY
- R FUEL PRES
- L GEN
- L GEN OIL PRES
- L GEN OIL TEMP
- L RECT
- FLT BATT OFF
- EMER GEN ON
- GND BATT ON
- R GEN
- R GEN OIL PRES
- R GEN OIL TEMP
- R RECT
- HYD FLT QTY
- HYD CMB QTY
- SAFCS
- AUTOPILOT
- FCC FAULT
- STAB AUG
- RUD TRIM INOP
- HYD PRES *
- MAX RUDDER
- PITCH FEEL
- MANUAL Q
- ELE TRIM INOP
- MODE 4 INOP
- MODE 5 INOP
- MODE 4 REPLY
- MODE 5 REPLY
- MODE S
- AIRSPACE *
- RDR/GEAR OVRD
- VAPOR CYCLE
- IFF LOOP TEST
- GPWS VOICE OFF
- CDU CAUTION *
- AFMC MISCOMPARE *
- BARO MISMATCH
- COMM ALERT *
- CDU ADVISORY *

Too Much of a Good Thing

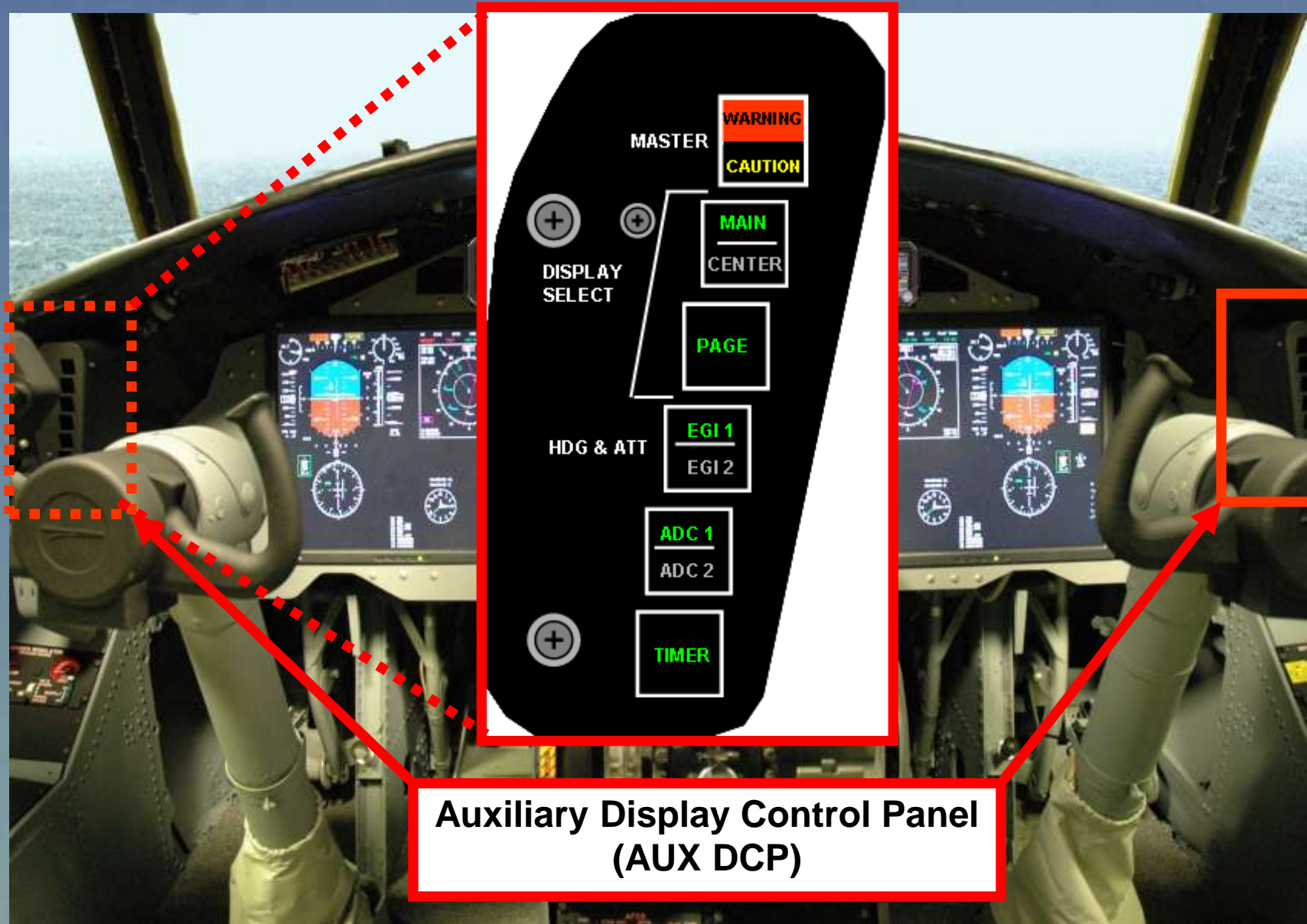
A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT



**Auxiliary Display Control Panel
(AUX DCP)**

Too Much of a Good Thing

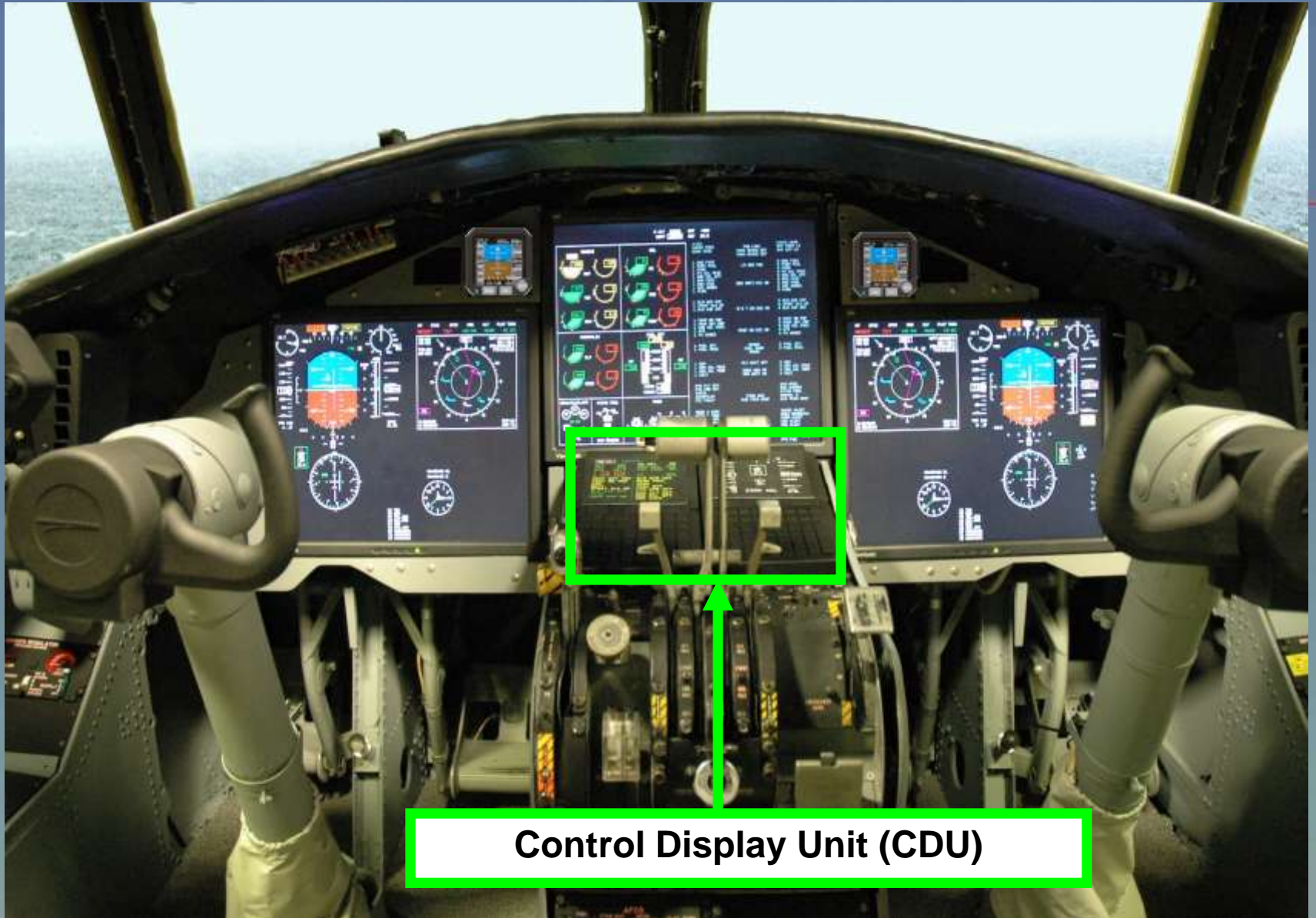
A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT



Auxiliary Display Control Panel (AUX DCP)

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A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT



Control Display Unit (CDU)

C ALT 00000 OAT -000C
DIFF -00000

Annunciation with an asterisk (*) after the ACAW requires aircrew to use CDU for specific information

STALL
CABIN PRES
DOOR OPEN

AIRSPACE *
TOW LINK
PARK BRAKE SET
PARK BRAKE SET

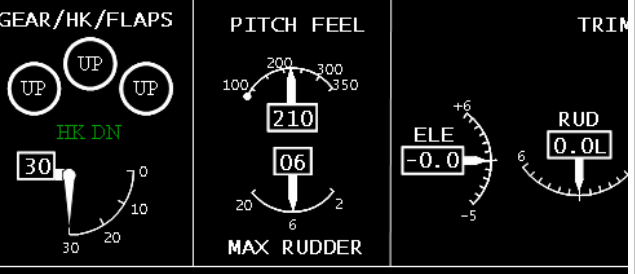
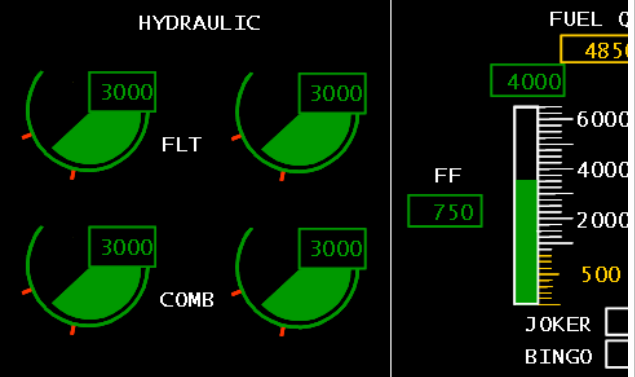
CHECK GEAR
OXY PRES LO
OXY QTY LO

L ENG FIRE
L PCMU FAIL
L PCMU *
L PS OIL PRES
L ENG OIL QTY
L ENG CHIP *
L ENG VIBE *
L APR ARMED
L PCMU *

LO ENG PWR

ENG ANTI-ICE ON

R ENG FIRE
R PCMU FAIL
R PCMU *
R PS OIL PRES
R ENG OIL QTY
R ENG CHIP *
R ENG VIBE *
R APR ARMED
R PCMU *



CURRENT ACAWS 1/1
HISTORY >

L ENG FIRE
XXXXXXXXXXXXXXXXXXXX
L RGB CHIP
XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXX
L BLD AIR OFF
XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXX

Too Much of a Good Thing
A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

Ground & Flight Test Results



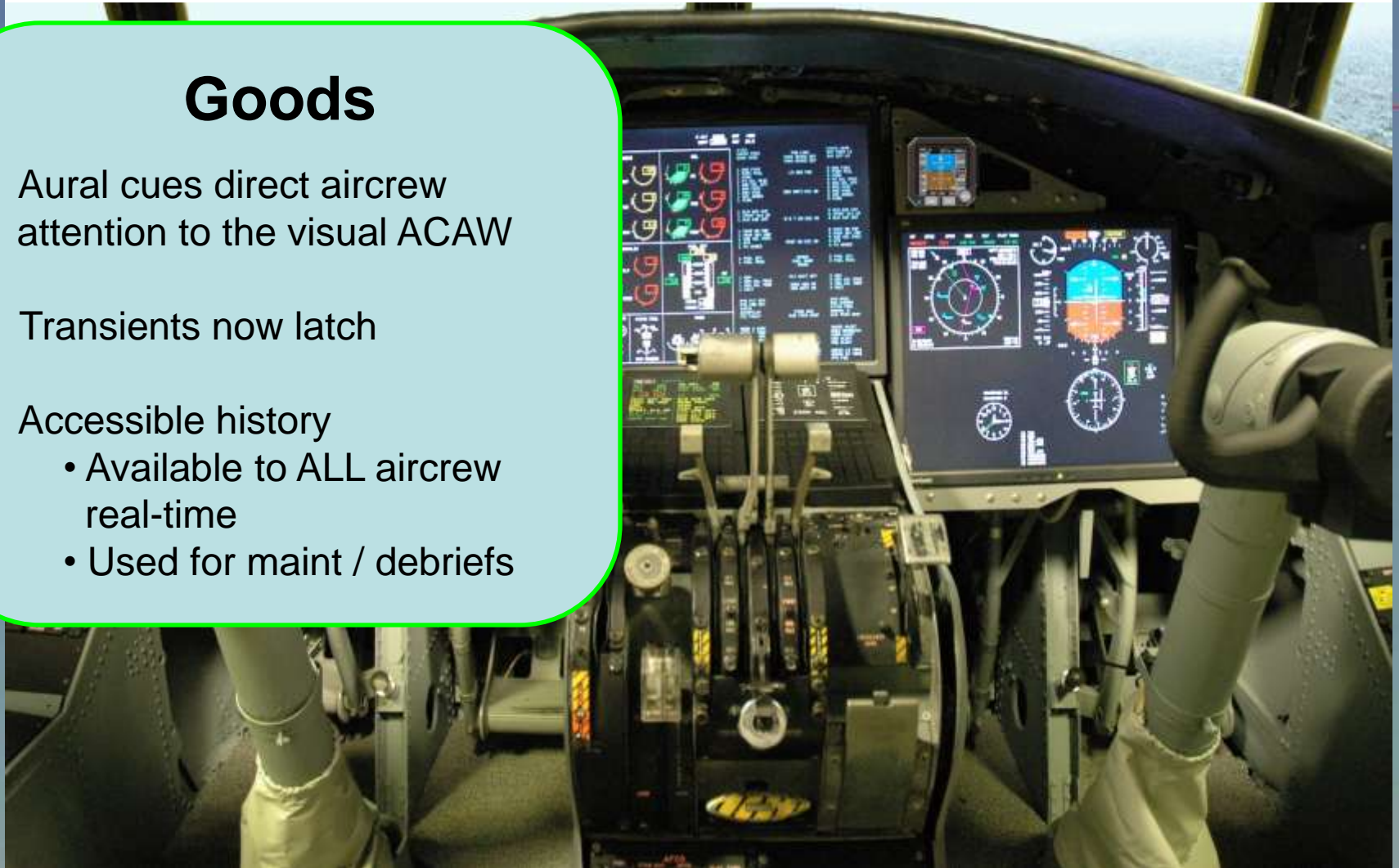
Too Much of a Good Thing

A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

Ground & Flight Test Results

Goods

- Aural cues direct aircrew attention to the visual ACAW
- Transients now latch
- Accessible history
 - Available to ALL aircrew real-time
 - Used for maint / debriefs



Ground & Flight Test Results

Others

ACAWS:

- Functioned as intended
OR
- Erroneous = Wrong or inaccurate
- Nuisance = Annoying, Unpleasant
- Excessive = Erroneous + Nuisance

- Excessive ACAWS observed from start of ground testing
 - *Contributed to RTB during 1st flight*

- Situational Awareness and Workload correlation



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A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

Ground & Flight Test Results

Flight Test Specific Impacts



Telemetry Station

- Loss of SA
- Reduced effectiveness of communications

Test Efficiency

- Delayed start of test point
- Inadvertent KIOs
- Unplanned RTBs (10+)

Ground & Flight Test Results

Aircrew Safety Impact



Annoying

Distracting

Disrupting

Desensitizing

Ground & Flight Test Results

Aircrew Safety Impact

Annoying

Distracting

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Desensitizing

Ground & Flight Test Results

Aircrew Safety Impact

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Aircrew Safety Impact

Annoying
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Disrupting
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Ground & Flight Test Results

Aircrew Safety Impact

Annoying

Distracting

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Desensitizing

Too Much of a Good Thing

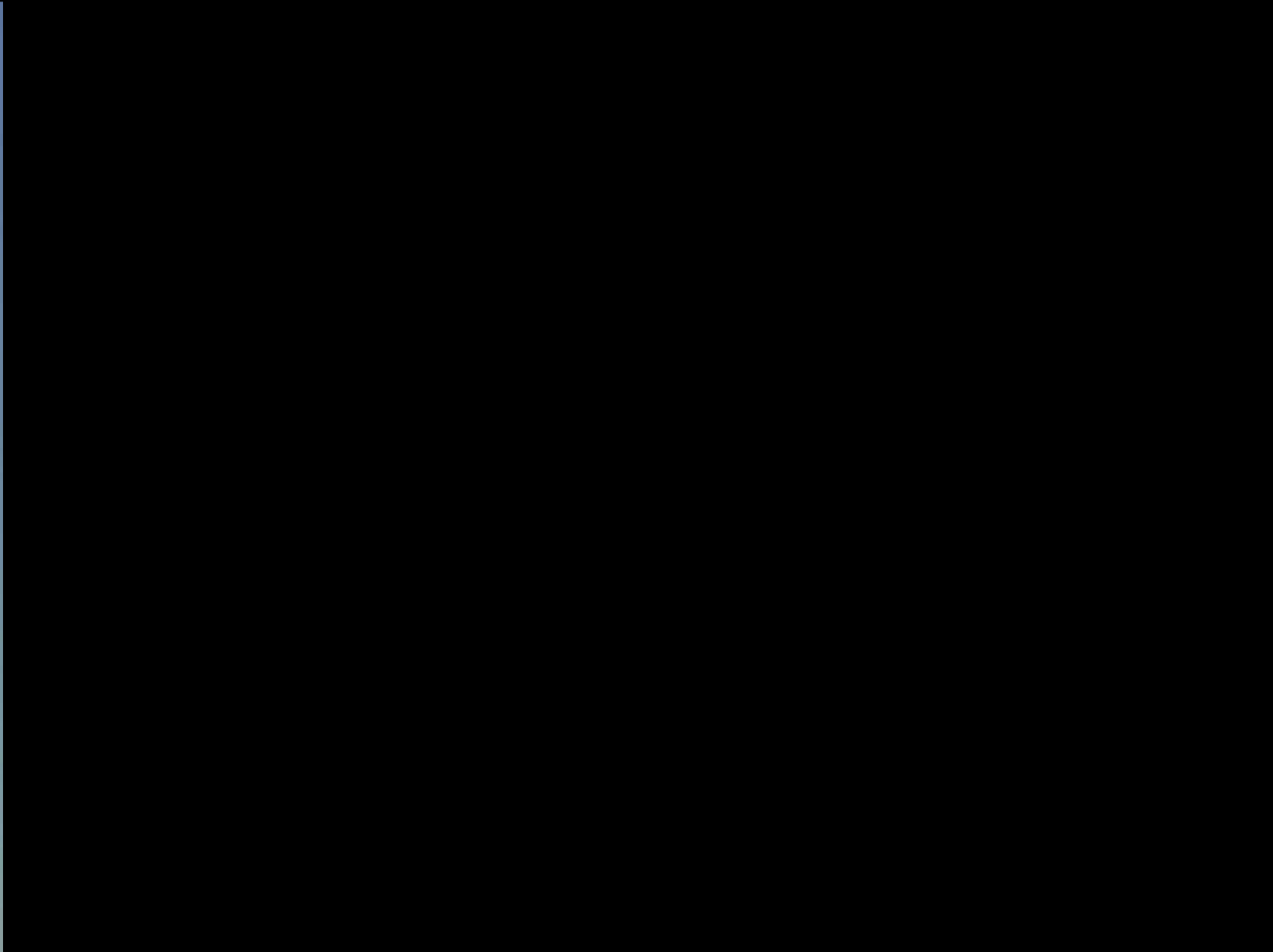
A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

Flight Test Footage



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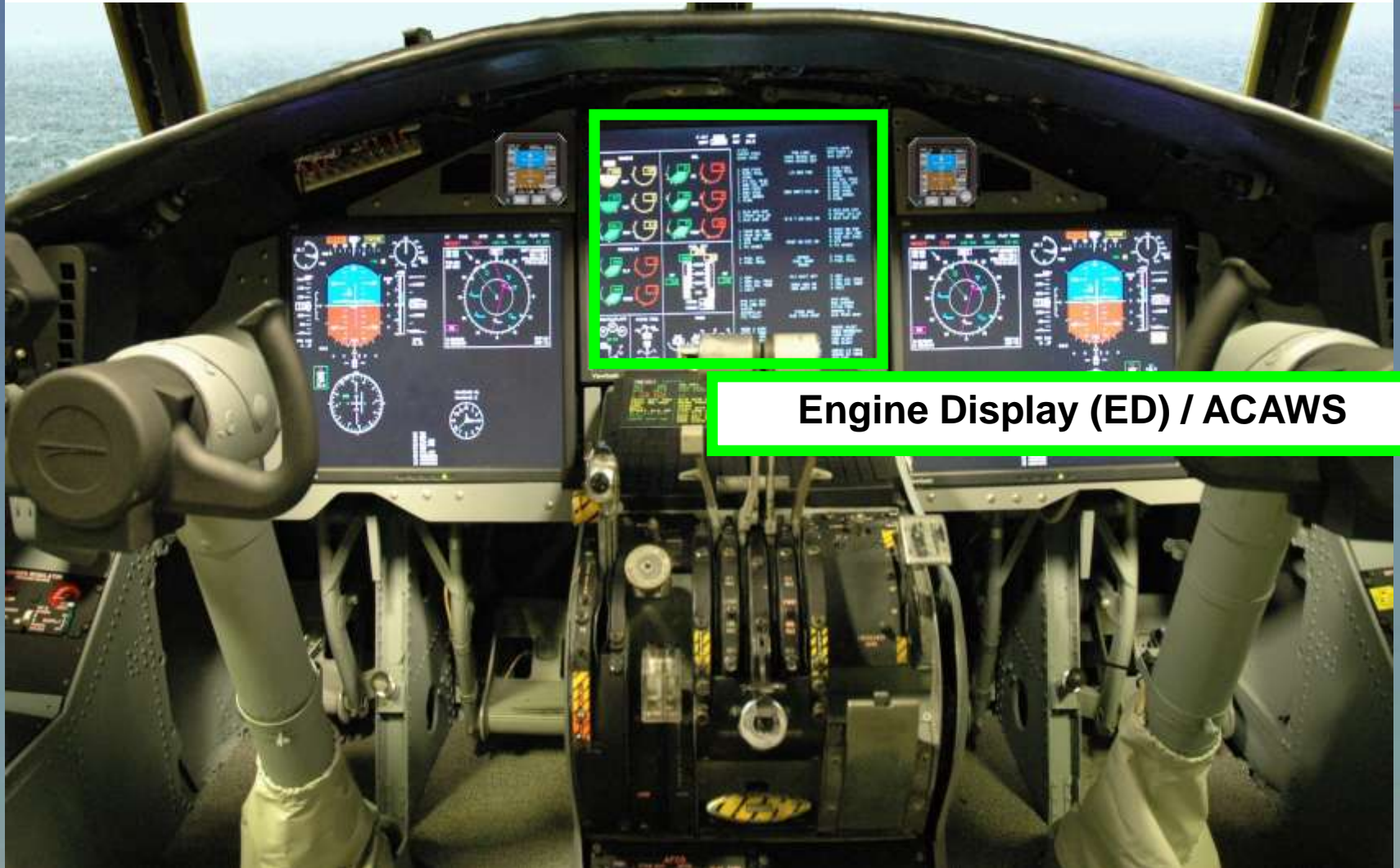
A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT



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A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

Negative-G: Desensitized



Engine Display (ED) / ACAWS

Too Much of a Good Thing

A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT



Too Much of a Good Thing

A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

MISSION IMPACT

Excessive nuisance ACAW indications will **distract** pilots from controlling the aircraft during high workload tasks, such as night carrier landings, and **desensitize** the aircrew from providing immediate response to actual critical alerts, or may cause unnecessary actions to be taken, resulting in potential loss of the aircraft and aircrew.

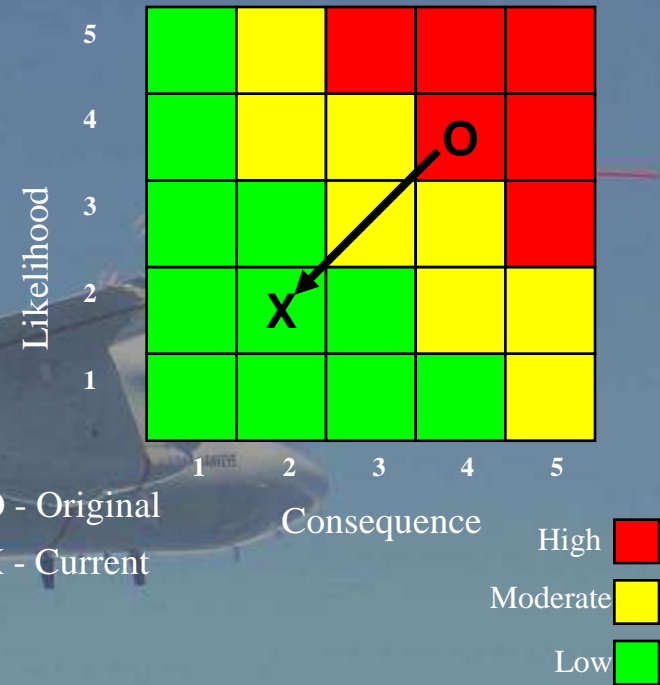


Risk Mitigation

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A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

Risk Mitigation



- Thorough briefs / debriefs
- TM station backing up aircrew
- Aircrew read board
- Good old fashioned information sharing in aircrew cubicle spaces
- Kneeboard cards (KBC)

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A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

E-2D Flight Test ACAWS

COMPLETELY IGNORE

FUEL FILT IMP BYP
FUEL FILT BYP
PWR LEVER FAIL
HP LMT FAIL
TMT LMT FAIL
COND LEVER FAIL

PMA FAIL
PLT PFD
CPLT PFD
CTR PFD
PROP PITCH FAIL
PROP SYNC FAIL

PCMU POWERUP ANOMALIES

PCMU FAIL

Indicates both channels powered up unhealthy.
Power cycle PCMU until ACAW doesn't illuminate

FF CTL DGRD
ENG CTL DGRD
CHAN FAIL

If one channel is unhealthy after PCMU powerup, these ACAWS may be illuminated to indicate speed or torque faults. Fault Reset (3x) during start will clear the speed or torque faults.

FF CTL DGRD
ENG CTL DGRD

The illumination of both may indicate a MV fault that the PCMU Fault Reset switch can probably clear.

CONTINGENT ACAWS

PROP BETA LIGHT

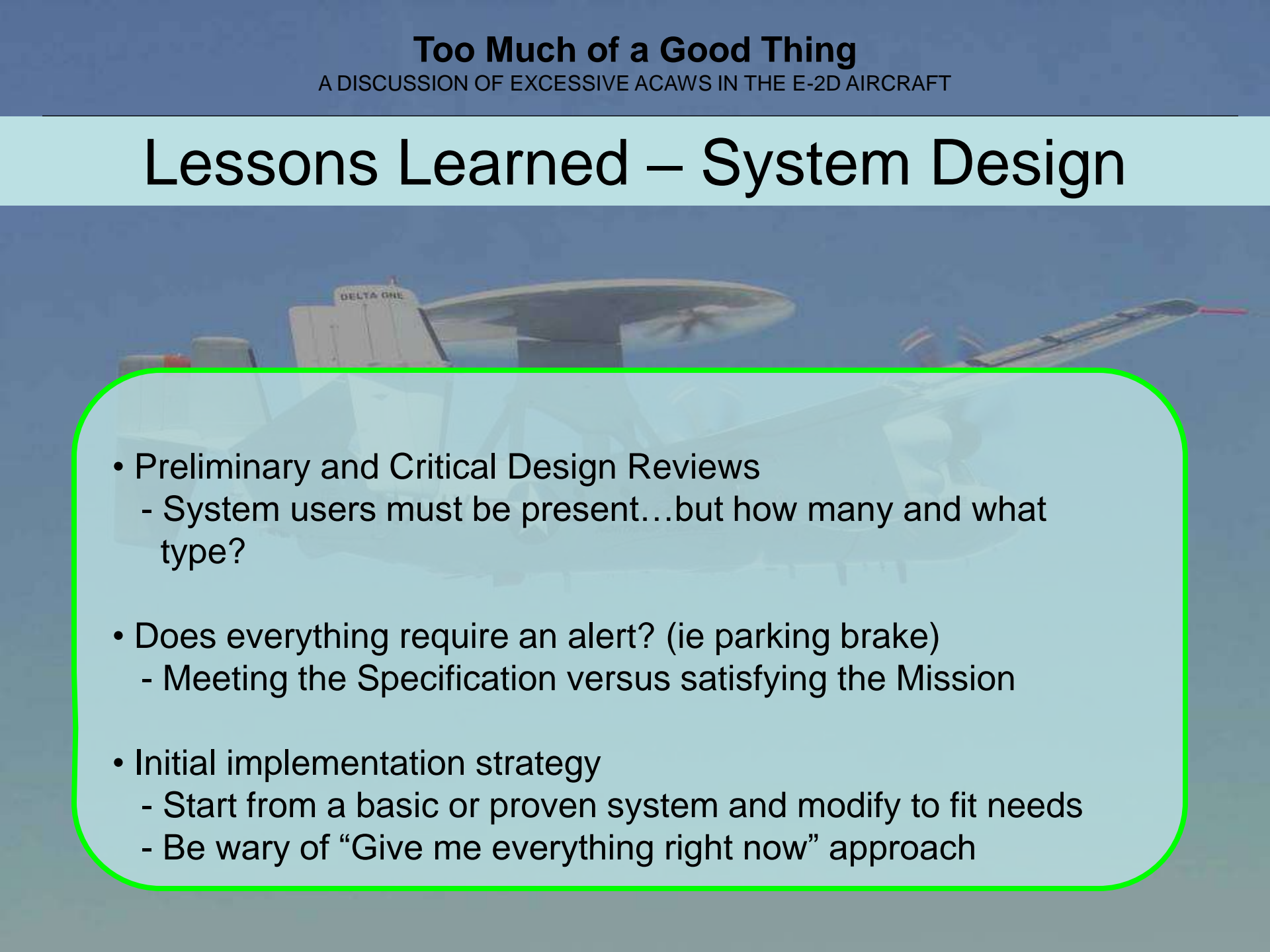
Ignore during engine start and when using reverse. Channel health change will require a Fault Reset. Steady illumination should be regarded as an actual failure of the Beta Light.

- Thorough briefs
- TM station back
- Aircrew read bo
- Good old fashion
- in aircrew cubic
- Kneeboard cards

Lessons Learned



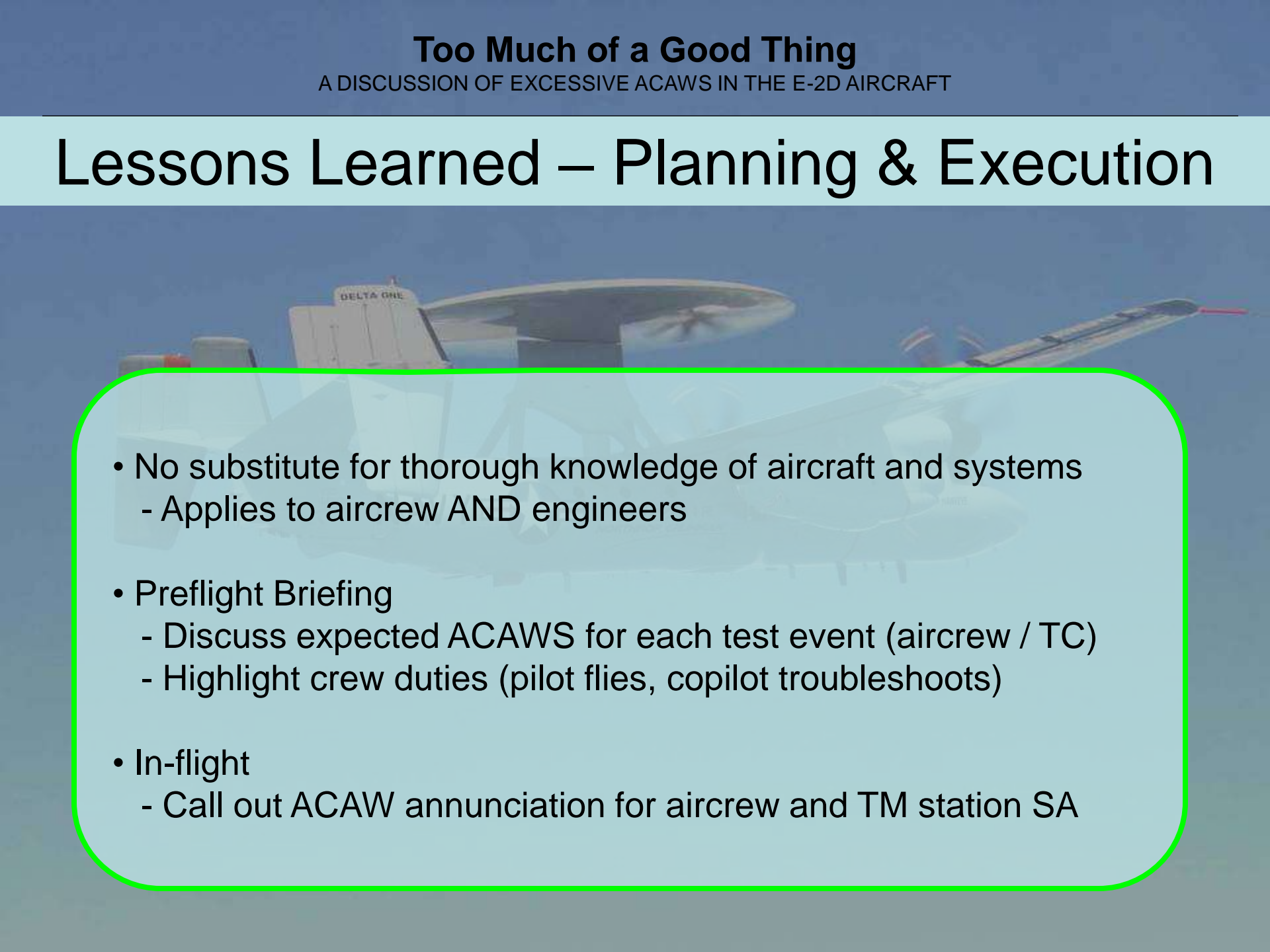
Lessons Learned – System Design

- 
- Preliminary and Critical Design Reviews
 - System users must be present...but how many and what type?
 - Does everything require an alert? (ie parking brake)
 - Meeting the Specification versus satisfying the Mission
 - Initial implementation strategy
 - Start from a basic or proven system and modify to fit needs
 - Be wary of “Give me everything right now” approach

Too Much of a Good Thing

A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

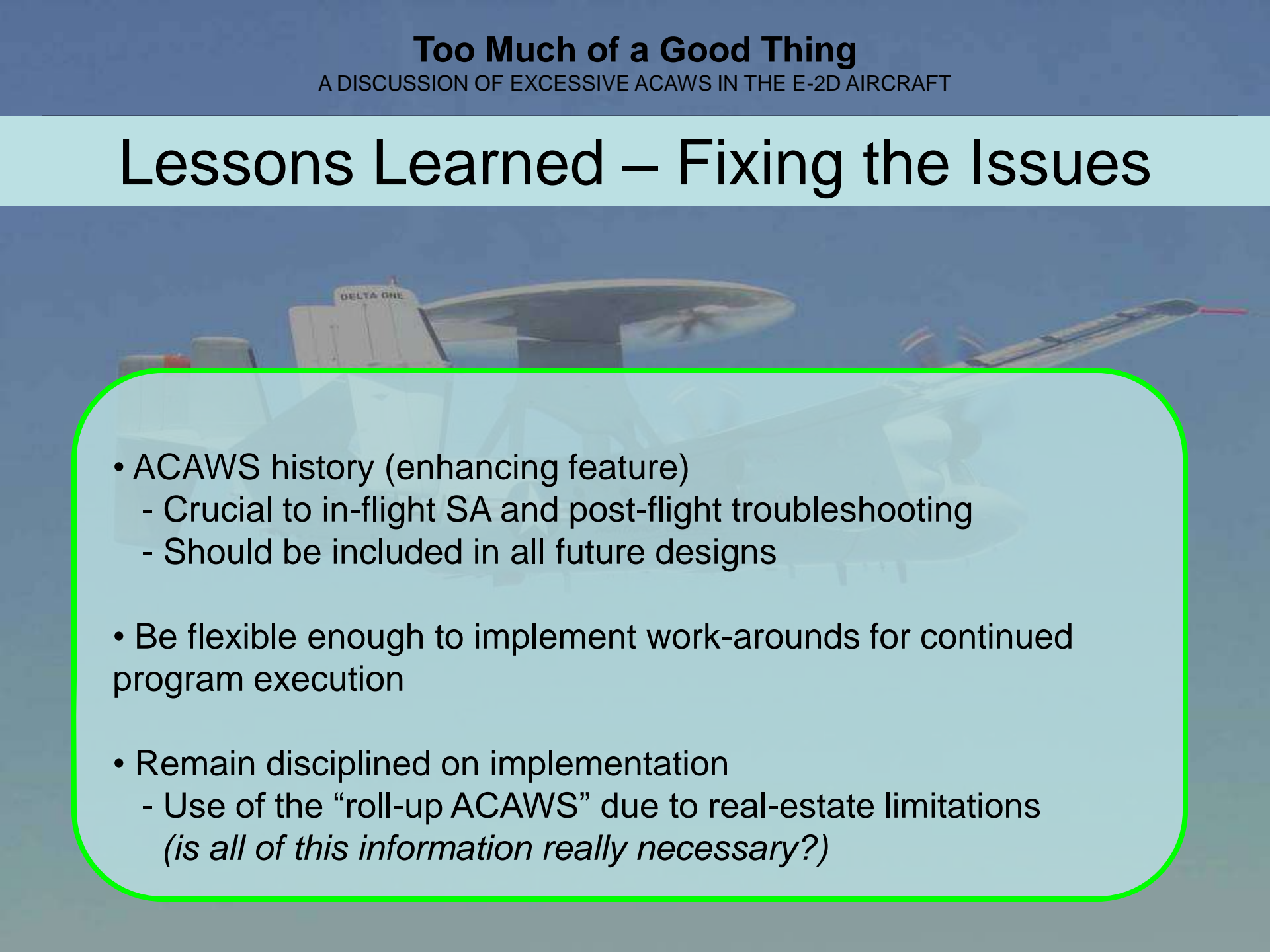
Lessons Learned – Planning & Execution

- 
- No substitute for thorough knowledge of aircraft and systems
 - Applies to aircrew AND engineers
 - Preflight Briefing
 - Discuss expected ACAWS for each test event (aircrew / TC)
 - Highlight crew duties (pilot flies, copilot troubleshoots)
 - In-flight
 - Call out ACAW annunciation for aircrew and TM station SA

Too Much of a Good Thing

A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

Lessons Learned – Fixing the Issues

- 
- ACAWS history (enhancing feature)
 - Crucial to in-flight SA and post-flight troubleshooting
 - Should be included in all future designs
 - Be flexible enough to implement work-arounds for continued program execution
 - Remain disciplined on implementation
 - Use of the “roll-up ACAWS” due to real-estate limitations
(is all of this information really necessary?)

Too Much of a Good Thing

A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT

BOTTOM LINE

Challenges will exist, but proper up-front planning, risk mitigation, and good team communication can lead to safe accomplishment of test objectives...

...even through “Deedles”



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A DISCUSSION OF EXCESSIVE ACAWS IN THE E-2D AIRCRAFT



Questions ?



Pilot: “And tower, do you have the current winds?”

Tower: “Yes I do...do you want them?”

Pilot: “Sure...”

Tower: “Winds are <deedle, deedle, deedle>” – short pause –

Pilot: “And tower, can you say again? One of my ‘deedles’ in the cockpit stepped on you.”