

Emergency Airplane RATs



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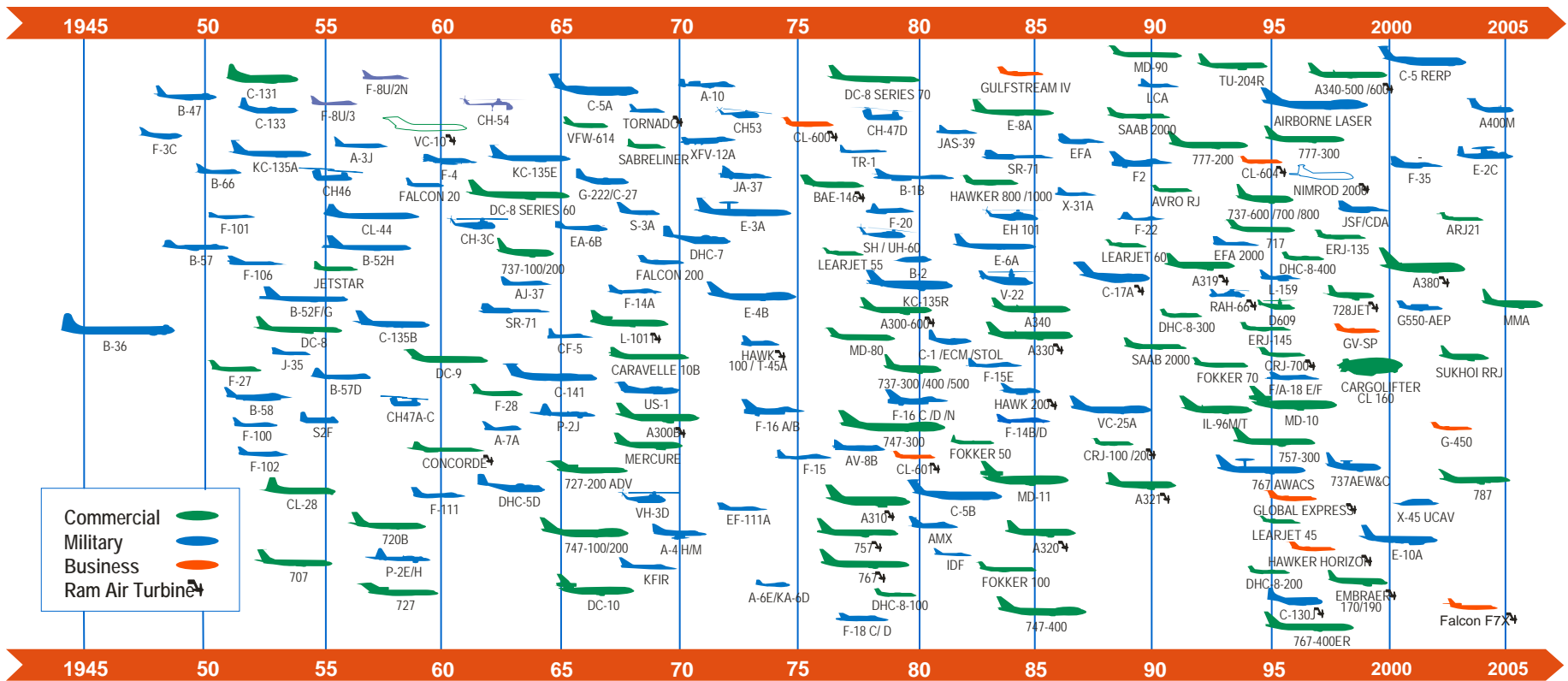
February 21, 2006



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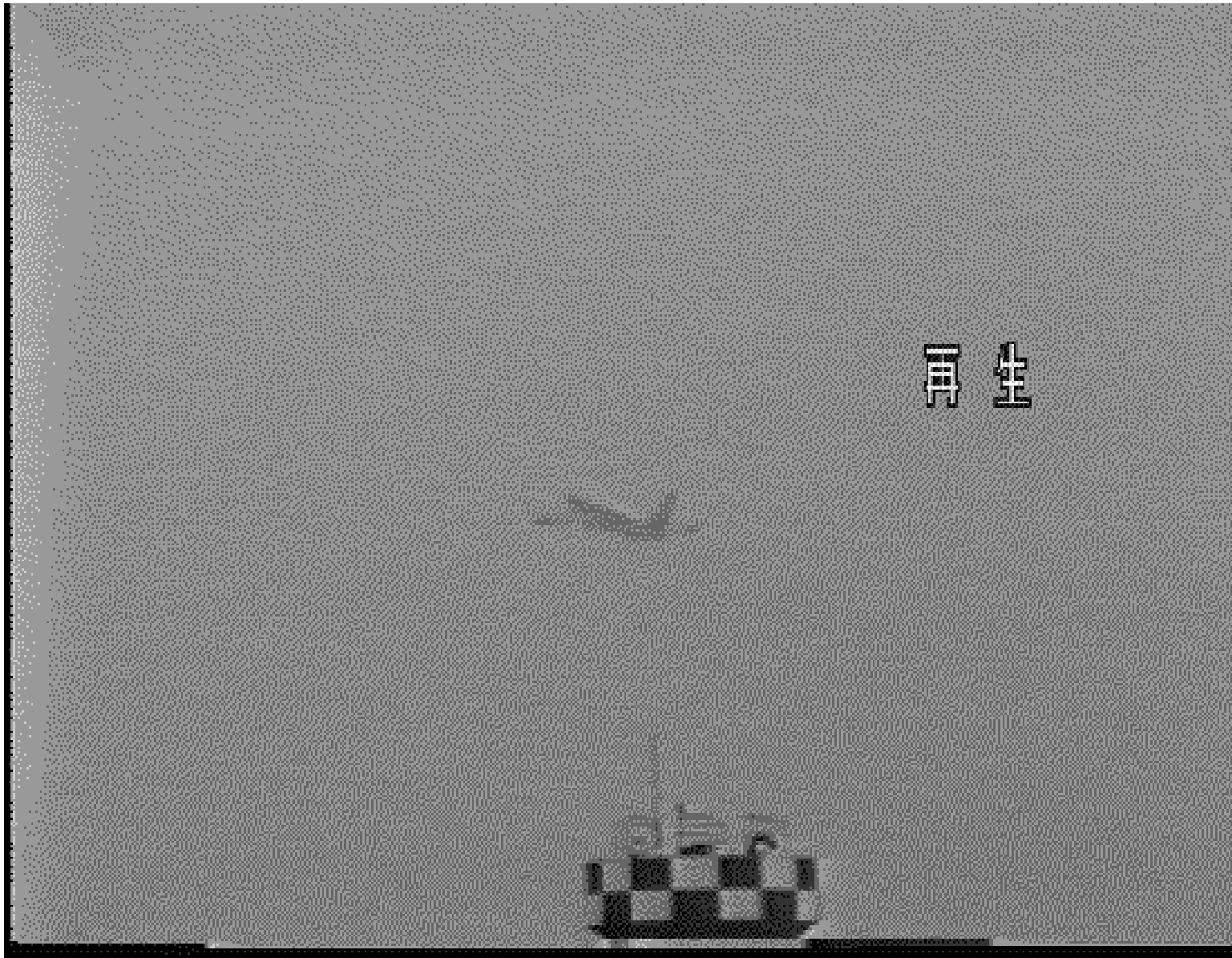
Video



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What is a Ram Air Turbine?



- ***A small windmill that extracts power from the airflow***
- ***Most common use is to provide emergency power in the event of an all-engines out failure***



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Page 5
12-2-2002

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Emergency Ram Air Turbine

Purpose: provide emergency power to essential systems when all engines fail

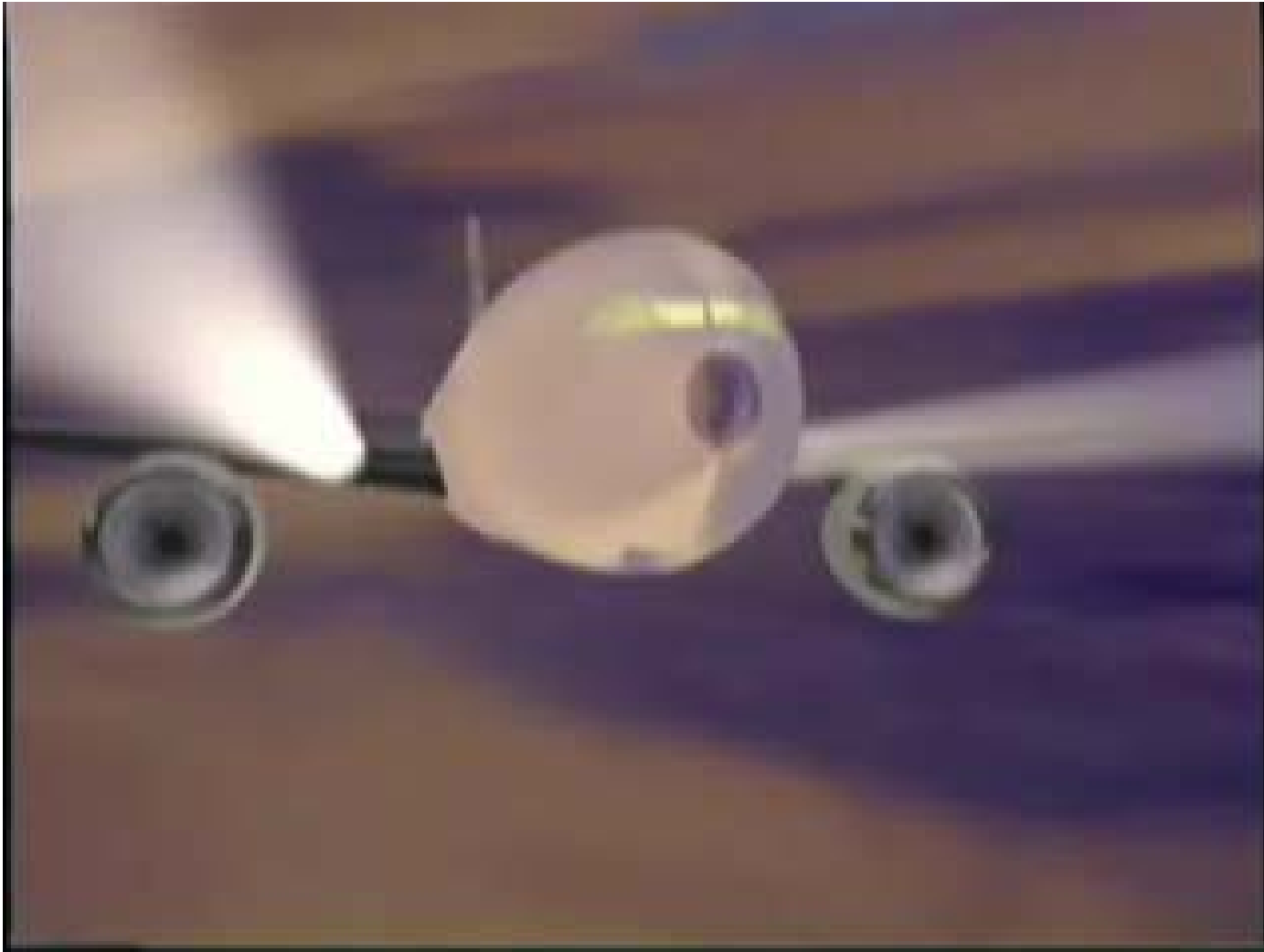
- *Hydraulic power for powered actuation of flight control surfaces*
- *Electric Power for flight control computers, essential instruments, radio, cockpit lighting, windshield and pitot tube de-icing*

The airplane becomes a glider
when all engines fail



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Page 7
12-2-2002



What could cause an all-engines out condition?

- *Fuel exhaustion*
- *Fuel contamination*
- *Volcanic ash damage*
- *Extremely heavy rain or hail*
- *Human error*



Ram Air Turbines Save Lives!



Boeing 767 - Fuel Exhaustion - August 1983
69 Lives Saved



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Page 9
12-2-2002

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Ram Air Turbines Save Lives!



CL600 - Fuel Contamination- March 1994
2 Lives Saved



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Page 10
12-2-2002

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Ram Air Turbines Save Lives!



A310 - Fuel Exhaustion – July 12, 2000

150 Lives Saved



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Page 11
12-2-2002

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Ram Air Turbines Save Lives!



A330 - Fuel Leak - August 24, 2001

304 Lives Saved



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Page 12
12-2-2002



Do Four-Engine Aircraft Need an Emergency RAT?



Fuel Exhaustion



Fuel Contamination



Volcanic Ash

Four-Engines Do Not Provide Protection From These Threats

A340, A380, C-5A, C-17, and Nimrod all have Ram Air Turbines



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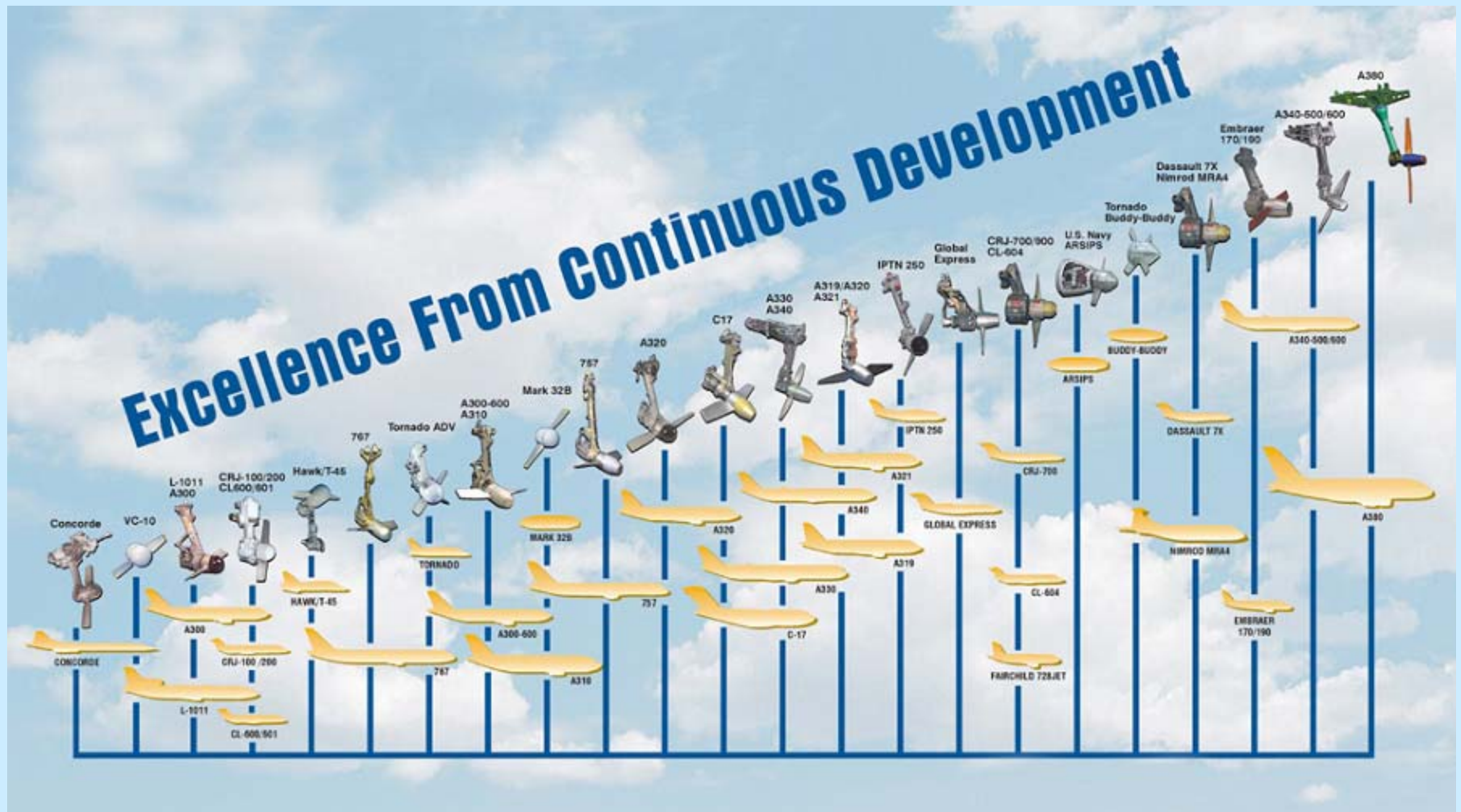
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Who uses RAT's

- **All Airbus airplanes**
 - A300/310, A321/320/319/318, A330/340/340-500, A380
- **Boeing's newer airplanes**
 - 757, 767, and 777
 - DC-10/MD-11
- **Several Business and Regional Jet's**
 - Challenger, GX, F7X, CRJ, ERJ-700, 728JET
- **C-17 & C-5A**
- **Many older military jets**



The Worlds Leading Supplier of Ram Air Turbines



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Why not use something else:

Such as batteries or an APU

- *RAT's offer:*
 - *Unlimited duration of power*
 - *No fuel required*
 - *Low cost of ownership*
 - *On demand reliable operation*
 - *Full flight envelope performance*
- *RAT's are usually the most efficient method of providing aircraft emergency power*



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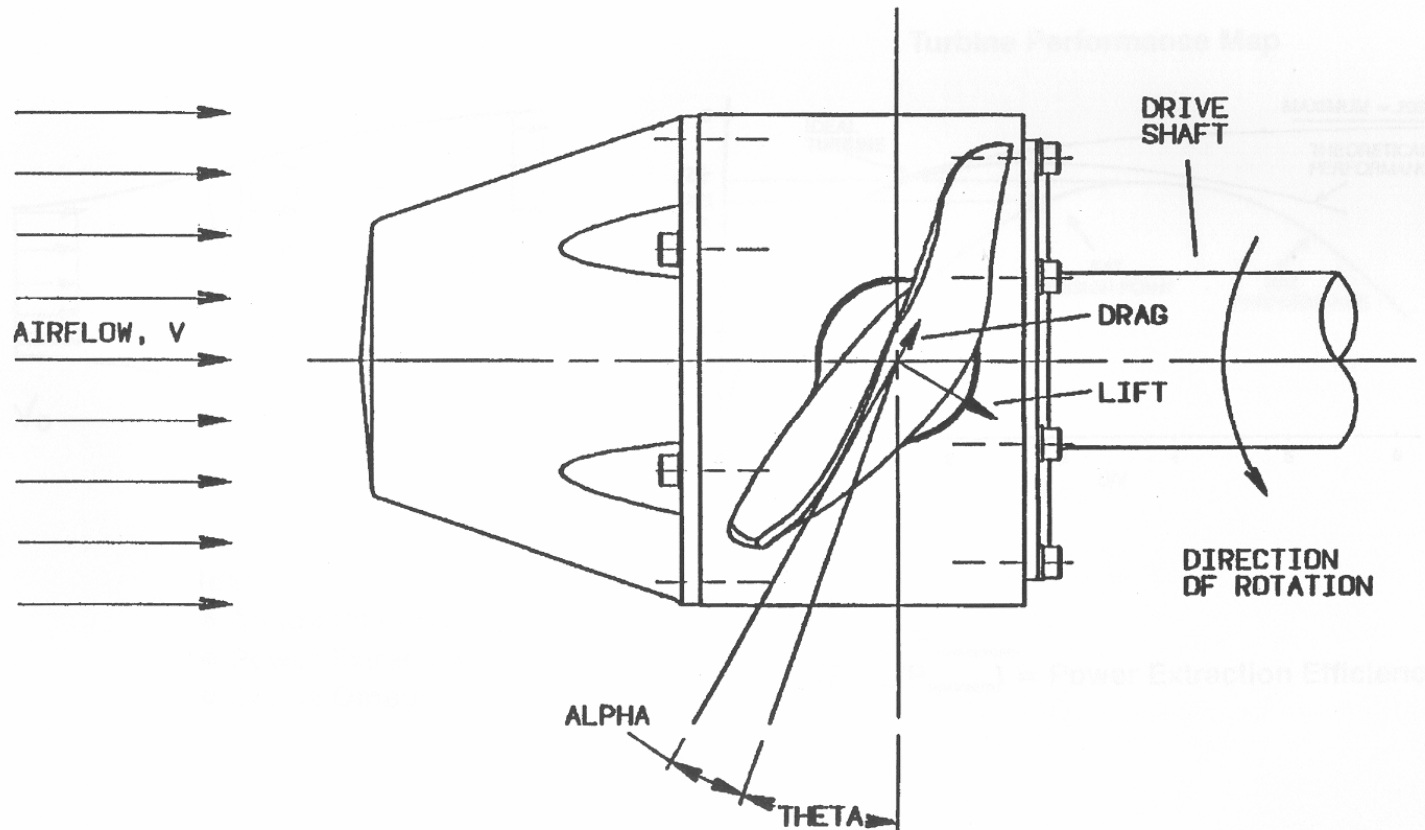
Page 16
12-2-2002

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Description of RAT Operation

- *Deploy signal commanded (automatic or manual)*
- *Uplock releases*
- *Deployment actuator provides force to open RAT compartment doors and deploy RAT into airstream*
- *Turbine locked in position until blades clear aircraft*
- *Turbine is released and accelerates to rated speed*
- *Turbine governor maintains speed control*
- *RAT provides emergency power to aircraft*
- *RAT remains deployed for rest of flight*

Turbine Speed Governor



Turbine governor adjusts blade angle to maintain constant rotational speed

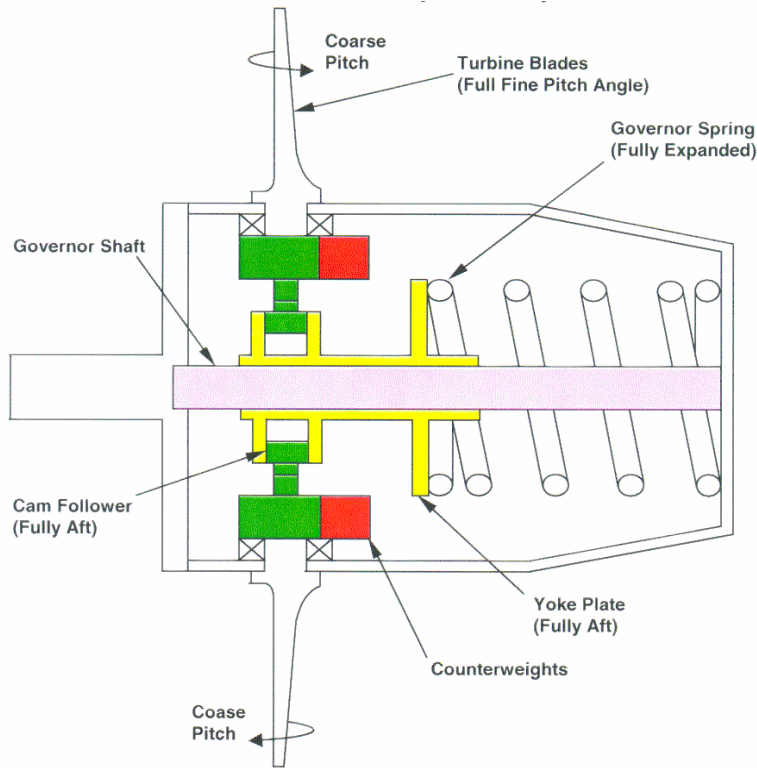


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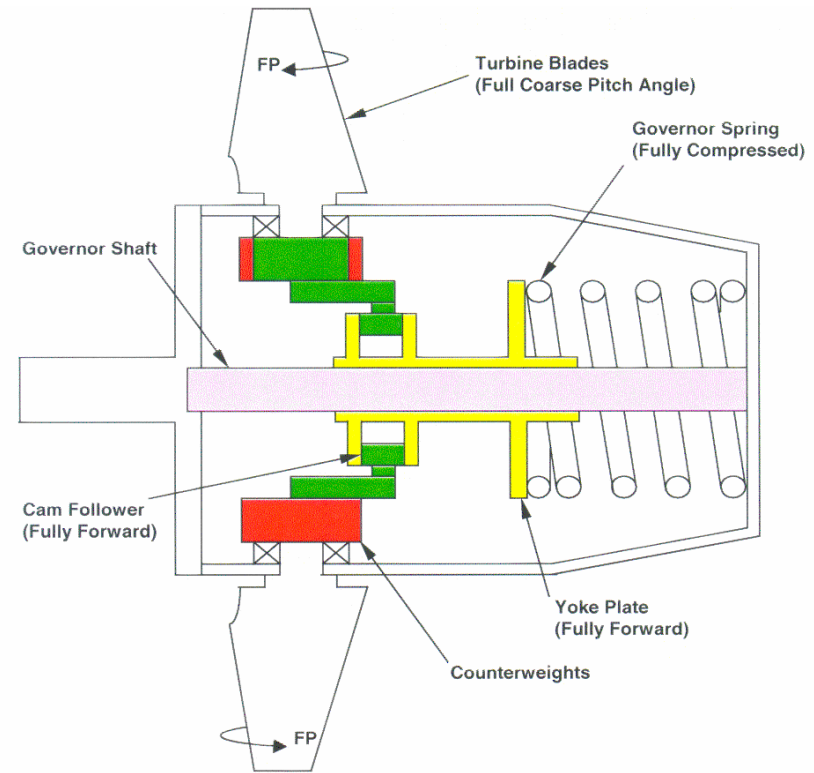


RAT Speed Governor Mechanism



At low speed

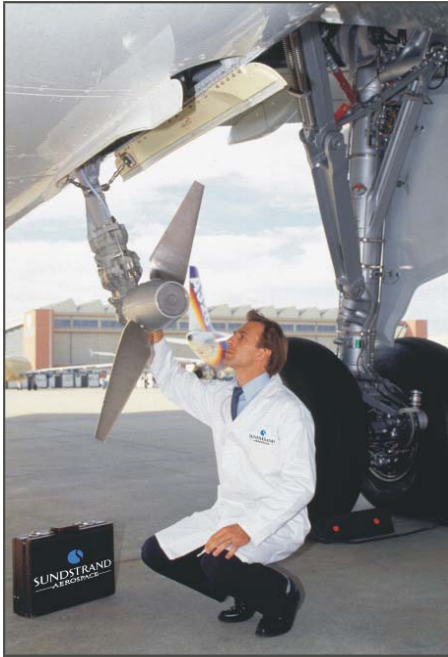
Spring holds blades in fine pitch position (high power extraction)



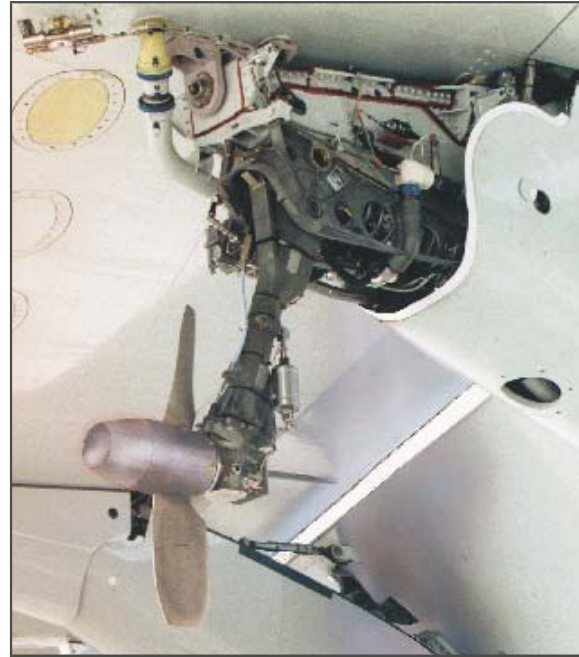
At high speed

Counterweights act to compress spring and rotate blades to coarse pitch position (low power extraction)

Typical Installations for Emergency Ram Air Turbines



**Mid-Fuselage
(belly)**



**Under Wing
(Flap Track Fairing)**



**Forward Fuselage
(nose)**



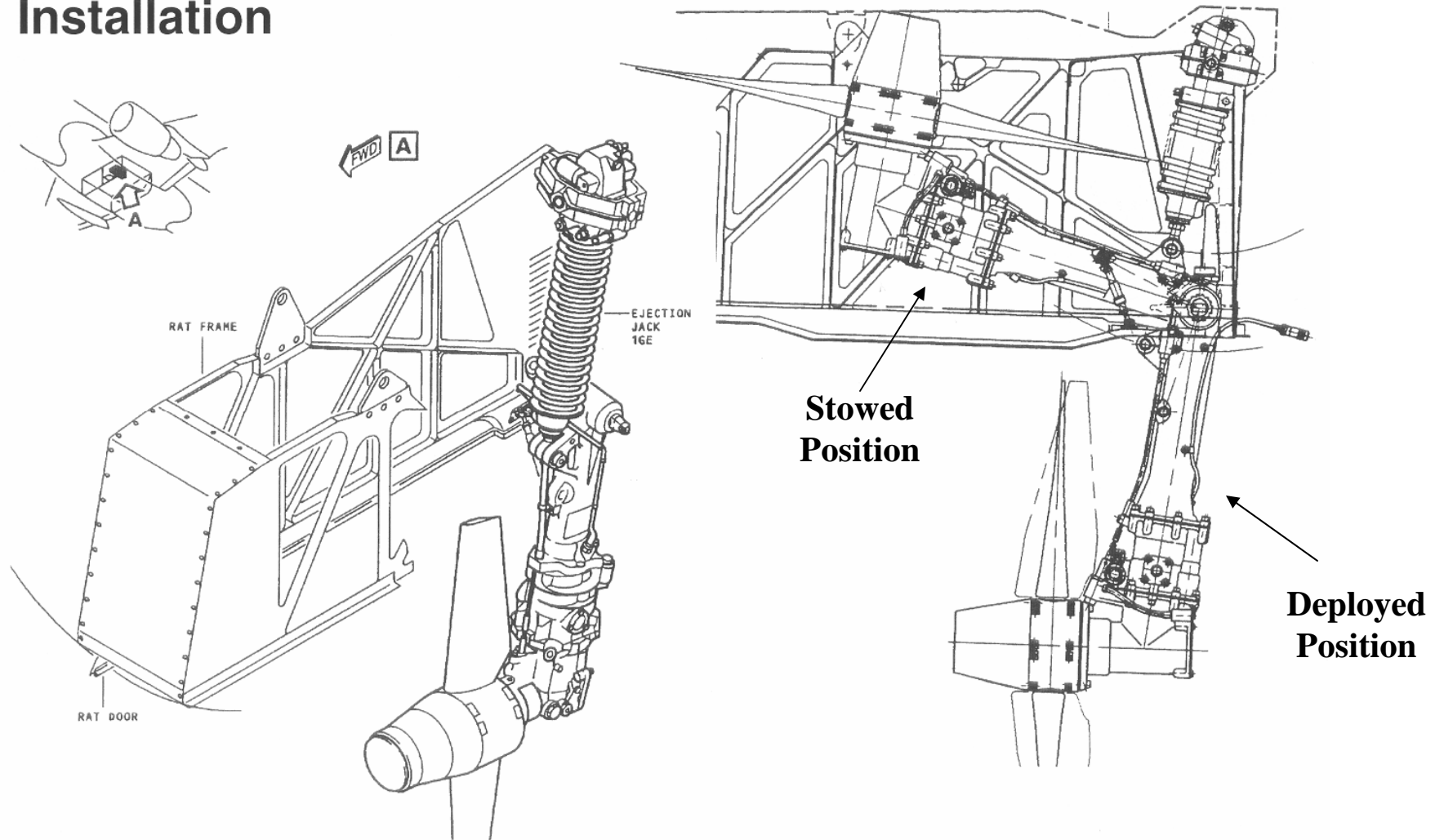
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Typical RAT Aircraft Installation

Installation



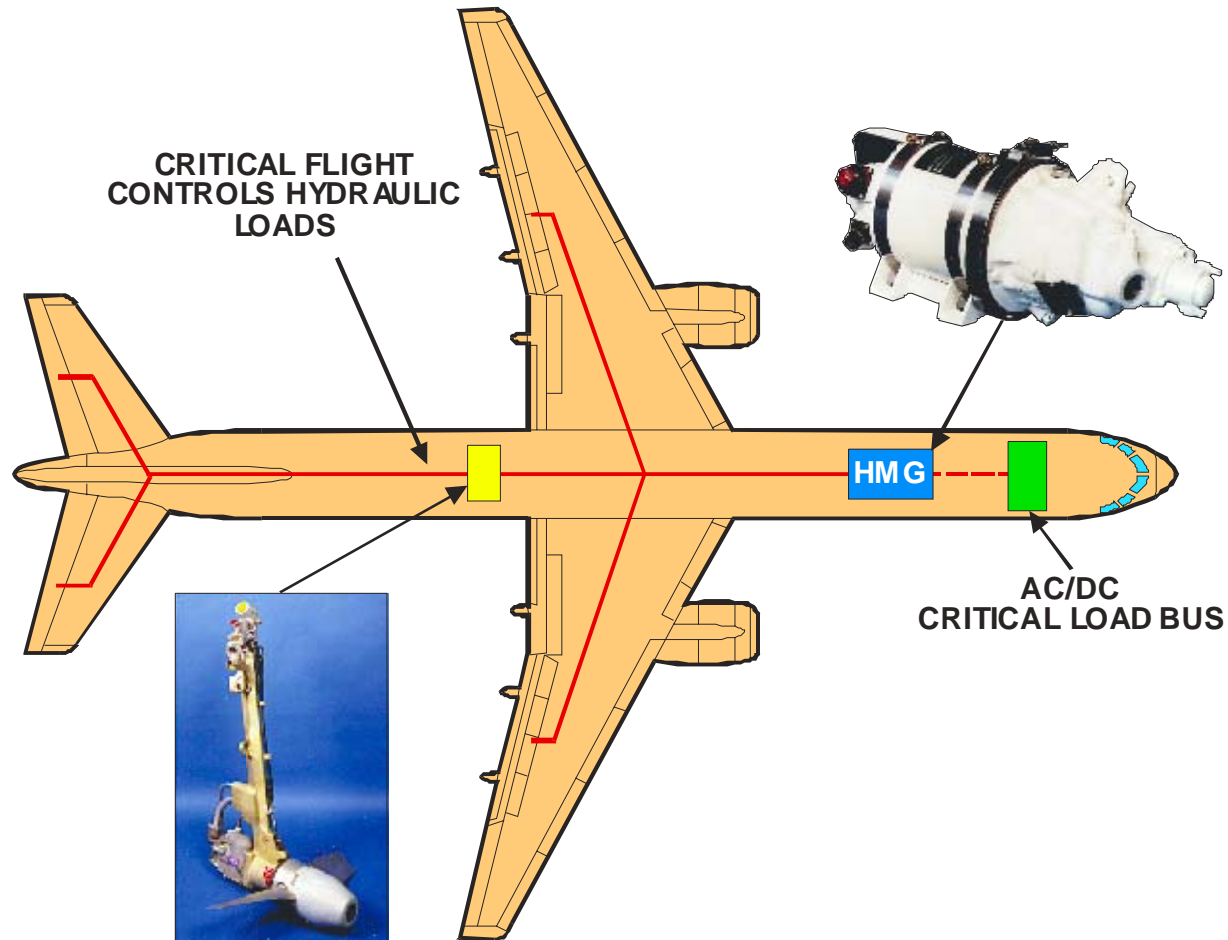
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Emergency Power Approach

Hydraulic RAT with HMG

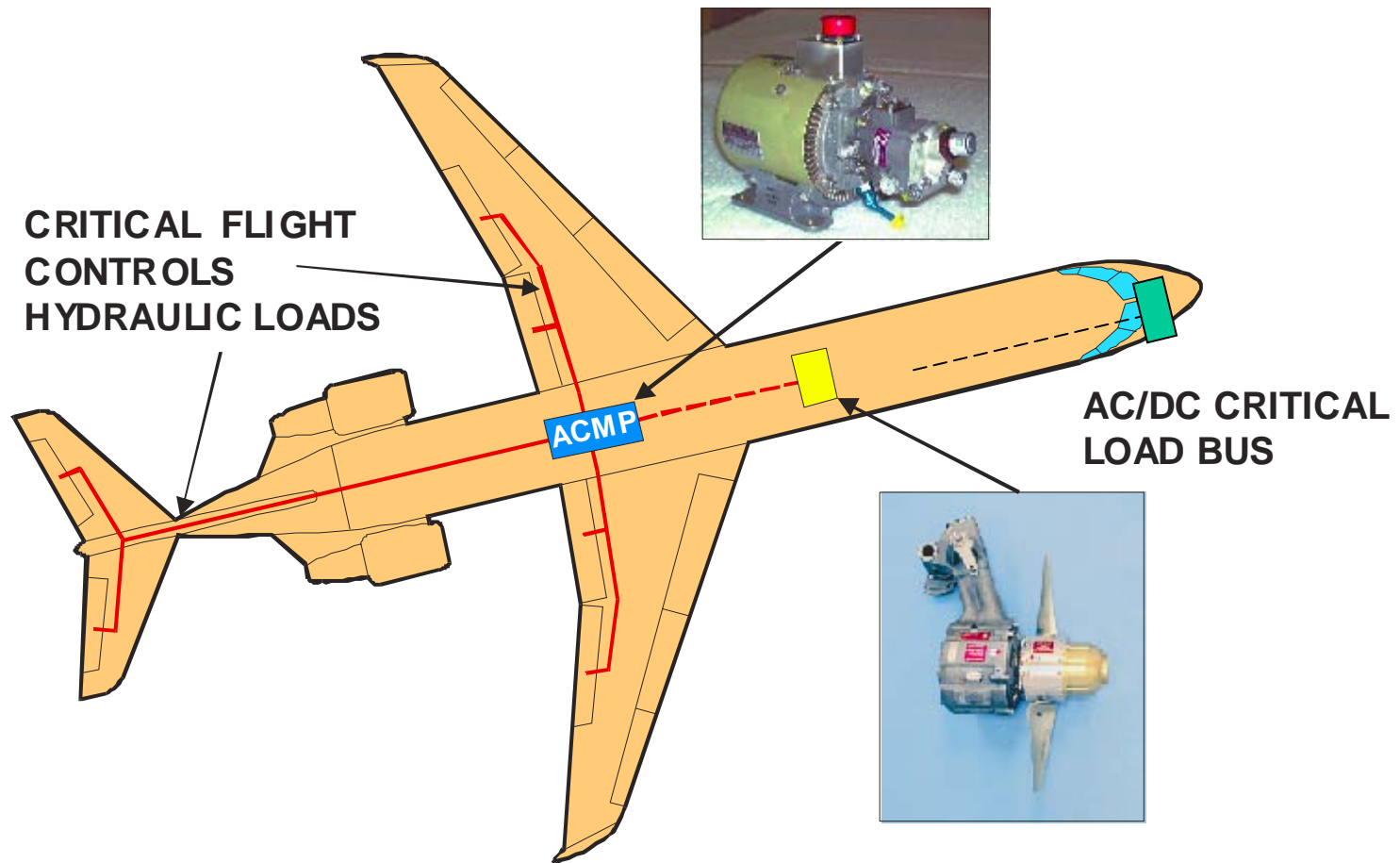


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Emergency Power Approach

Electric RAT with ACMP



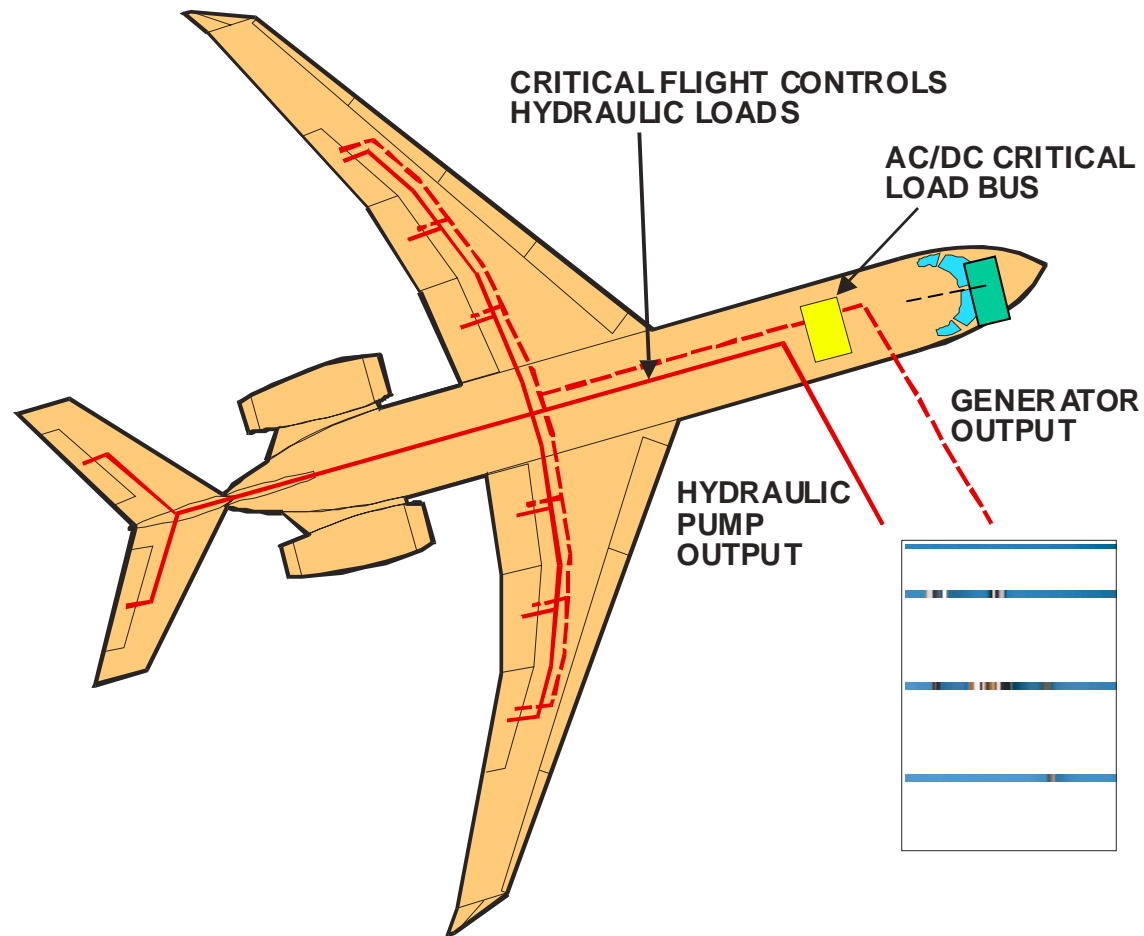
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Emergency Power Approach

Hybrid RAT (electric and hydraulic)

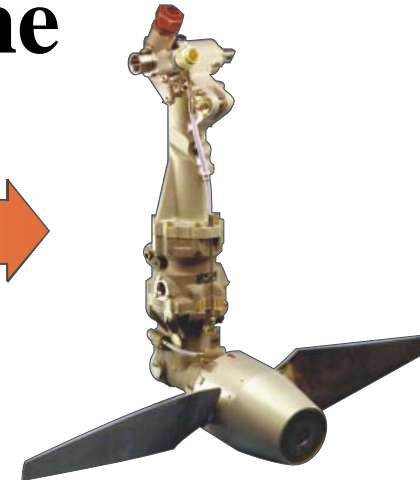
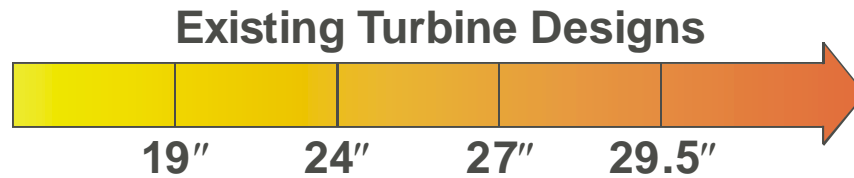


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Hamilton Sundstrand RAT Product Line



13 INCH DIAMETER

- Hawk
- Tornado

39.5 INCH DIAMETER

- A321
- A320
- A319
- A318
- A340-500/600

2.6 HP at 130 KEAS

Horsepower Range



54 HP at 130 KEAS

Under development - 62" Diameter A380 RAT - 85 HP at 130 KEAS

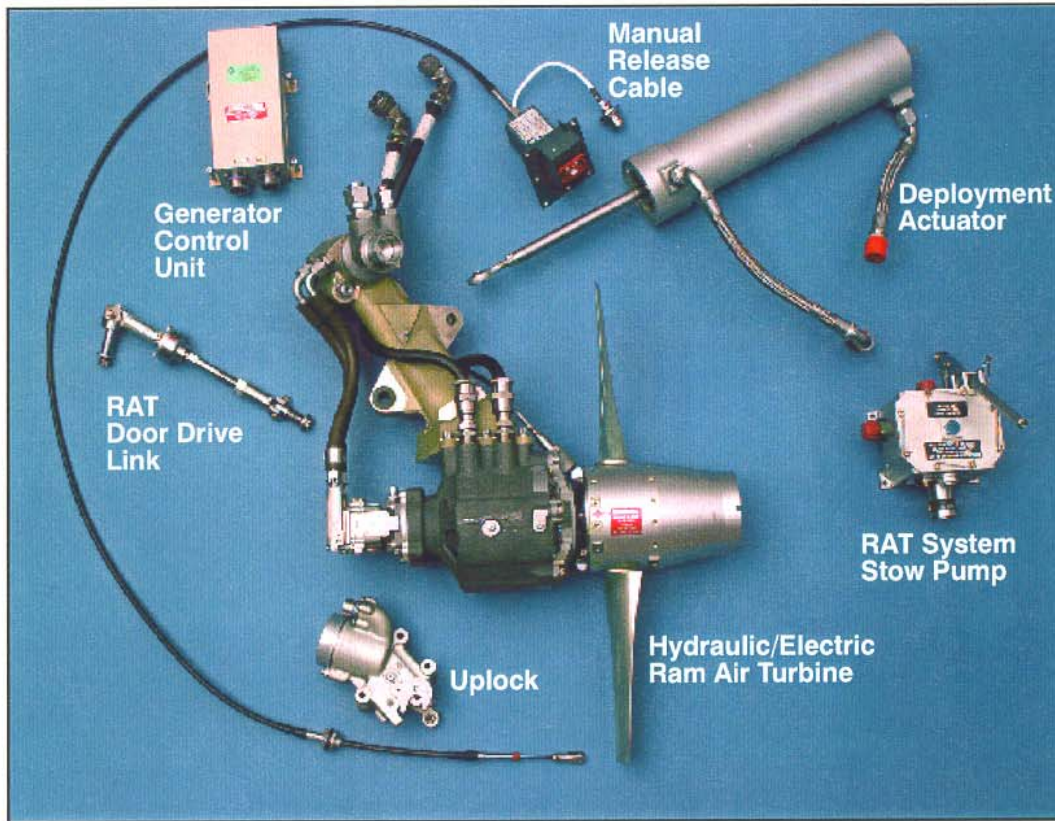


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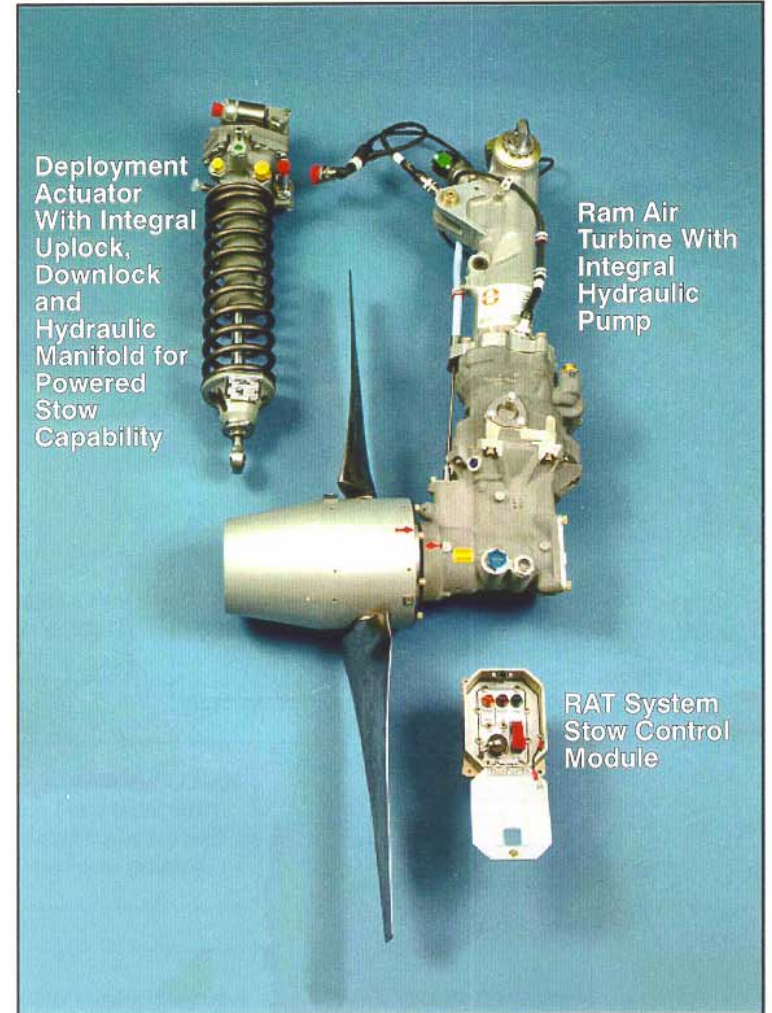
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Typical RAT Systems



**Global Express
Ram Air Turbine System**



A321 RAT System



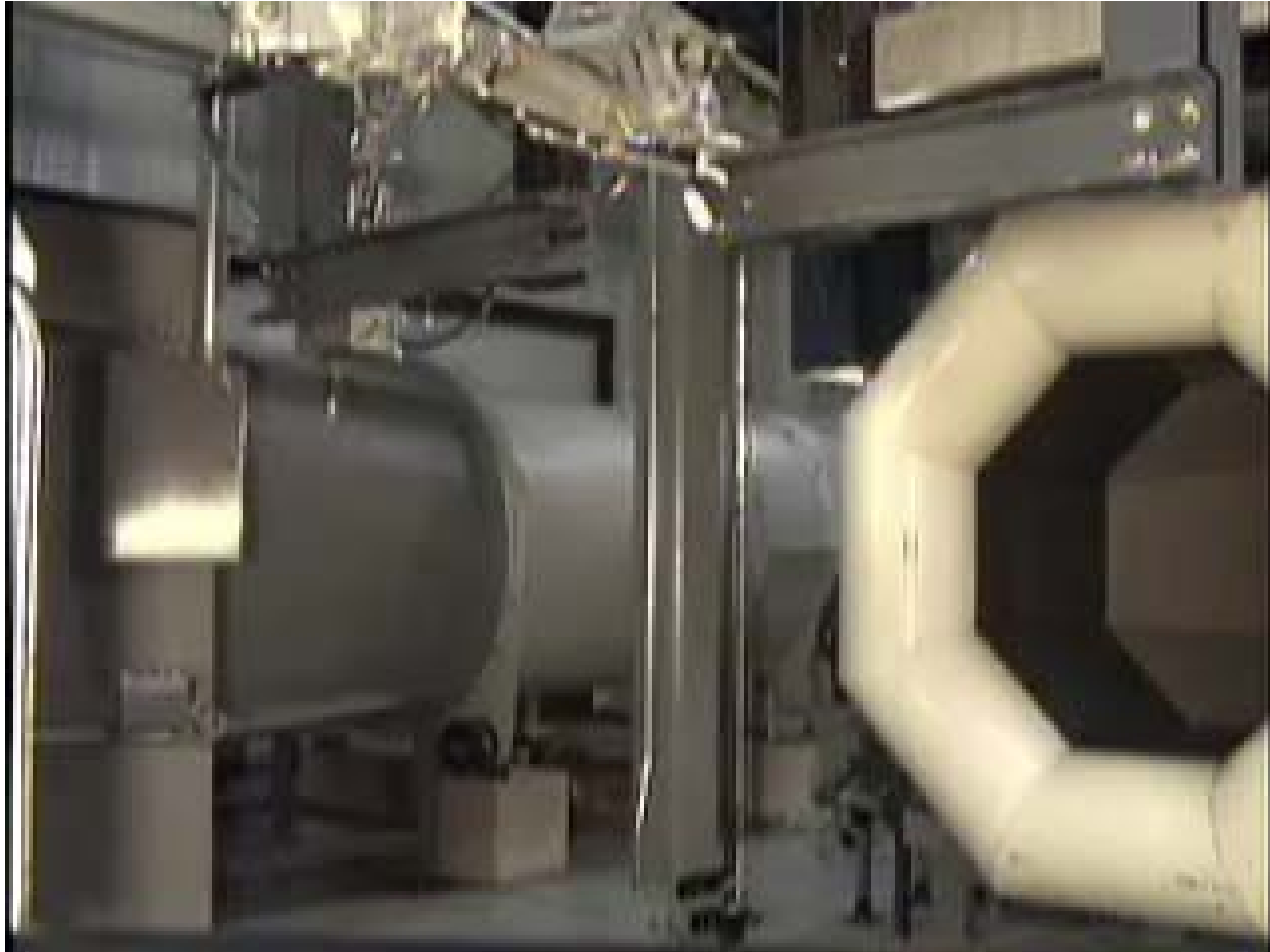
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RAT TEST

Wind Tunnel Deployment and Start-up



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Icing Conditions Testing

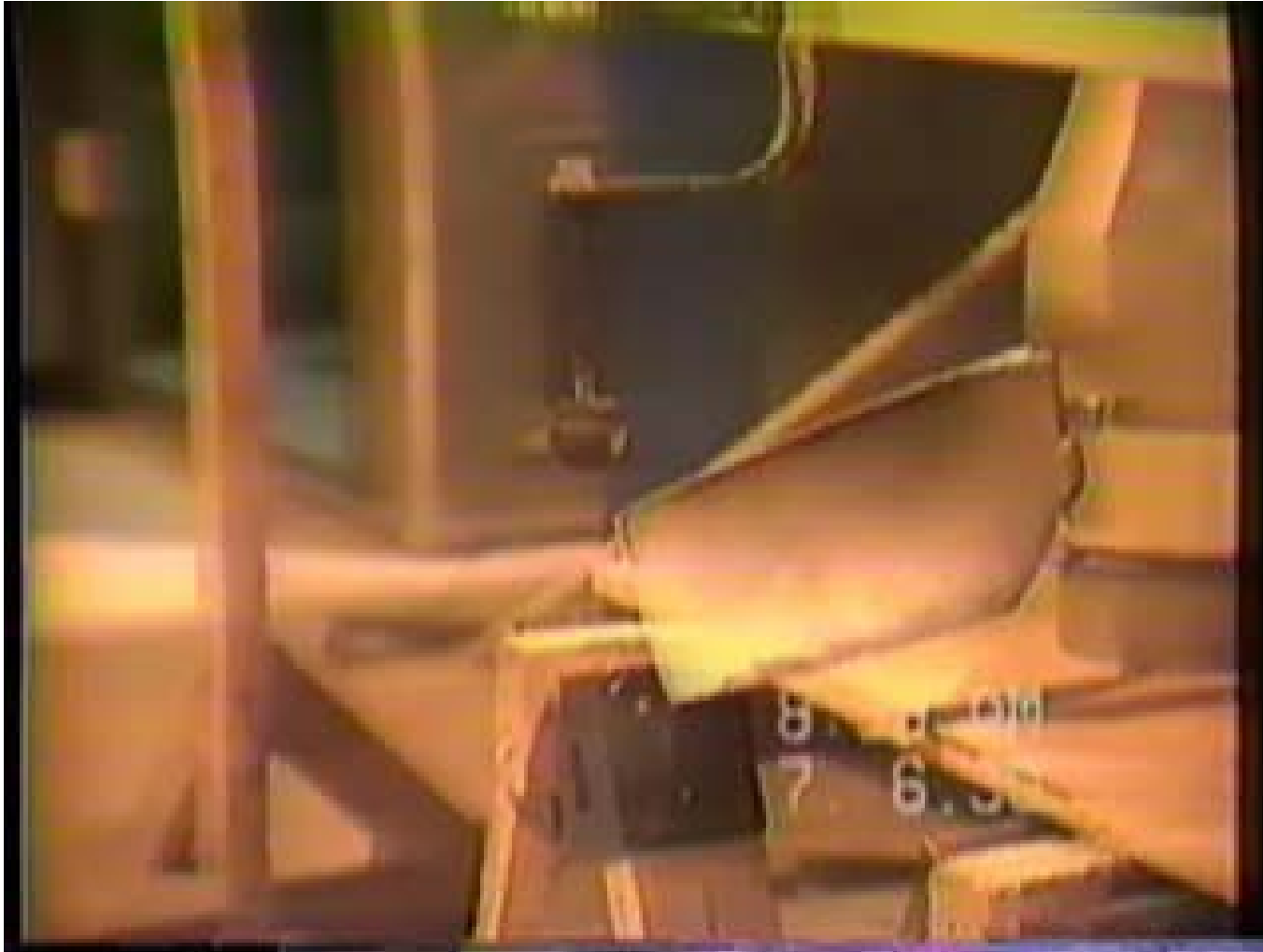


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Lightning Strike Testing



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RAT Powered Aerial Refueling Pod

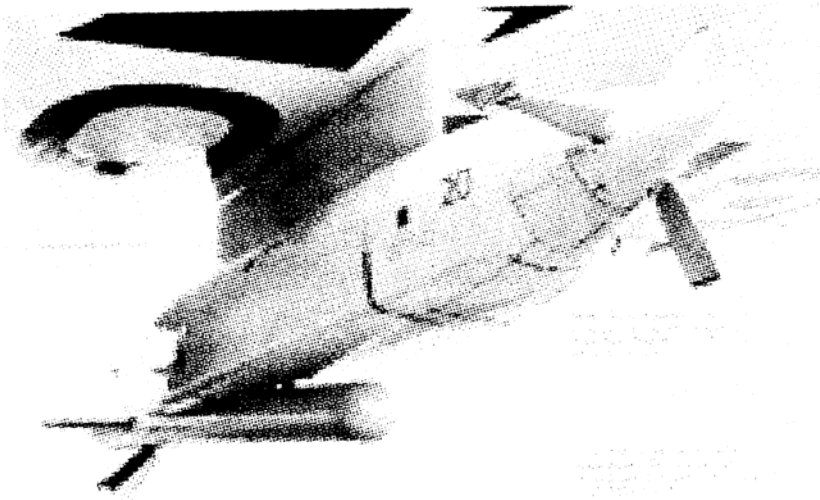


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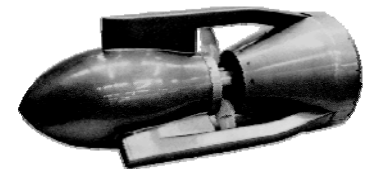
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Other Pod RAT Applications



Target Towing



Electronic Warfare

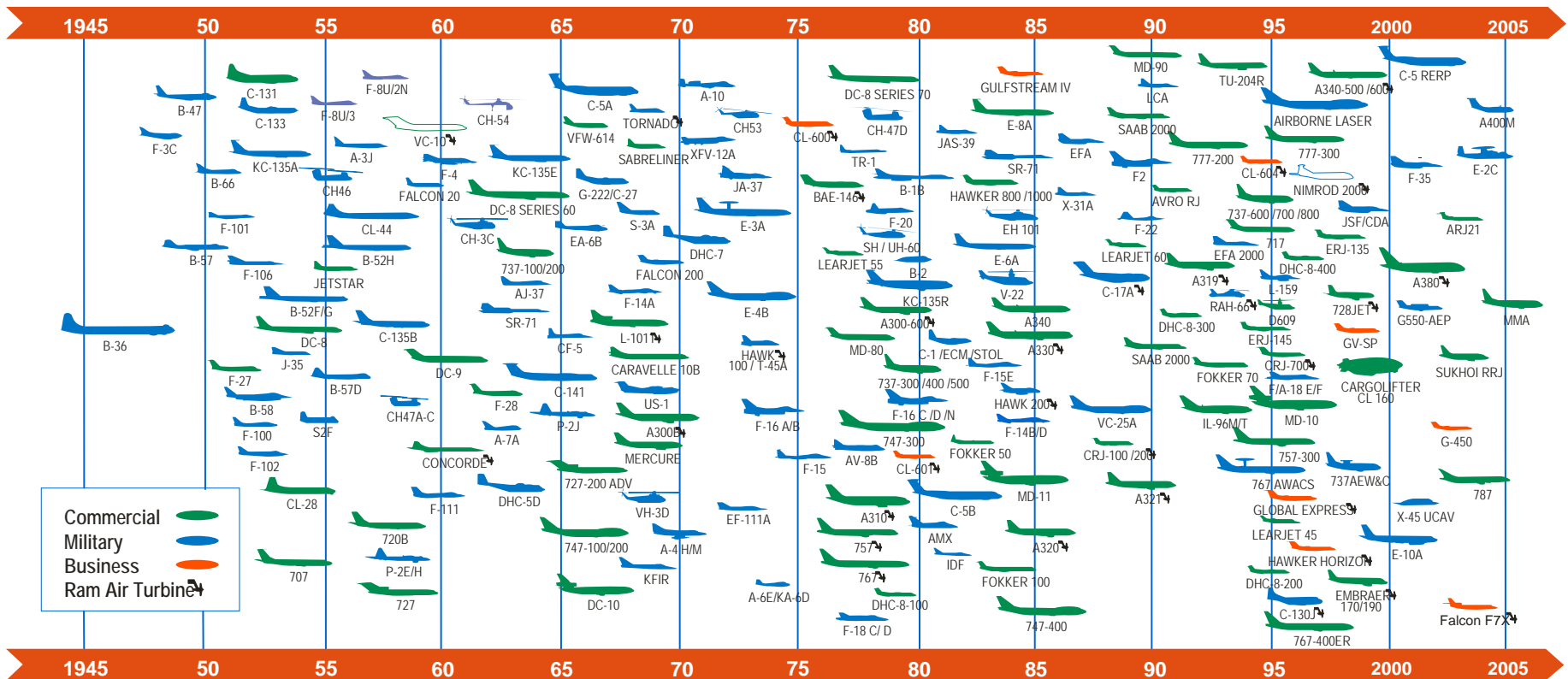


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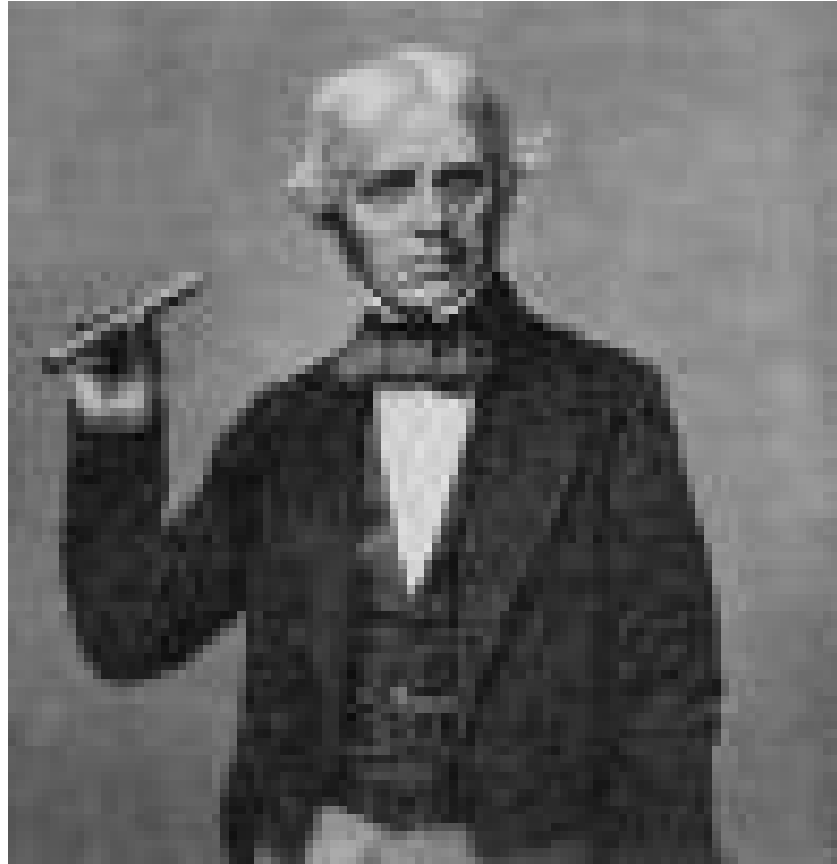
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$$e = \frac{d\theta}{dt} \text{ Volts}$$



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Page 34
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