NASA OBIGGS/OBOGS Research

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1. What’s with the OBIGGS / OBOGS?

OnBoard Inert Gas Generation System
OnBoard Oxygen Generation System

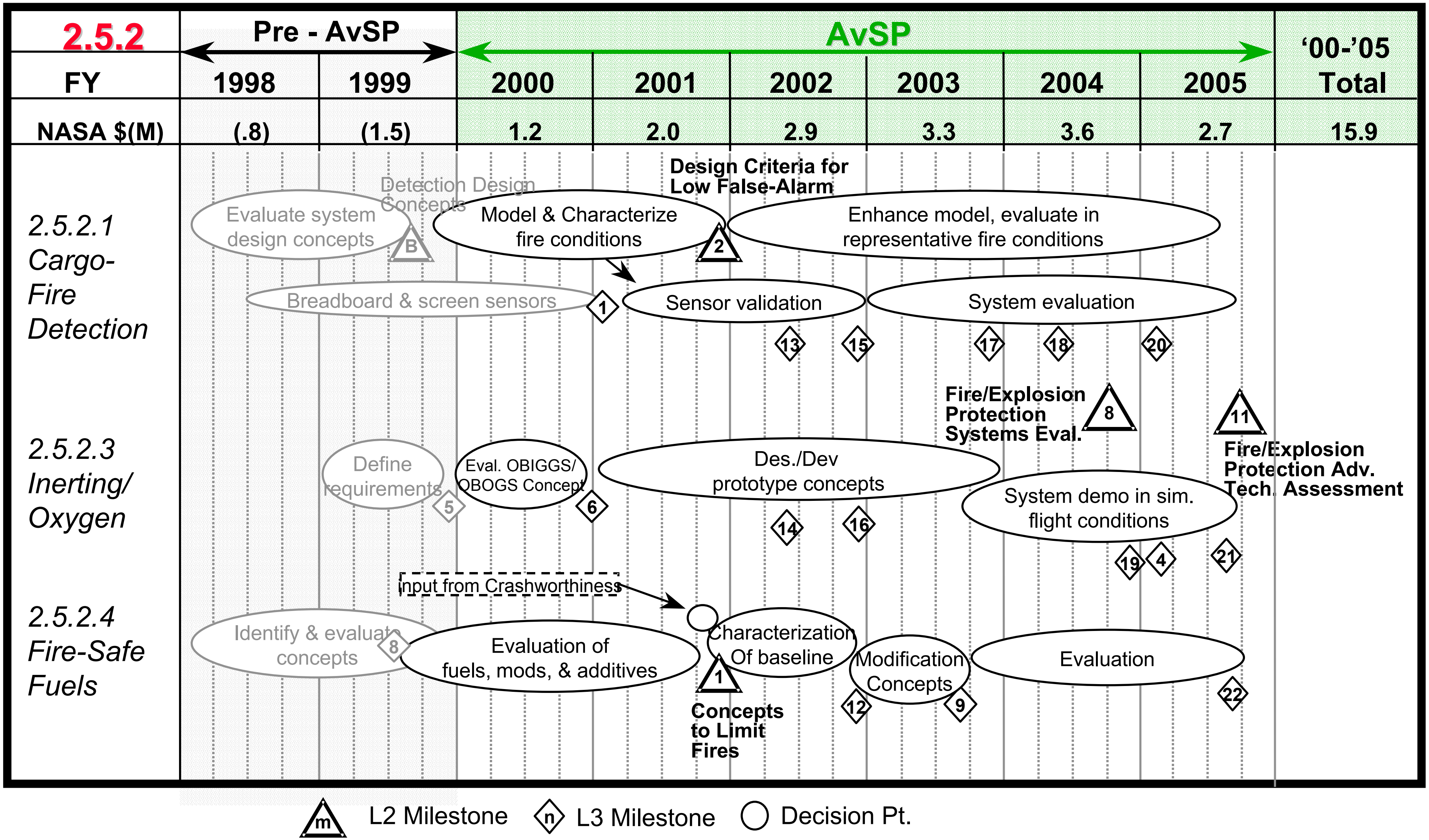
Why OBOGS

Task-sharing drives the cost down
Oxygen required for high-altitude depressurization
Pressurized oxygen system servicing needs
highly-skilled personnel

1.1 Where does our work fit in?

- 2. Aviation Safety Program (Langley)
  - 2.5 Accident Mitigation (Glenn)
    - 2.5.1 Crash worthiness (Langley)
    - 2.5.2 Fire Protection (Glenn)
      - 2.5.2.1 Fire-Detection
      - 2.5.2.3 OBIGGS / OBOGS
      - 2.5.2.4 Fire-Safe Fuels

1.2 NASA Fire Protection Work Plan -- Milestones and budgets



Note: OBIGGS/OBOGS = On-board inert-gas/oxygen generation system

1.3 What's our schedule?

N_2-based OBIGGS / OBOGS		Non-N_2 based OBIGGS /OBOGS	
RFI & RFP to OEMs	11/01		
Eval. Phase I Proposals	01/02	Evaluate options	02/02
Award Phase I	02/02		
Complete Phase I	08/02	finish detailed design	08/02
Down-select			
Award Phase II	10/02		
Complete Phase II	08/04	Finish hardware fabrication	08/04

Ground-based cargo fire-suppression test 12/04

Integration into demo aircraft & safety clearance 12/04

Flight test on B757 03/05

2. Fostering Emerging OBIGGS / OBOGS Technology

2.1 NASA-Sponsored Technology Demonstration on B757 in ‘04-’05

- NASA-Boeing relationship changed
- NASA will release the Request For Proposal directly

- Direct funding of OEM
  - Up to 6 Phase I feasibility studies for $600K total in 6 months
  - Up to 3 Phase II hardware buildup, $1.8M in 2 years total
  - May be more $, depending on the technical nature of project

- NASA seed funding - OEM contribution needed
- “Technology development”, not “Prototype development”

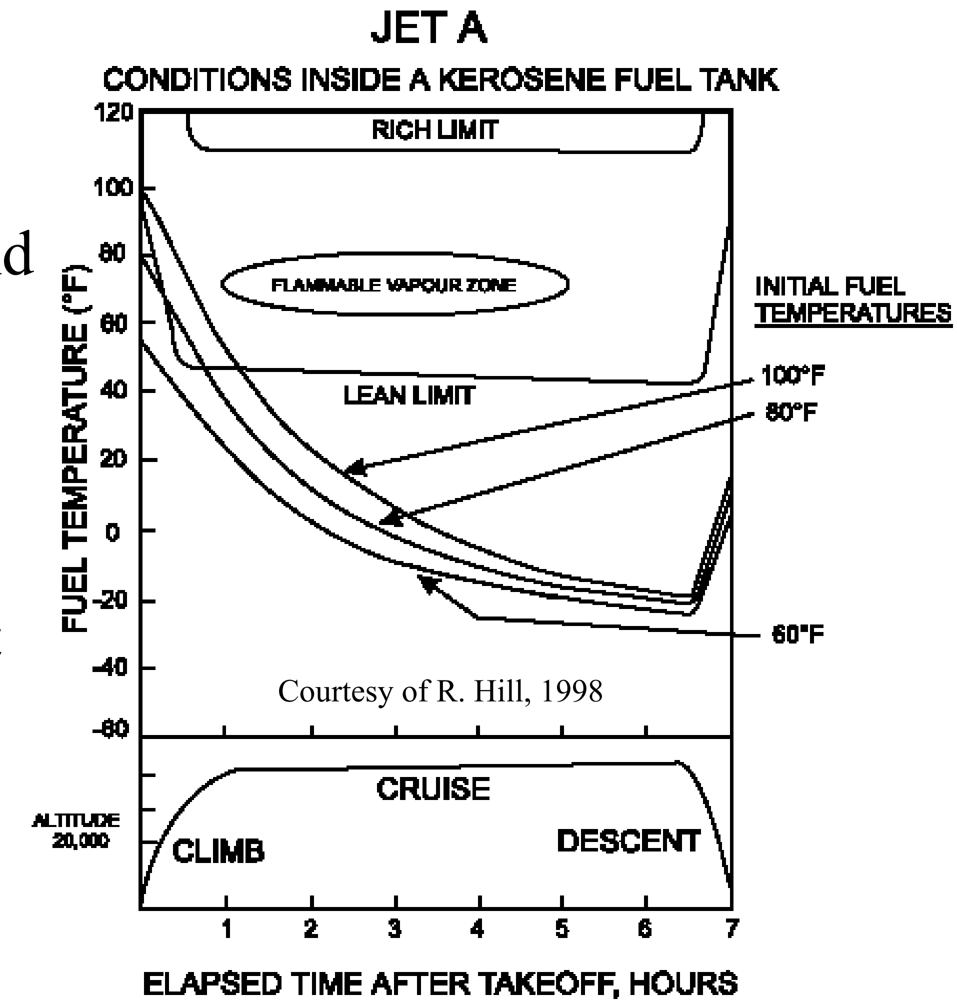
- OEM retains ownership of hardware (under discussion)
- NASA OBIGGS/OBOGS funding:

  FY02: ~1M, FY03: ~1.5, FY04: ~1.9M

2.2 Performance Requirements on B757-200 Flight Test

2.2.1 Center Wing Tank (CWT) inerting only

- Tank vented to atmosphere
- 10% O_2 concentration at departure time
- Assume 40 minutes turn-around between flights
- 7080 US gallons capacity
- Eliminate the fire hazard in first 1-1/2 hr
- Full-time purging during flight



2.2 Performance Requirements on B757 Flight Test

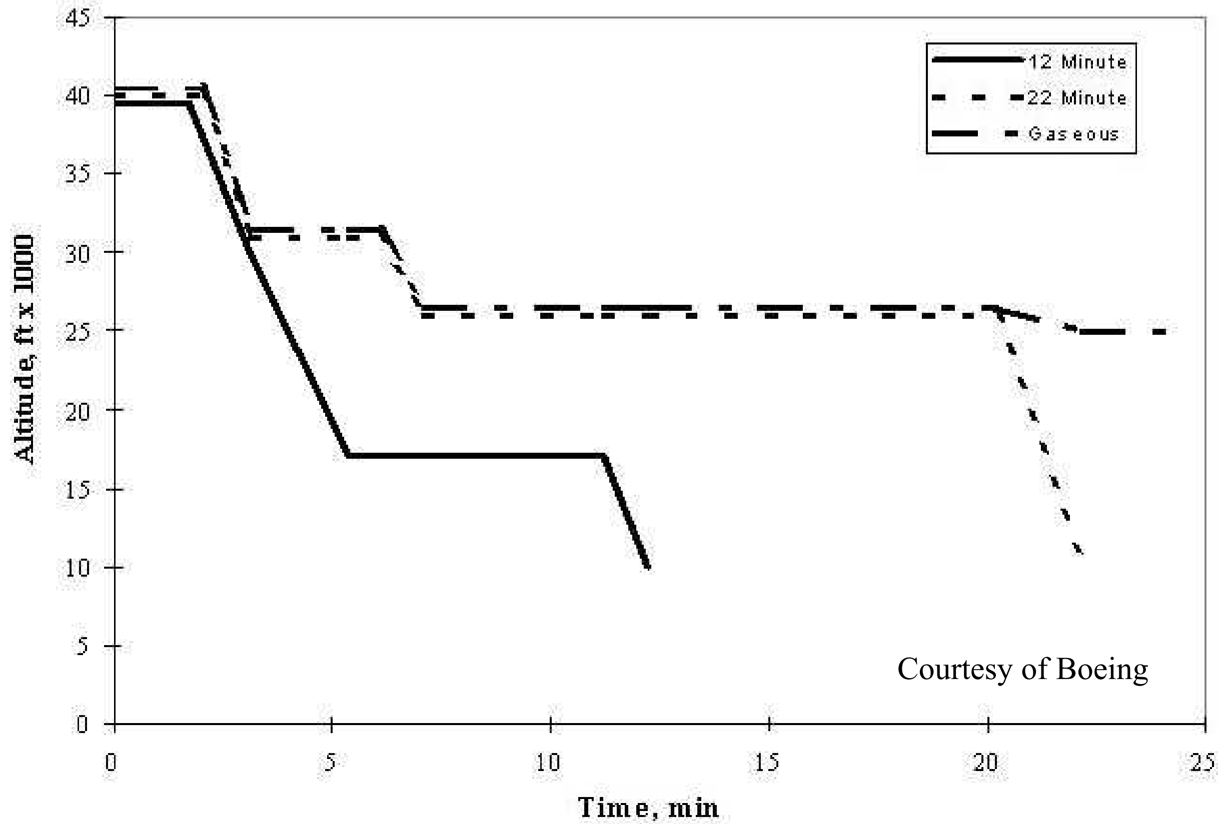
2.2.2 Cargo compartment fire suppression (tentative)

- 1300 ft^3 aft cargo compartment
- Assume initial knock-down already done
- Assume leakage of 11 ft^3 per minute
- Reach <12% O_2 concentration in 25 minutes at 8000 ft pressure and hold for 120 minutes
- OBIGGS not required to inert CWT when inerting cargo compartment

2.2 Performance Requirements on B757 Flight Test

2.2.3 Emergency OBOGS requirement (tentative)

- 35,000 ft depress.
- 10,000 ft in 12 min.
- 268 persons
- 93%+ pure O_2
- ~2 liter O_2 (STP) /min/person or ~1.2 lbm/min peak flow



2.2 Performance Requirements on B757 Flight Test

2.2.4 Physical and resource constraints (tentative)

At the gate:
- No engine power
- APU provides ~35 lbm/min air at 35 psi
- But APU also needed to operate air-cond. and electrical sys.

Take off & cruise:
- Plenty of engine air and power
- Must conserve to reduce fuel-consumption

Descent & taxi:
- Little power and bleed air
- May get power and air if APU is used

Pallet-mounted, fit through normal 757 door, operated inside passenger cabin, minimal connections - power and bleed-air in, N_2 & O_2 out, cooling air in & out.

2.3 Where to get the information for the RFI and RFP

Commerce Daily

NASA GRC AvSP website:
http://www.grc.nasa.gov/WWW/avsp/reports_fire_prevention.htm

Additional Boeing Reports

- Task-1 Aircraft Requirements
- Task-2 State of the Art OBIGGS / OBOGS

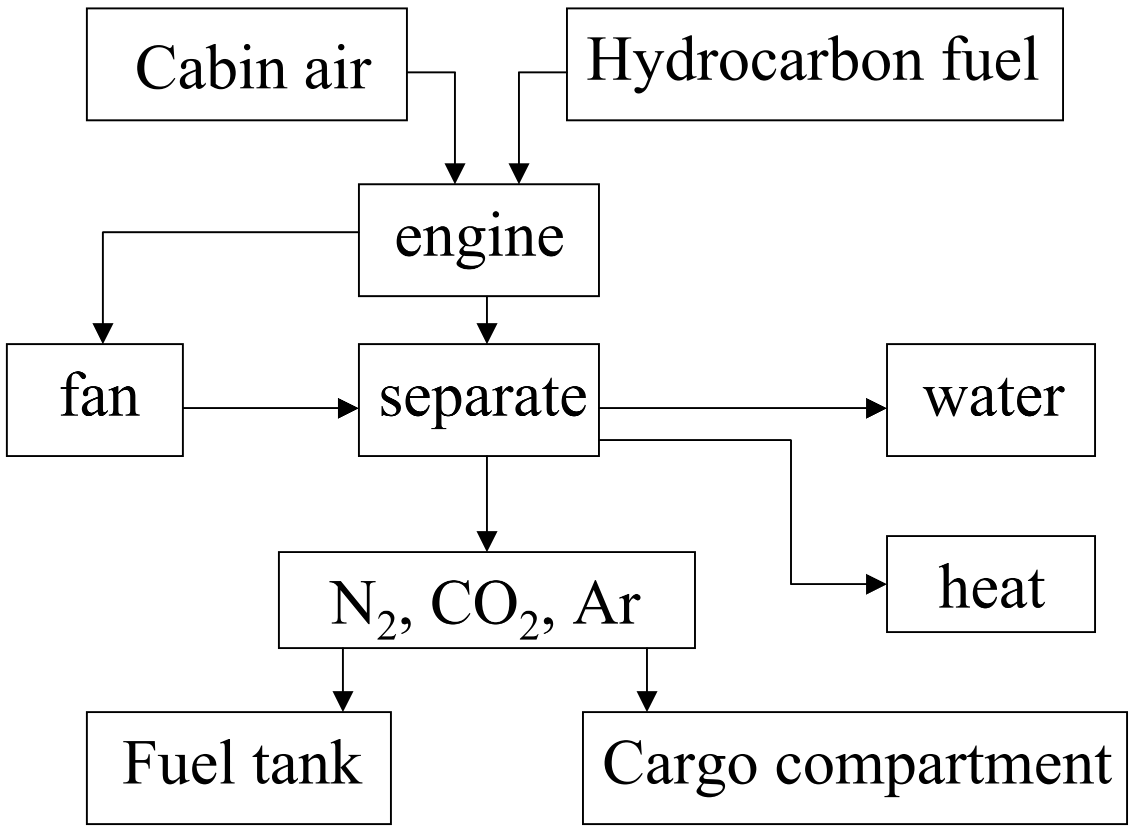
3. NASA’s In-House OBIGGS Work

3.1 Why a Non-N_2 based system?

- Fire doesn’t care about what kind of inert gas.
- Air-separation is hard.
- Oxygen removal is easy.
- Burning air removes oxygen.
- You can make burnt air much faster than
  air separation

3. NASA's In-House OBIGGS Work

3.2 Conceptual diagram



The devil is in the details, of course…

Here's our brick.
Let's see your jade.

3. NASA's In-House OBIGGS Work

3.3 How much fuel does it take to inert a B757 CWT?

species	fraction	mole count	wt	M	STP vol.	STP vol.	exhst fract
N2	0.782	66.4	1860	28			0.84
O2	0.209	17.8	568	32			
Ar	0.009	0.8	31	40			0.01
total air		84.9	2458	28.94	2.076		
C		12	144	12			
H		23	23	1			
total fuel			167			0.055	
CO2		12	528	44			0.15
H2O		11.5	207	18			
dry total		79.2	2418	30.5	1.936		
units		mole	gm	gm/mol	m3	gal	

B757 CWT: 7080 gal = 27 m^3 => 0.76 gal of fuel

How long does it take to fill up B757 CWT?

Assume a 5 HP lawn mower engine with 25% η,

Δh_{fuel}=42 MJ/kg, ρ_{fuel}=6.7 lbm/gal

it consumes fuel at 1.3 kg/hr or 0.4 gal/hr

or $[O_2]$ from 20% to 10% in ~o(1 hr.)

3. NASA's In-House OBIGGS Work

3.4 Other CO_2 issues under investigations

- How will dissolved CO_2 affect pump cavitation?

- How much more ignition delay will CO_2 chemical equilibrium introduce?

- How much will dissolved CO_2 retarding fuel coking?

- Will CO_2 blanketing the fuel and retard fuel vaporization?

4. Summary

NASA intends to develop OBIGGS/ OBOGS to offset the cost of inerting fuel tanks alone.

NASA intends to fund development of emerging technologies for ground-based technology demonstration in FY04 and flight test aboard the B757 (type of A/C) in FY05.

RFP for multiple-award $70k Phase I seed funding for 6-month feasibility study will be announced in 11/01. Check with NASA Glenn Aviation Safety web-page for details.

NASA's internal CO_2 program suggests relatively simple and feasible means of inertng fuel tank and suppressing cargo compartment fire.