



21st Century Aerial Firefighting Capabilities for the Hercules

Applying Lockheed Martin Technologies to
Improve Wildfire Containment Effectiveness

Richard Cree – Advanced Development Programs



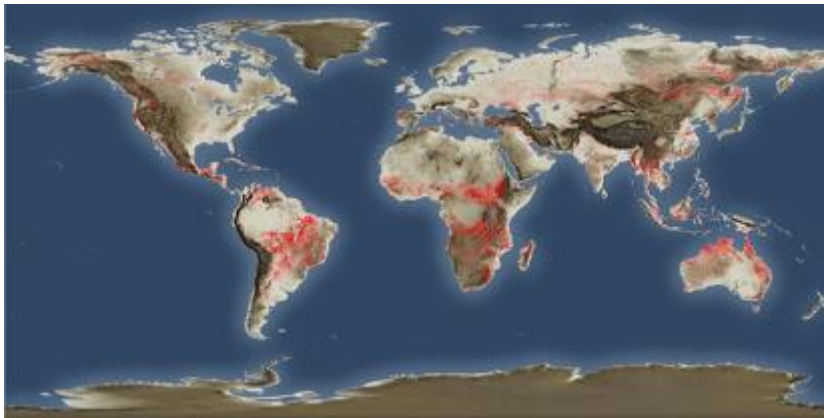
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Operational Need

Increased Wildfire Activity Impacts

- Population Growth into what were once uninhabited wildland areas
- Past Forestry Management Policies have allowed an increased build-up of Fuels
- Large wildfires affect citizens and infrastructure annually worldwide with high cost



Wildfire Impact 1995-2010 Graphic – European Space Agency



Impact in the United States

- Each year, an average of approximately 73,000 wildfires burn about 7 million acres of land.
- Agriculture, Cattle & Structures – over \$5 billion in economic loss
- Over 2,000 homes and Structures lost
- Wildfire fighting/suppression costs approximately \$1 million per day

Wildfires are a Global issue that Impact All Nations Directly or Indirectly

Definition of Terms

Direct Attack

- Dropping Water or Fire Retardant directly on the Flames to extinguish the Fire.
- Typically only effective on smaller fires – larger fires too intense for this technique to be effective
- Used frequently to protect structures and infrastructure that are in danger



Indirect Attack

- Technique of laying down a line of Fire Retardant in front of the direction of Fire Movement
- Retardant coats fuels on ground to stop the ability of the fire to progress
- Assists Ground Crews in ultimately Containing and Extinguishing Wildfires



Coverage Level (CL) – Number of US Gallons of fluid evenly applied across 100 square foot area

Definition of Terms



Pressurized Drop Systems

- Uses Air Pressure to ‘push’ the Retardant out of the aircraft via a Control Nozzle
- Requires additional support Air Compressor Support Equipment (either on the ground or onboard the aircraft)
- Typically more narrow Ground Coverage Lines
- Limited Coverage Levels
- Typically Indirect Attack Only



Gravity Drop Systems

- Less Complex with Drop Doors and Gravity pulling the Retardant out of the aircraft downward
- Minimal Ground Support Required
- Lighter Empty Weight enables higher capacity
- Best and more consistent Ground Coverage Lines
- More effective and provides higher Coverage Levels
- Able to perform Direct and Indirect Attack effectively

Choice of System is Dependent on Operator Needs

Requirements for Effective Aerial Firefighting

- Safe Operations are paramount!
- Controlled maneuverability in degraded conditions
 - Low altitude/low airspeeds
 - At near maximum operating weight
 - Typically hot environment with shifting winds
- High lift and ruggedized wing structure
- Immediate rapid power response
 - Turboprop ideal – turbofans lag
- Large payload capacity per sortie (3000 US gallons)
- Controllable/consistent drop capability
 - To deliver best suppression for conditions
 - Certified to recognized standards
- Endurance to reduce ground time for refueling

The most effective drops are conducted at:

- 200-150 feet above terrain
- 120 knots IAS
- Enables retardant or water to fall vertically and without disbanding from wind shear



The Hercules Checks All The Boxes

Why Herc Is Superior

- C-130 Aerial firefighting capacity:
 - Up to 4,000 US gallon capacity per sortie
 - Larger capacity than most other widely used airtanker options
 - AT-802 (800 gallons), Dash 8-400MRE (2450 gallons), CL-515 (1621 gallons)
 - More capacity equals longer drop lengths or more effective split load ability
 - Flexible support - Direct Attack or Indirect Attack Capable
 - Non-Swept High Lift Wing for outstanding low airspeed/low altitude controlled maneuverability
- Most versatile option for aircraft utilization
 - The C-130 retains basic airlifter capabilities when not configured for aerial firefighting
 - Full mission capable after drop system removal

The C-130 as an Aerial Firefighter offers the most overall flexibility

C-130 Aerial Firefighting System Options



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MAFFS II – United Aeronautical

- Roll On/Roll Off System
- Minimal Aircraft Mod – Electrical Panel/Software
- 3000 gallon capacity – Pressurized Discharge
- Operated on US Air Force C-130J-30/C-130H
 - Eight systems in the United States
- Also has been delivered to two International C-130H/J operators

RADS-XXL – Coulson

- Semi-Roll On/Roll Off System
- Major Aircraft Mod to Cargo Underfloor
- 4000+ gallon capacity – Gravity Drop
- Installed on Commercially-operated C-130H/Q/382Gs
- Five systems installed with seven more pending
- Simplest & Best Performance

Note: Neither system are currently LM Aero certified

Current Ops



MAFFS II

RADS-XL

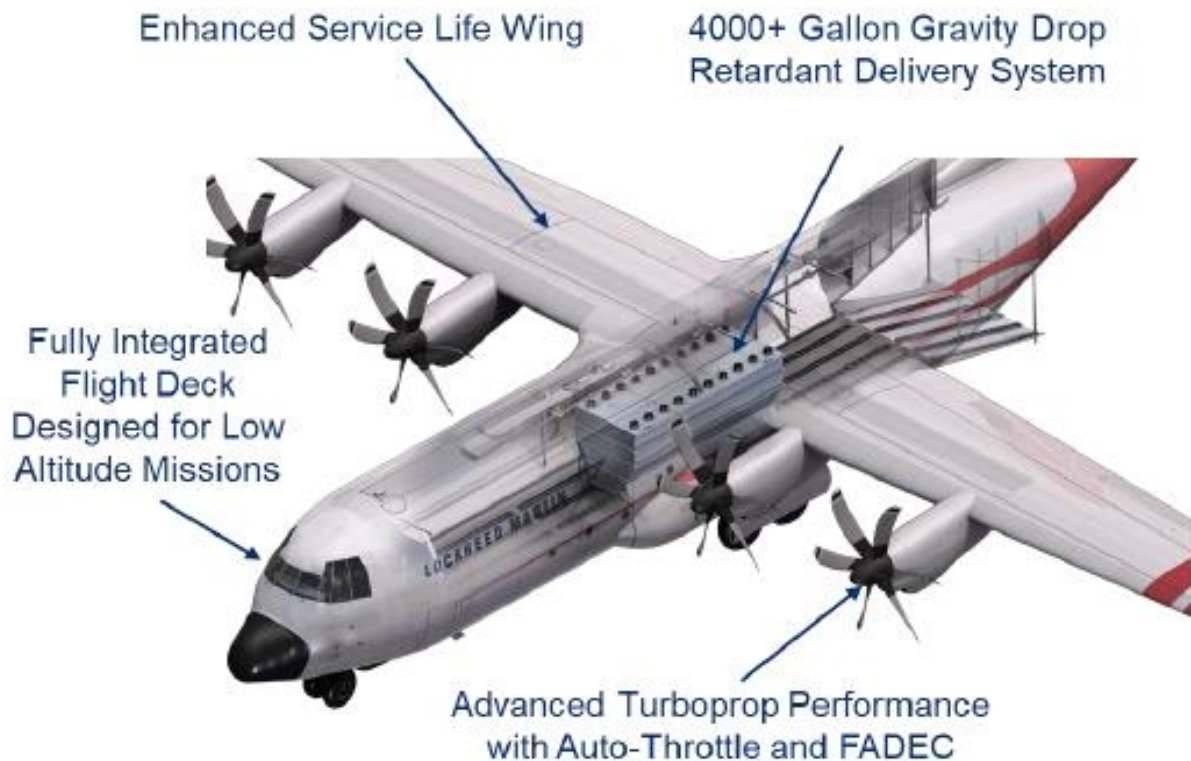


Best Choice for current Systems Depends on Individual Operator's Requirements

C-130J FireHerc - Baseline



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HUD for superb Situational Awareness (Primary Flight Display)

NVIS Compatible Flight Deck

Advanced Centralized Advisory, Caution, Advisory & Warning System



Modern Safety Features: Stall Warning, Energy Cue, Windshear Detection, GCAS



C-130J Technology = Most Capable Aerial Firefighter

Current Airtanker Operations Tempo

CAL FIRE REDBOOK 2016

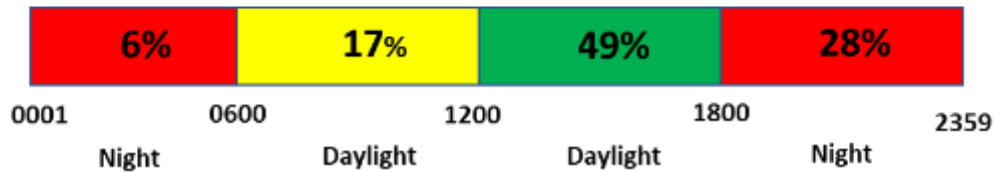
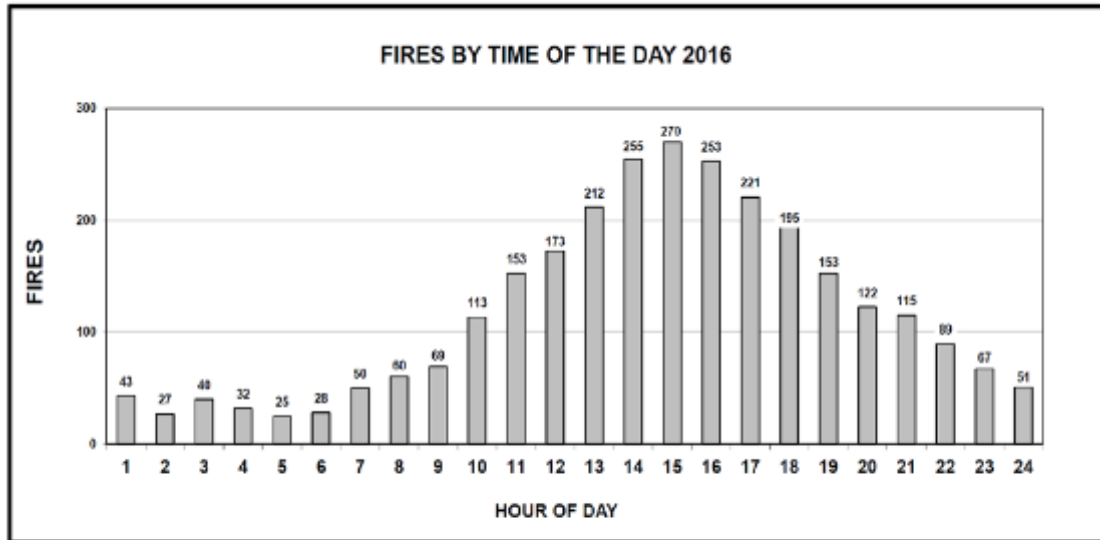
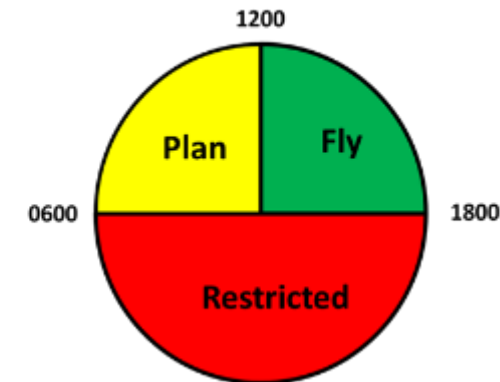
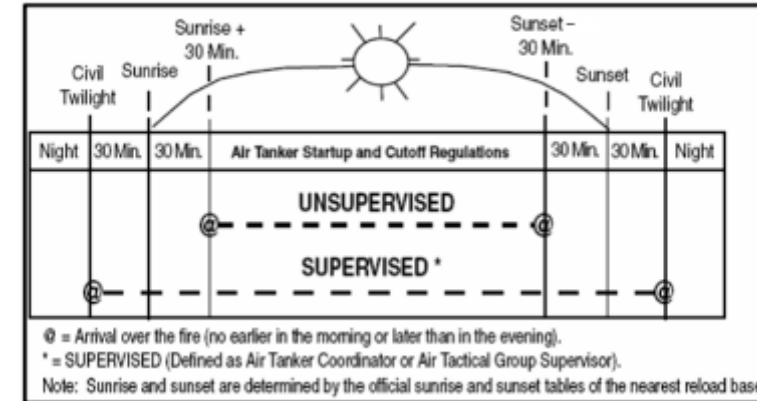


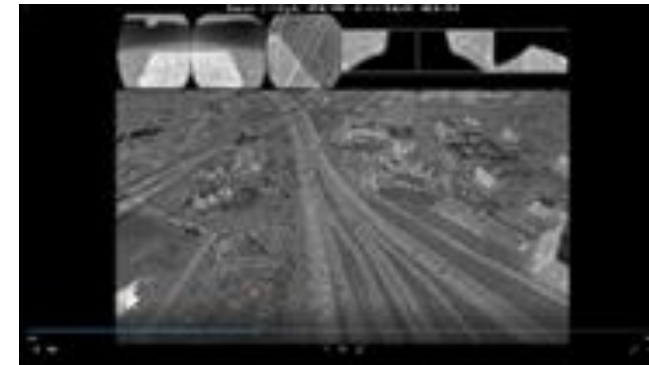
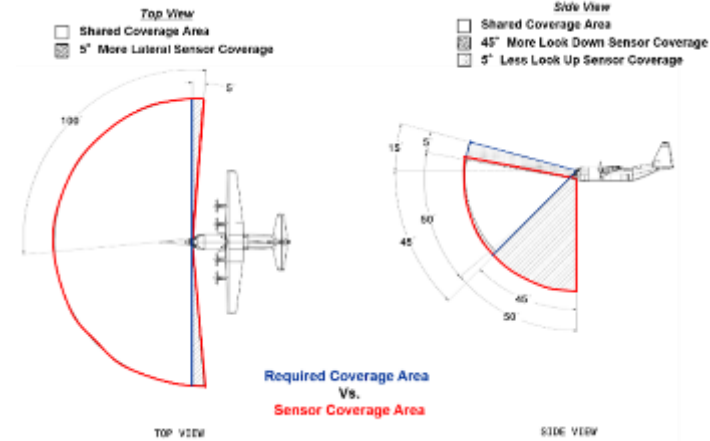
Figure 3. Multi-engine Airtanker Startup and Cutoff Regulations



Safety in a Challenging Environment Drives Daytime Firefighting

C-130J FireHerc – Enhanced (expand into night)

- Addition of Distributed Aperture System (DAS) Sensors (IR & Smoke detection)
- Creates ‘Day Like’ VFR imagery presentation to Pilots
- Introduce Head-worn Display for increased Horizontal 180° field of view beyond a HUD
- Addition of advanced Mission Planning Tools and Situational Awareness Updates



Advanced Technology Could Enable Night Ops – Faster Containment, Resources Saved

Lockheed Martin Night Ops Enabling Technologies



LM Aero provided:

- Baseline C-130J Super Hercules w/advanced avionics systems, NVIS lighting and proven RADS-XL installed
- Development of Distributed Aperture System (DAS) and Synthetic Vision (SVS) techniques leveraged from F-35 experience
- Open System Architecture for Integrated SA
- Head-mounted Display systems to provide 180° FOV to Flight Crews
- Advanced Mission Planning System

LM Rotary & Mission Systems (RMS) & LM Space

- Refined Wildfire Behavior Predictive Tools
- Firefighting Intelligence as a Service (FlaaS)
- Cognitive Mission Manager (CMM) System

Hercules Training Center

- Develop Advance Crew Training Systems tailored for Night Airtanker Operations

FireHerc Solution Leverages Proven Product From Multiple LM Businesses

Summary



- The C-130 aircraft is recognized as one of the very best Aerial Firefighting platforms in the world
 - Highest Payload Capability = Large Fire Retardant Capacity per sortie 4,000+ gallons
 - Hot ambient temperature and short field capability does not restrict retardant loads
 - Outstanding maneuverability in challenging low altitude/low airspeed environments provide greater safe flight operations during critical mission phases
 - Cargo Compartment Flexibility enables true multi-mission capability
 - Aircraft can be pre-modified to accept Aerial Firefighting Mission Systems to enable rapid conversion between normal airlift operations to Aerial Firefighting missions
 - Basic airlift mission retained unlike other dedicated fixed-wing aerial firefighter options

Addition of C-130 Aerial Firefighting Capability enables superior support for containment of wildfires to greatly diminish impact to citizens



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