

NASA DC-8 DUAL ENGINE FLAMEOUT – CLOSE CALL (MIG-11951)



CRM CASE STUDY

MATT BERRY – THE INDIVIDUAL

- **Born:** [REDACTED]
- **From :** New Mexico
“The Land of Enchantment”
- **Highlights**
 - International Space Hall of Fame – Home of Ham the Monkey
 - The world's first AstroChimp, and the first free creature in outer space
 - Ham's body was shipped west, and is buried in the front lawn of the International Space Hall of Fame in Alamogordo, NM, under the first slab of natural-tone concrete poured in Otero County.
 - White Sands National Monument
 - Hatch Green chile
- **College:** New Mexico State University **Born**
- **Degree:** Bachelor of Science in Electrical Engineering
- **Master's Degree in Electrical Engineering** **Raised**
 - Electromagnetics - Antennas
 - Direction Finding Systems

MATT BERRY— THE PROFESSIONAL

NASA
Autonomous L
Field
Real-T



Field Test Site (Dry



NASA



QUESTION POLICY



“I don’t care if you don’t know, but you have to know what you don’t know” - unknown

OVERVIEW

- Objectives
- Critical Skills Review
- Case Study Focus Skill
- Synopsis
- Focus Questions

OBJECTIVES

- Terminal Objective
 - Upon completion of this case study the aircrew will understand the importance of Mission Analysis in aircraft operations.
- Enabling Objective
 - Understand the need to identify the potential threats during all phases of a mission.
 - Recognize that even with the most thorough and thought out plan there is always something which may have been missed.

CREW RESOURCE MANAGEMENT

- Allows a crew to interact effectively while performing mission tasks
- A program to effect behavior modifications in order to prevent human factor and crew preventable errors
- To improve mission effectiveness through increased awareness of associated behavioral skills
- *The process of transforming a group into an effective team by mastering the basic set of key skills which when utilized together can greatly reduce the human factor and crew preventable errors.*

“A team is not a group of people who work together. A team is a group of people who trust each other.”

Simon Sinek

CRM CRITICAL SKILLS REVIEW

- Decision Making (DM)
- Assertiveness (AS)
- **Mission Analysis (MA)**
- Communication (CM)
- Leadership (LD)
- Adaptability/Flexibility (AF)
- Situational Awareness (SA)

CASE STUDY FOCUS SKILL

MISSION ANALYSIS

- The ability to make short-term, long-term, and contingency plans and to coordinate, allocate, and monitor crew and aircraft resources

MISSION ANALYSIS INCLUDES

- Organizing and planning for what will occur during the mission
- Monitoring the current situation
- Reviewing and providing feedback on what has occurred

THREE STAGES OF MISSION ANALYSIS

- Pre-mission organizing and planning
- In-flight monitoring and updating
- Post-mission review

PRE-MISSION ANALYSIS

- Establishes mission requirements and constraints
- Specifies both long and short term plans
- Advises the crew of what to expect

IN-FLIGHT ANALYSIS

- Critiques and updates existing plans
- Evaluates results of previous decisions
- Informs the crew of changes to flight concept

POST-MISSION ANALYSIS

- Critiques entire mission
- Determines areas of future improvement

PROJECT OVERVIEW – ACCESS II FLIGHT CAMPAIGN



<https://www.nasa.gov/aero/access-II.html>



Variable	DC-8	HU-25C	Falcon 20	T-33
Overall Length	187 ft	56 ft	56 ft	38 ft
Wingspan	148 ft	53 ft	53 ft	42 ft
Max Landing Wt	275,000 lb	32,000 lbs	28,880 lbs	
Max Gross Wt	355,000 lb	32,000 lbs	30,325 lbs	16,800 lbs
Powerplants	(4) CFM56-2B	(2) Garrett ATF-3-2C	(2) Garrett TFE 731-5BR-2C	RR Nene 10 turbojet
Cruise	0.8 mach	0.65 mach	0.72 mach	0.8 mach
Range	7,000 mi	2,080 mi	2,080 mi	1,275 mi

ACRONYMNS

- NASA – National Aeronautics and Space Administration
- ACCESS I/II – Alternative fuel Effects on Contrails and Cruise Emissions
- MD – Mission Director
- OE – Operations Engineer
- FE – Flight Engineer
- OM – Operations Mechanic
- OA – Operations Avionics
- HEFA – Hydrolyzed Ester Fatty Acids)

SYNOPSIS

PRE-MISSION

- DC-8 was Emissions Source Aircraft for 3 previous campaigns in 2009, 2011 and 2013 (ACCESS I).
- 2013 Campaign included Independent Review Team (IRT) and Tech Brief (TB) prior to issuance of Flight Release
 - Project identifies Engine Flameout as a potential hazard
- 2014 ACCESS II Campaign also had IRT with primary focus on the changes from the 2013 ACCESS I Campaign
 - Update to Mission Rules Document
 - **No Update to Fuel Loading Checklist**
 - **Update to Fuel Switching Checklist**
 - Update to Communications Plan
 - Update to Flight Cards

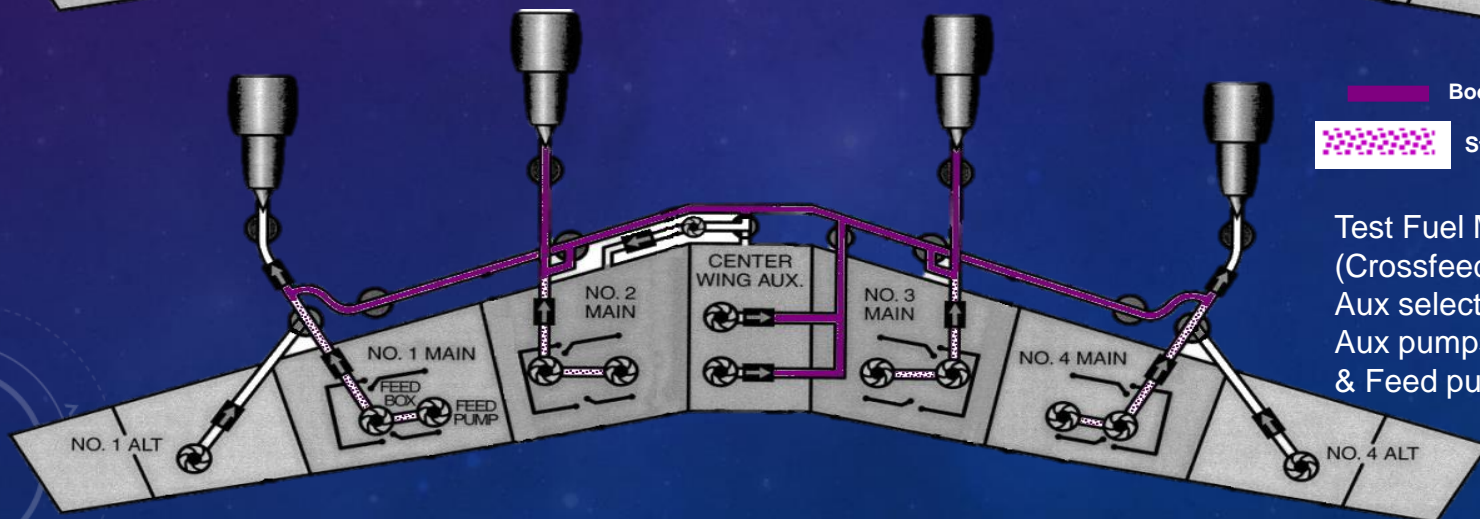
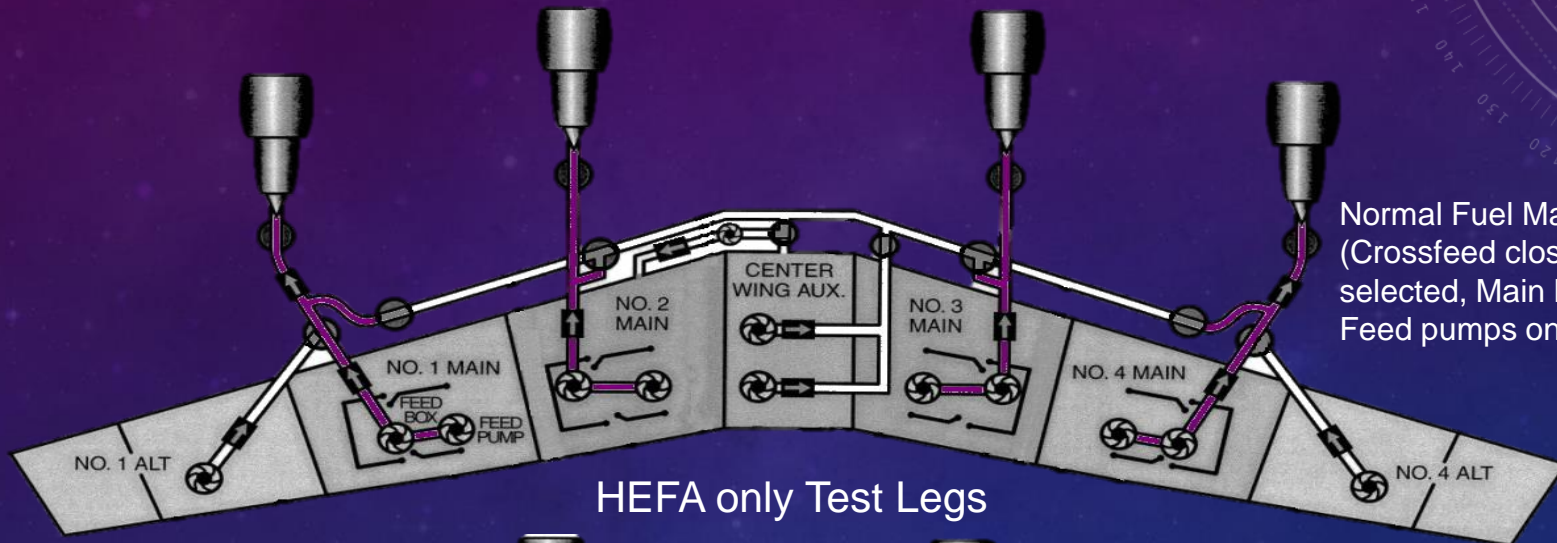
SYNOPSIS

PRE-MISSION

- 2014 ACCESS II incorporated lessons learned from ACCESS I
 - Peculiarities in the DC-8 fuel system led to slow contamination of the JP-8 fuel with blend
 - Boost Pumps for Center Wing Aux Tank are physically located in No.3 Main Tank and not the CW Aux Tank
 - HEFA only loaded in Center Wing Tank
 - 1st test point was always JET A to all engines and 2nd was always HEFA to all engines via Crossfeed Manifold
 - Engine flameout hazard updated as a result of boost pump #3 being off during climbs above 10kft.
- Oct 2013-Mar 2014 – DC8 in Roswell, NM for Heavy Maintenance Visit
 - Aircraft repainted

DC-8 TANK CONFIGURATION

Taxi, Takeoff, Climb, Turn, Downwind Cruise, Descent, Landing



 Boost Pump Pressure
 Static Line Pressure

Test Fuel Management
(Crossfeed open, Center Aux selected, both Center Aux pumps on, Main boost & Feed pumps off)

MAY 12 2014

- NASA 817, DC-8-72 SERIES, AFRC
- AIRBORNE SCIENCE PROGRAM
- ACCESS II CAMPAIGN
 - HEFA FUEL SUITABILITY
- SORTIE #5 OF 6 PLANNED; DC-8 FLEW 9 TOTAL
- CREW –
 - AIRCREW
 - **PROJECT PILOT (PIC)**
 - **CO PILOT**
 - **FE – Most experience in DC8; actually was part of certifying the production aircraft; over 20 yrs in type. 1st Mission with NASA DC8**
 - **MD/FTE – Also OE for platforms; Lead and a CO-OP**
 - **MAINTENANCE**
 - **Crew Chief**
 - **Operations Inspector – most experienced with a/c (1999); respected as A/C SME**
 - **4 OM/2 OA – group of very high performing AFRC members; known for “can-do” attitudes**

SYNOPSIS – DOF

- Fuel
 - High sulfur Jet-A in main tanks
 - HEFA in the center aux
- Ground Operations
 - **Samples for science taken from Crossfeed manifold pre-flight**
 - **No Crossfeed sampling had occurred pre-flight in ACCESS I**
 - CC noticed “premature ceasing” of the fuel draining and realized they were draining from the Forward Aux Tank fill manifold and not the Crossfeed manifold
 - **Drained approximately 3 gallons of fuel from the Crossfeed Manifold prior to flight for sampling**
 - **CC informs aircrew and OE about sampling incorrect manifold**
 - **Pressed on with remaining aircrew pre-flight checks which included verification of the boost pumps for all 4 main tanks and Center Wing Tanks**

SYNOPSIS – IN-FLIGHT

- Took off time @1655Z, CT-133 Took off @ 1653Z
- Climb out to FL350 and conduct first test point; JETA to all four engines
- Flight Card 15, Step 9
 - FL349,0.54 MI, 180 KIAS
- Switch to Flight Card 20 for the Fuel Switching Checklist
 - HEFA BLEND FUEL SWITCHING CHECKLIST
 1. Igniters - ON
 2. Center Wing Pumps - ON
 3. Center Aux Tank Selector - DOWN
 4. Crossfeeds - OPEN
 5. Configure Fuel Output IAW Run Table
 - a. Main Boost Pump – OFF
 - i. Wait 10 to 15 Seconds
 - b. Proper Fuel Flow and Fuel Pressure – CONFIRM
 - c. Repeat as Necessary

SYNOPSIS – IN-FLIGHT

- Engines 2 and 3 already burning HEFA from Center AUX via Crossfeed Manifold, Burning stable
- **Switched number 4 then number 1 to run via Crossfeed Manifold – Valves from main tank 1 / 4 to engine 1 / 4 always open.**
 - Fuel pressure fluctuated significantly
 - Fuel flow decreased
 - Engine flameout as a result
- **Returned to run via main tank to engine IAW engine flameout procedure**
 - Engine 4 restarted while wind milling
 - Engine 1 failed to restart even after assisted start.
- **Aircrew were all cool calm and collected during the event; called RTB as they were uncertain of cause being related to the HEFA fuel**

SYNOPSIS – POST-MISSION

- 2 Weeks of stand down while we incident was reviewed.
- Formal conversation with Boeing and GE engineers led to FACT SHEET UPDATES
 - Fuel Tank Boost pumps only designed to feed 2 engines simultaneously
 - Engine restart above 20kFT is not reliable
 - A unique bend in crossfeed manifold section leading to engine #1 restricts fuel flow to engine #1
- Obtained a more accurate depiction of A/C fuel system
- Fuel system checklist was updated to reflect additional time for verification boost pumps were primed from 15 seconds to 5 minutes.
- Ultimately – Due to taking sample from the Crossfeed manifold, air was introduced into the system unknowingly causing the respective fuel pump to cavitate when feeding from center wing auxiliary tank to all four engines.

MISSION EFFECTIVENESS



Incident/Accident

TEM is what we do...

...CRM is how we do it

CRM 7 Critical Skills

Decision Making

Assertiveness

Mission Analysis

Communication

Leadership

Adaptability / Flexibility

Situational Awareness

FOCUS QUESTION #1

- What THREATS came “at” the crew and what Strategies were used to Prepare for Threats and initially deal with them?

Strategies to Prepare:

- CRM
- ORM
- TEM
- Clearly defined roles of aircrew members
- Complete briefing and effective communication
- System Knowledge

Identify and PREPARE

Focus Question #2

- What ERRORS came “from” the crew and how did they use MA to Repair the Errors?



Errors: Crew action or inaction that leads to deviations from expectations, reduces safety margins, and may occur from either mismanaged threats or mistakes.

Identify and Repair

FOCUS QUESTION #3

- What Undesired Aircraft State was achieved and how did the crew Recover?



Undesired Aircraft State: A position, speed, attitude, condition, or configuration of an aircraft that reduces safety margins.

Identify and RECOVER

REMEMBER

- Mission analysis is a crew effort – how well you coordinate actions can make a difference
- Each stage of mission analysis has an impact on the overall mission.
- Failure to develop a good plan, or to revise a plan when the situation changes, can result in a failed mission or a mishap

QUESTIONS?

