The SkyHook HLV Aircraft

A Heavy Lift, Short Haul Vertical Transportation System

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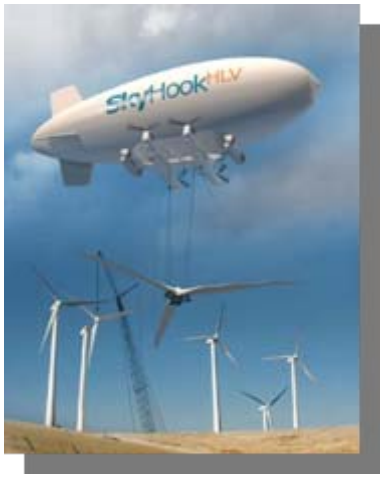
Introduction

Existing Arctic Logistics Alternatives

- **Trucks via Ice Roads**
  - Capable of carrying 100+ ton loads, but only two months per year
  - Thinner ice in a warming climate reduces operating window
  - Ice roads pose hazards to drivers
- **River & Sea Barges**
  - Capable of carrying 1000+ ton loads
  - Navigable approximately 5 months per year
  - Limited to areas that are accessible via water
- **Rotorcraft**
  - Sikorsky S-64 Skycrane
    - Out of production, 10 ton payload
  - Boeing Model 234 Tandem
    - Only 8 in existence, 12 ton payload
  - Sikorsky H-53
    - 16 ton payload
  - Russia Mil Mi-26
    - Only one available in Canada, 18 ton payload

SkyHook HLV
The World's Heaviest Vertical Lift Aircraft

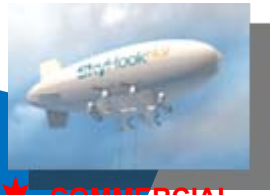
- **Vision — To commercialize the world's heaviest vertical lift aircraft, designed for remote operations and harsh conditions.**
- **The SkyHook Aircraft — Conceived and owned by Skyhook International Inc, engineered and developed by Boeing. More than twice the payload of any helicopter, capable of transporting loads at half the current helicopter price per ton. The aircraft can safely transport more than 40 tons, over 200 miles, at -30C, in zero visibility and 25 knot winds.**
- **Customers — Oil, gas and mine operators, construction contractors, governments and the military**



The first SkyHook HLV can be ready for commercial service by 2014

PROGRESS TO DATE:

- 2007:IP and initial funding secured
- 2007: Teaming Agreement signed with Boeing,
- 2008: Design frozen, main systems and equipment suppliers selected
- 2009: Full Logistics and detailed cost comparison carried out by Shell



Value Creation

Completed
Critical Systems Selection
Config Freeze
Conceptual Design

Prelim Design
Detailed Design
Certification
Assembly
Certification
Testing
Certification

COMMERCIAL DEPLOYMENT

Hardware & Equipment Purchases

NEXT STEPS: (6-12months)

- Engage customers with detailed proposals to secure contracts
- Secure funding through First Flight

2007 2008 2009 2010 2011 2012 2013 2014

The SkyHook HLV Aircraft
Operating Environment and Aircraft Performance

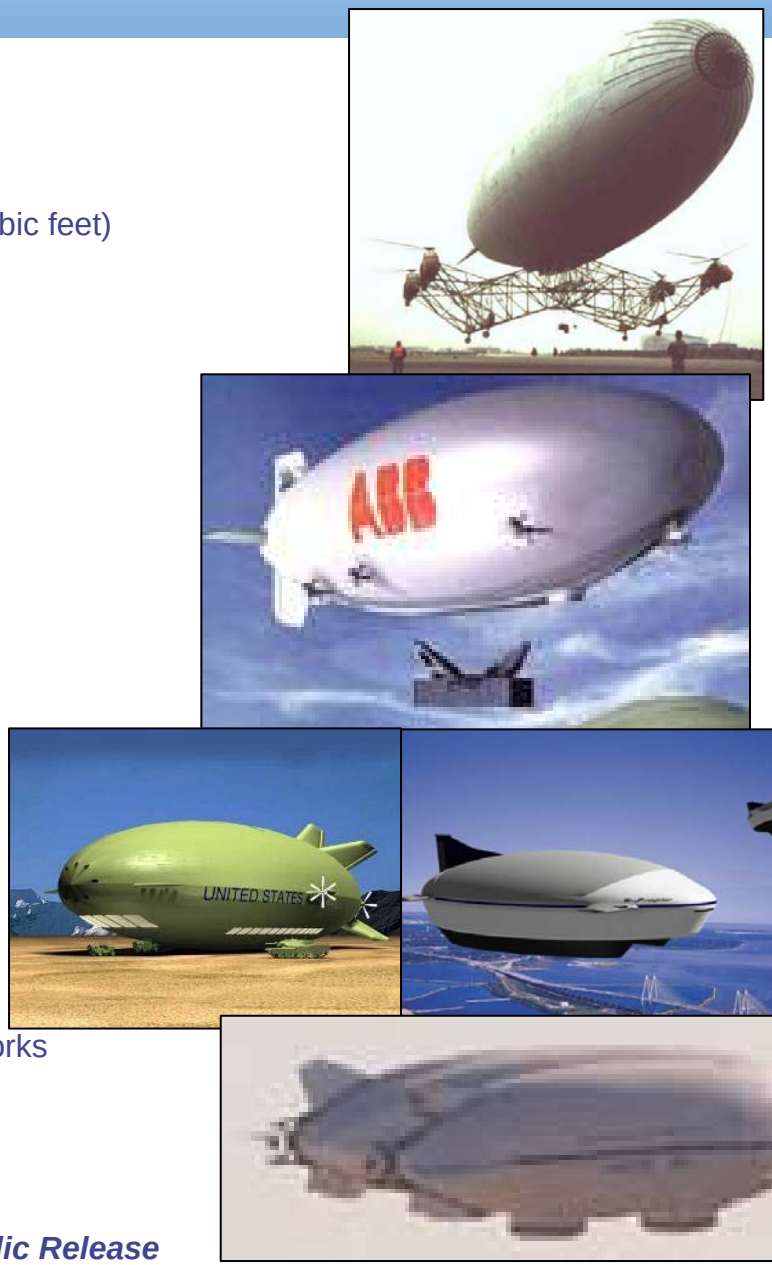
Previous Cargo Carrying Airship Attempts

- **Piasecki Model PA-97 HELI-STAT**
  - Built under a 1980 U.S. Navy contract for the Forest Service
  - The demonstration vehicle utilized
    - Navy ZPG-2W aerostat (volume greater than 1,000,000 cubic feet)
    - Four H-34J helicopters

- **CargoLifter CL 160**
  - Semi-rigid airship developed by CargoLifter AG
  - Design requirements
    - 160 metric ton lift capacity
    - Aerostat volume (volume greater than 4,500,000 cubic feet)
    - Range of up to 10,000 km
  - Company made an application for insolvency June 2002

- **DARPA Walrus**
  - Technology demonstrator for hybrid airship
  - Two contracts awarded – FY05
    - Lockheed ADP - $2.9M
    - Aeros Aeronautical Systems - $3.3M
  - Contract terminated FY-06 (Congress pulled funding)

- **Lockheed Martin P-791 Hybrid Airship**
  - Independent research and development project by the Skunk Works
  - First flight was witnessed by a few passers-by on Jan. 31, 2005

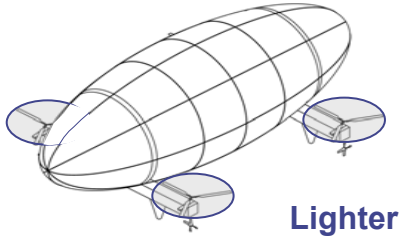


SkyHook Customer Requirements

- The aircraft shall operate in ambient air temperatures between -40C to +30C.
- The aircraft shall support loads from outdoor mooring in extended duration heavy weather conditions without the need of a hangar.
- The aircraft design shall be ITAR & EAR compliant for civil commercial export to Canada and shall be safe for civilly-certified manned operation
- The aircraft development shall be focused on performance levels achievable with COTS or modified COTS hardware
- The aircraft development shall maintain stability during variety of CONOPS missions

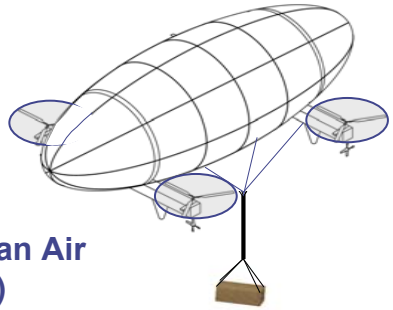
Why SkyHook Concept Is Different

- **Previous attempts fall into 2 categories**
  - Lighter Than Air (LTA) primary behavior
    - Yields stability & control issues
  - Helicopter primary behavior
    - Yields dynamics & safety issues



Lighter than Air (LTA)

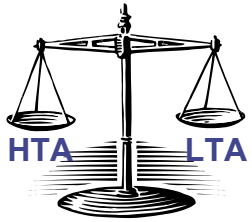
- **SkyHook is a neutrally buoyant aircraft**
  - Without payload: Acts as a controlled airship
  - With payload: Long reaction times would allow for "punching off" the load & regaining airship behavior



Heavier than Air (HTA)

Rotors only lift the payload which can be jettisoned during emergency restoring LTA flight characteristics

- **Previous attempts have tried to be all things to all people**
  - Universal requirements led to
    - Over complication of the design & missing fundamental behavioral issues
    - Unacceptable growth of cost & schedule



Hybrid

- **SkyHook is being developed specifically for remote Arctic Operations**

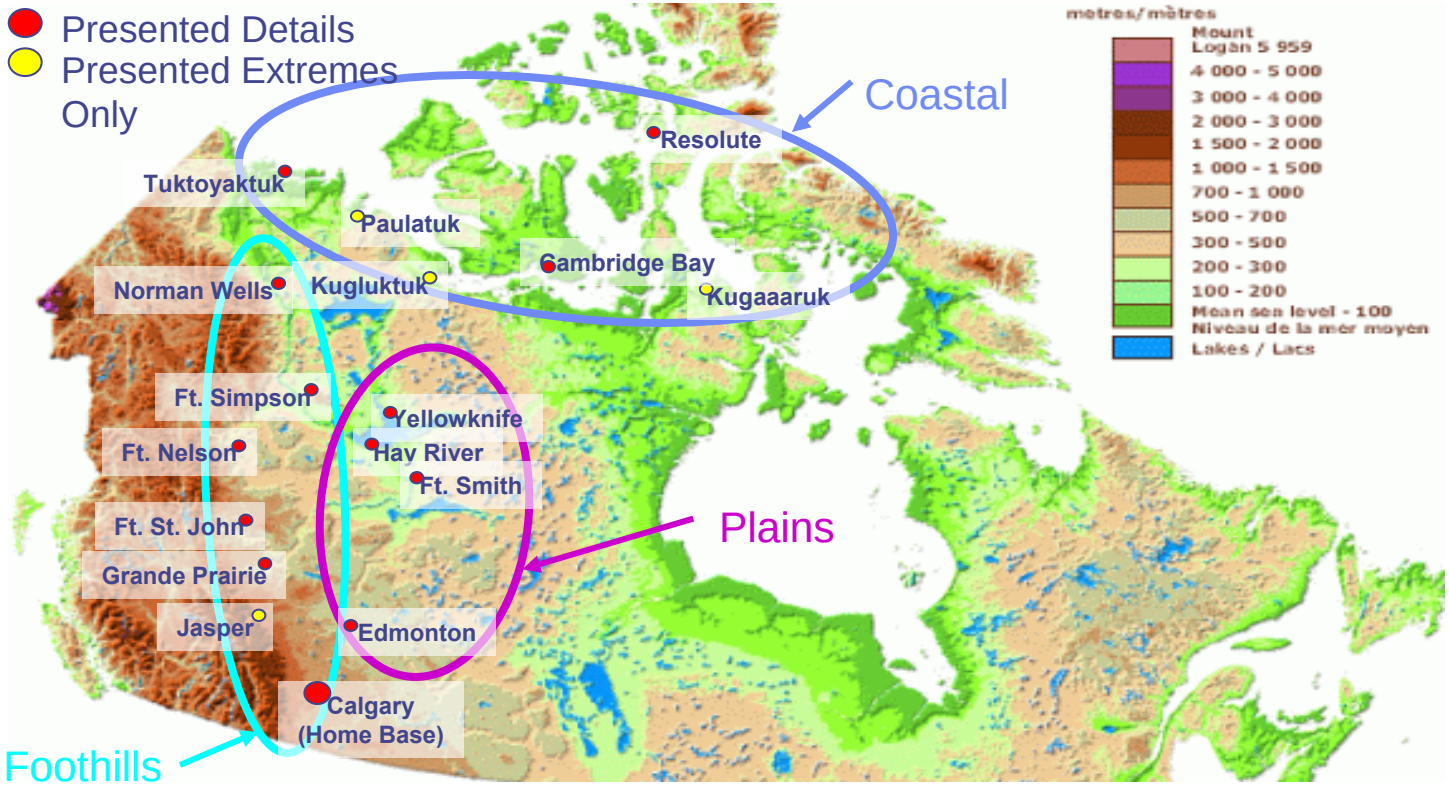
- **SkyHook is focused on less tonnage & shorter distance hauls (i.e. "the last mile")**

SkyHook Configuration 3E CSS Midpoint March 2009

Major features: Three-piece tail, Elimination of thrusters, COTS Propulsion, Four-piece ballonet, Improved LTA to Structure Interface

Aircraft Operating Spectrum Environmental Study Overview

- Selected 39 years of climate data from the Canadian National Climate Data and Information Archive (Jan 1st 1970 to Dec 31st 2008) http://www.climate.weatheroffice.ec.gc.ca/climateData/canada_e.html
- Selected 13 locations of interest for detailed examination and additional 4 locations for data on extremes.



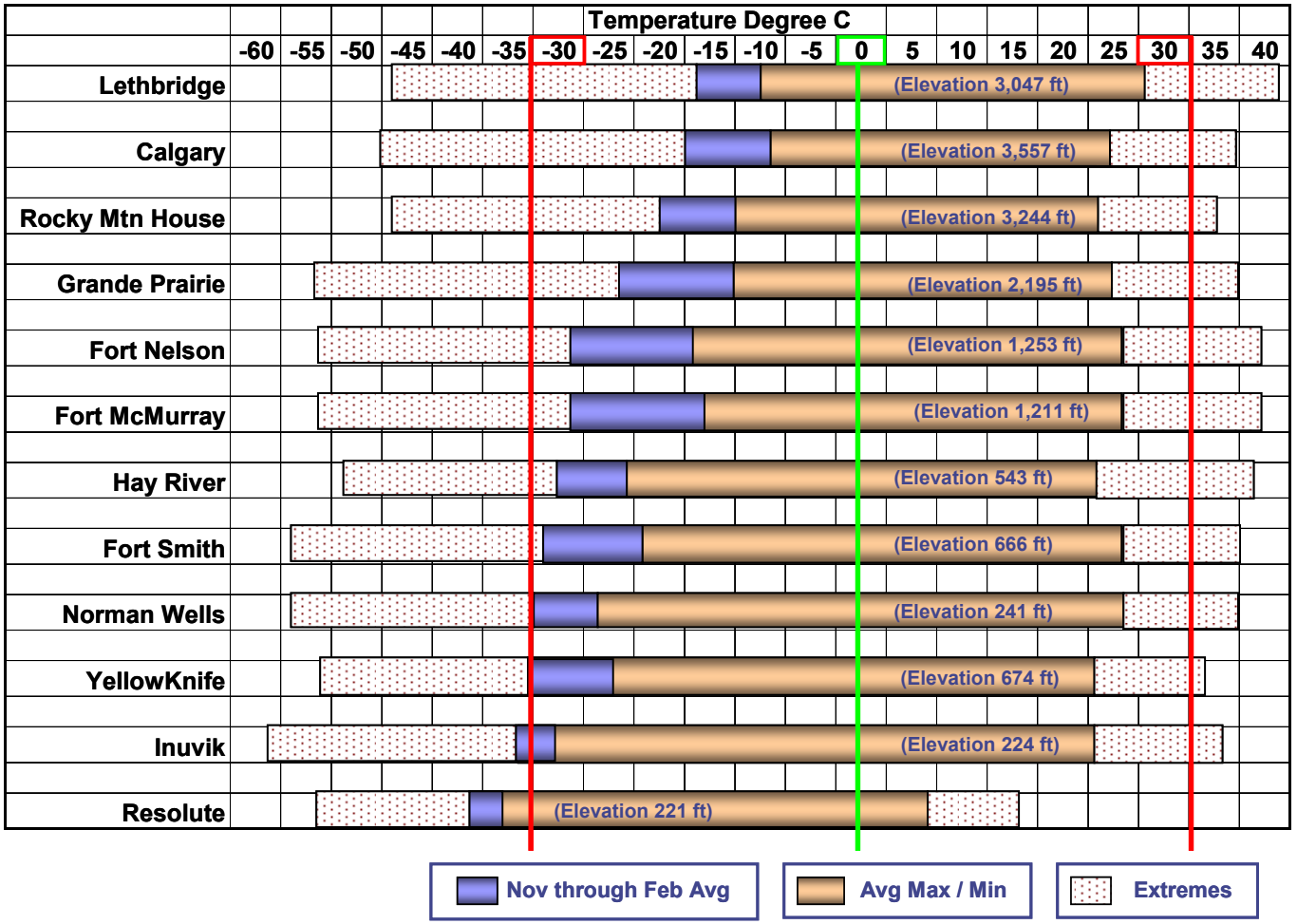
Key Environmental Parameters

Full environmental survey addresses the following parameters:

- Temperature
- Wind
- Blowing Sand & Dust
- Hail
- Fog
- Thunderstorms / Rain Rate
- Snow
- Ice

Significant design drivers

Temperature Effects

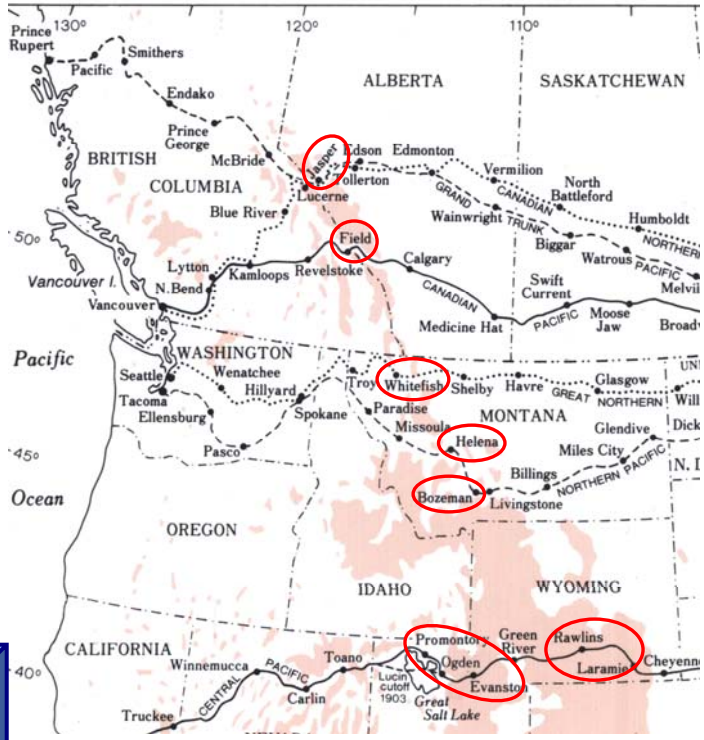


Aircraft Operational Temperature Range -30C to +30C
Aircraft Survival Temperature Range -53.9C to +50C

Aircraft Service Ceiling

- Mission scenarios: <4,500 feet with an external payload
- Ferry mission scenario: >4500 feet for improved performance (No external payload)

- Limiting factor will be the ballonet system
- Considering the ballonet constraint and typical mountain passes, a service ceiling of 6,000 ft has been established



Jasper = 5,680 ft

Field = 4,078 ft

Whitefish = 3,036 ft

Helena = 4,058 ft

Bozeman = 4,950 ft

Promontory = 4,902 ft

Ogden = 4,300 ft

Evanston = 6,749 ft

Rawlins = 6,755 ft

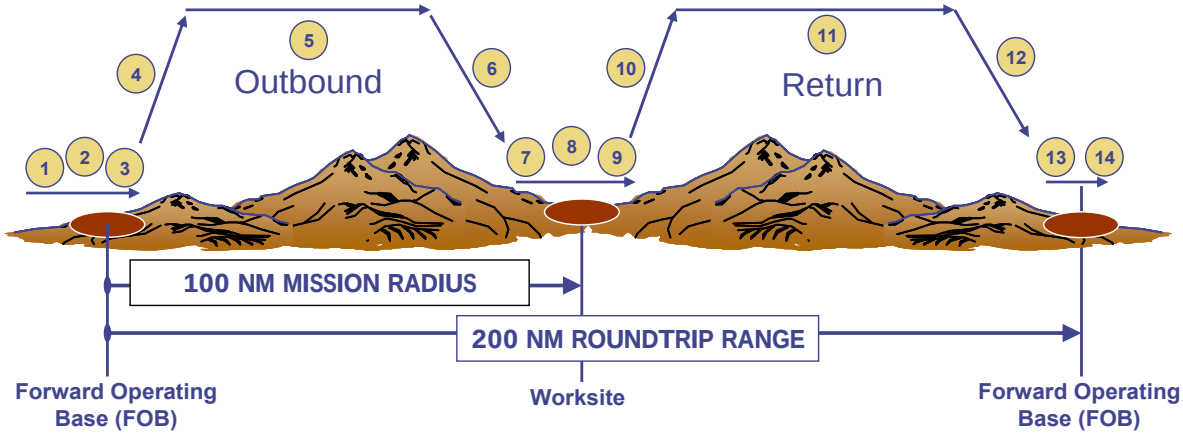
Laramie = 7,165 ft

Example mountain passes in the US and Canadian Rockies

Service Ceiling Limited to 6,000 ft

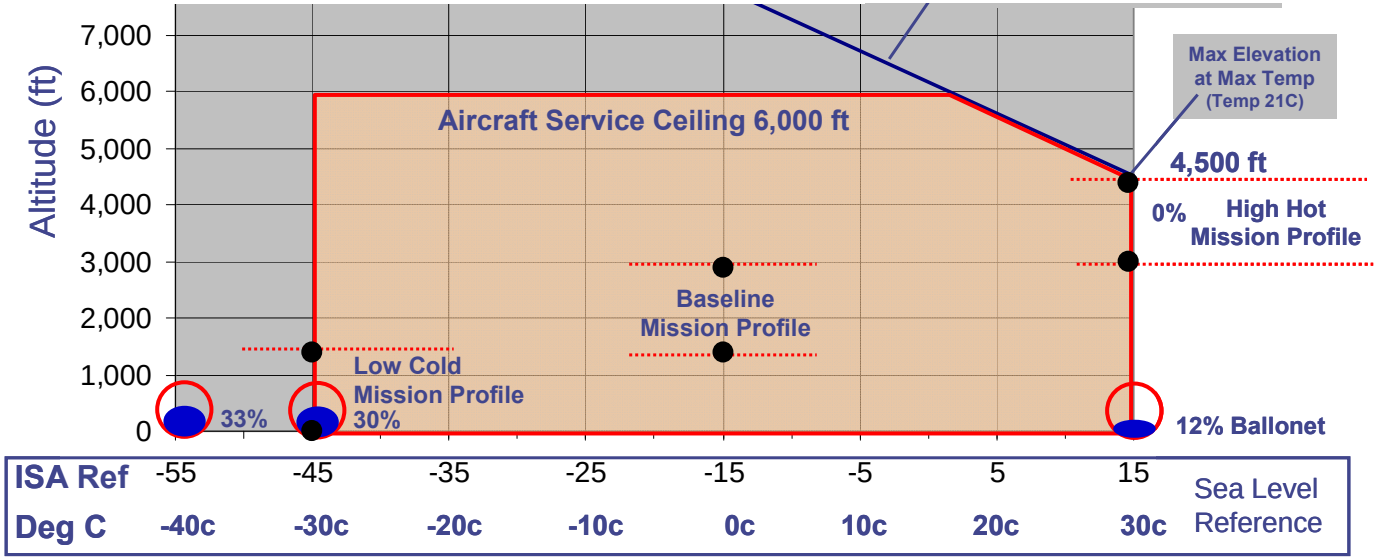
Mission Profile & Operating Envelope

Mission Profile



Shown as straight line graphic but it is assumed there is only one FOB and therefore out to worksite and return to same location

Operating Envelope



Wind Survivability

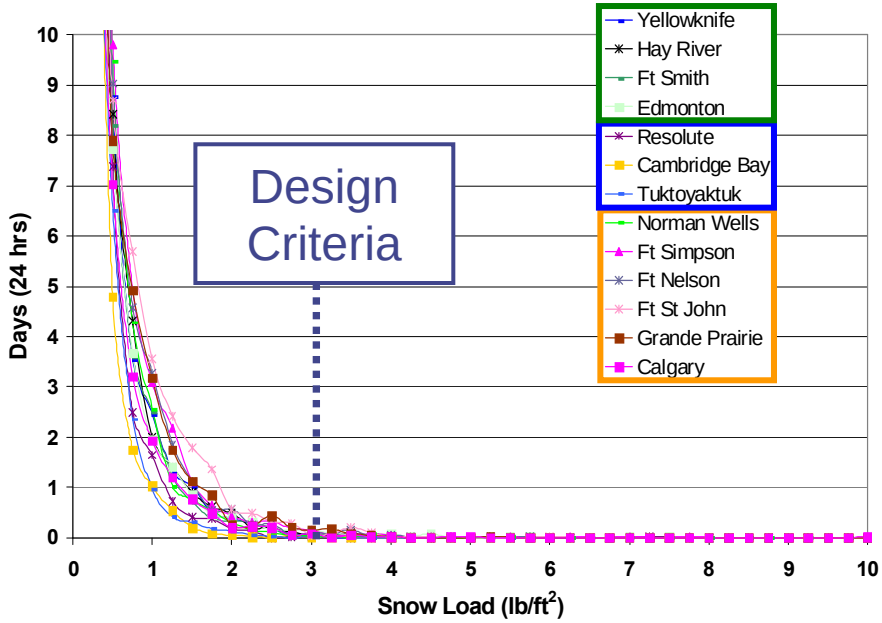
- Over 50 recorded Hurricanes as far back as 1927
- Only (10) storms with recorded winds above 70 kts

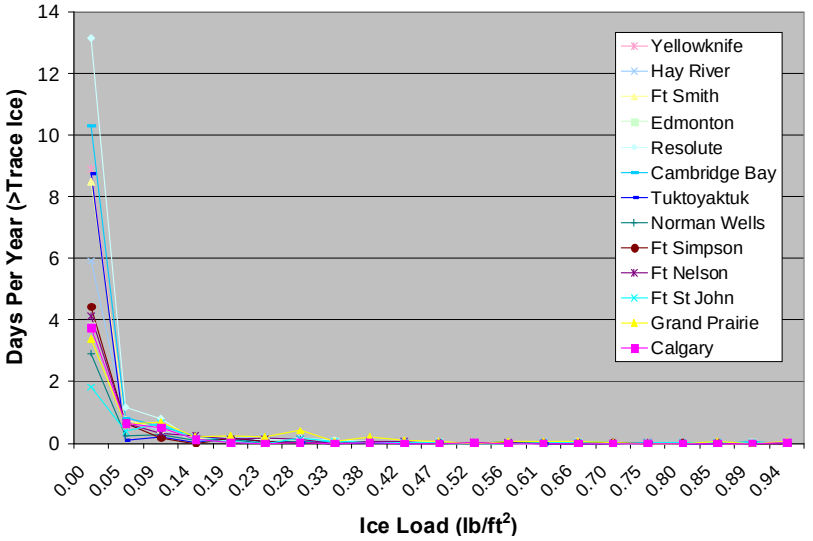
Year	Location	Wind (kts)	Comment
2003	Bedford Basin at head of Halifax Harbour	125	peak gust
2003	Gore, NS	115	highest winds
2000	St. Lawrence	93	gusts
1927	Gulf of St. Lawrence & Newfoundland	90	
2006	Sagona Island	88	peak wind gusts
2003	McNabs Island in Halifax Harbour	85	peak wind gusts
2000	St. Lawrence	80	Max wind speeds
1989	Sable Island, Nova Scotia	77	gusts
2004	northeast coast of Newfoundland	77	gusts
2006	St. Lawrence	72	peak wind gusts
1975	Halifax, Nova Scotia	70	gusts
1980	185 km SE of Cape Race, Newfoundland	70	Max wind speeds
1995	eastern Newfoundland	70	gusts
2001	Cape Race	70	gusts
2006	St. Pierre	69	peak wind gusts
1977	near the southwest tip of Newfoundland	68	gusts
1979	Sable Island	65	sustained
1989	Sable Island, Nova Scotia	65	sustained
1996	Cape Breton Highlands	65	gusts
1996	Atlantic Canada	65	Max wind speeds
2002	St. Paul Island & Sable Island	65	Max wind speeds
2006	Nova Scotia	64	peak winds
1999	east coast of Newfoundland	63	gusts
1998	Southwestern Grand Banks buoy	62	gusts

http://www.atl.ec.gc.ca/weather/hurricane

Severe weather events that result in winds in excess of 70 kts are assumed to be able to be predicted far enough in advance to relocate the aircraft

Snow & Icing Effects





- ***Aircraft will be designed to a moored snow load capability of 3 lbs/sq. ft in a 24 hr period.***

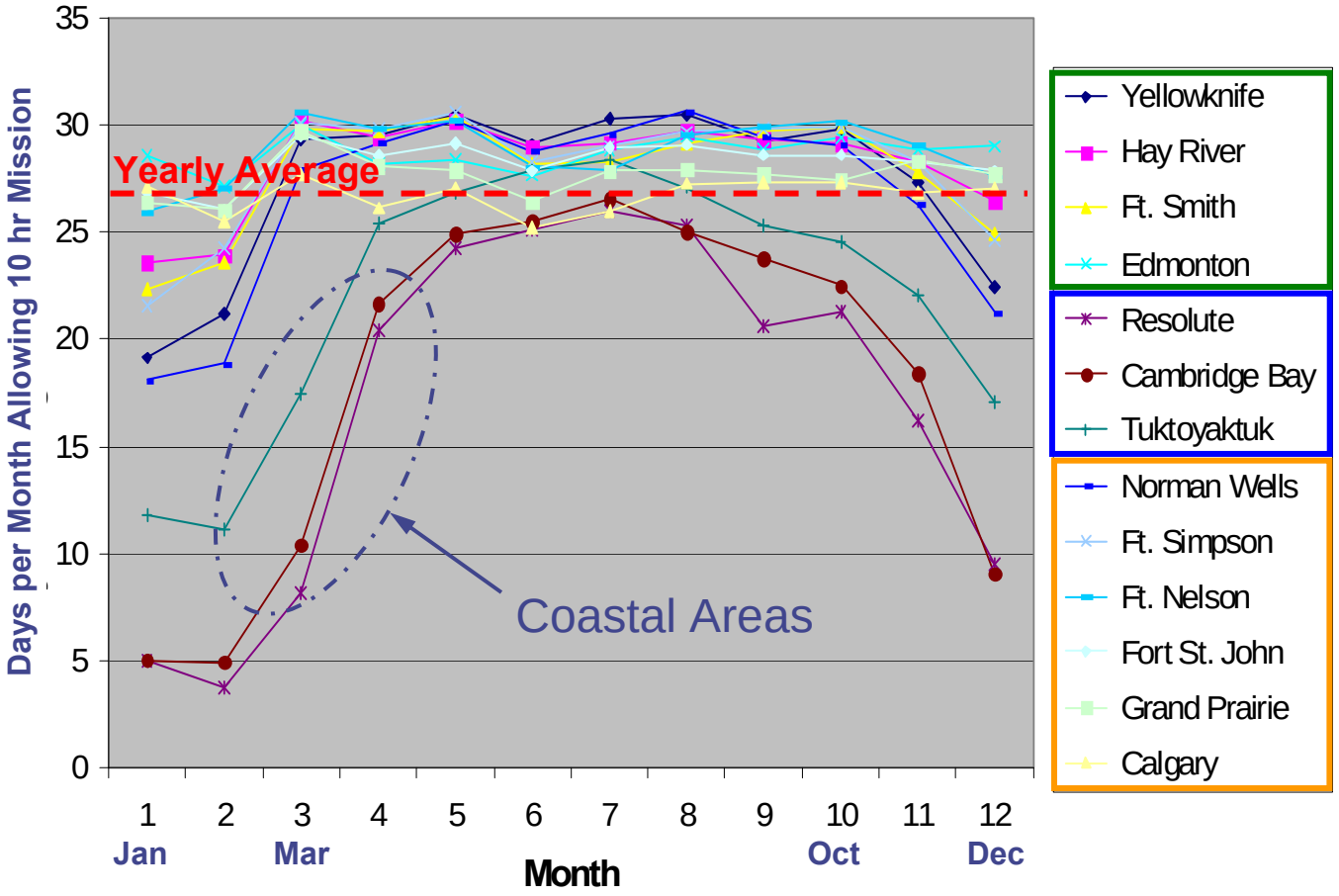
- ***Aircraft will not fly during known icing conditions. Inadvertent icing will be addressed via on-board detection/removal systems.***

- ***Ground Systems will be capable of excess snow and ice removal from critical areas during mooring.***

Aircraft Availability

Environmental Constraints

Baseline Flight Conditions	
MinVisibility (mi)	0
MinTemp (C)	-30
MaxTemp (C)	30
MaxWind (kts)	20
Fog	Yes
Hail	no
Thunderstorms	no
Light, Moderate Rain	yes
Light, Moderate Snow	yes
Heavy Rain	no
Heavy Snow	no
Blowing Sand & Dust	no
Rest Period (hrs)	2

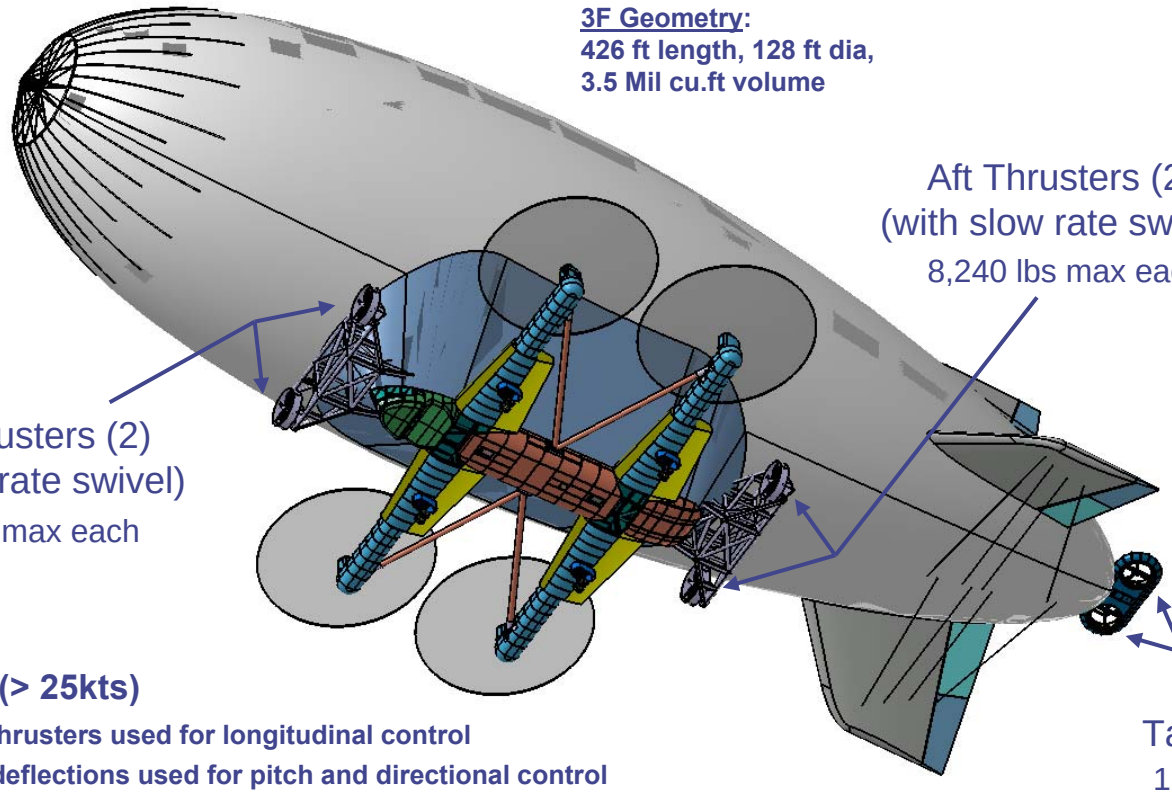


Environmental conditions allow SkyHook operations up to 260 days per year (26 days per month, 10 months per year) with 10 hr missions per day

Theory of Flight

Thrust values quoted for 1,500 ft, 0°C, 0 kts ambient conditions

3F Geometry:
426 ft length, 128 ft dia,
3.5 Mil cu.ft volume



Aft Thrusters (2)
(with slow rate swivel)
8,240 lbs max each

Note: Thrusters are forward facing for cruise and swiveled into the "X" configuration for station keeping

Fwd Thrusters (2)
(with slow rate swivel)
8,240 lbs max each

Tail Thrusters (2)
1,450 lbs max each

- **High speed flight (> 25kts)**
  - **Forward and aft thrusters used for longitudinal control**
  - **Tail surface flap deflections used for pitch and directional control**
  - **Rotor collective is used symmetrically for vertical control and differentially for roll control**
  - **Ballonets filled differentially for trim pitch control**
- **Low speed flight (< 25kts)**
  - **Forward and aft thrusters used differentially for longitudinal, lateral, and directional control**
  - **Tail thrusters used for pitch control**
  - **Rotor collective is used symmetrically for vertical control and differentially for roll and pitch control**
  - **Rotor lateral cyclic is used symmetrically for lateral control and differentially for yaw control**
  - **Ballonets filled differentially for trim pitch control**

Basic Maneuvers

- Maneuver list
  - 90 degree heading change at 50 kts cruise
  - Climbing flight at 10 and 50 kts
  - Acceleration/Deceleration from hover to 50 kts
  - Longitudinal and lateral reposition
  - Hover turn
  - Hover station keeping in lateral crosswinds
  - Hover station keeping in wind shift
  - Hover station keeping in light turbulence

Flying Qualities Summary
Cruise Maneuvers

Maneuver: Cruise Turn

Configuration	Angle of Attack (deg)	Turn Radius (mi)	Steady Turn Rate (deg/sec)
IPU	2	0.35	3.20
MMDO	-5	0.37	2.95
HIFR	-5	0.31	3.75

Maneuver: Climb

Configuration	Increase in Thrust per Rotor for 300 ft/min Climb at 10 kts (lbs)	Increase in Angle of Attack for 425 ft/min Climb at 50 kts (deg)	Increase in Thrust per Rotor for 425 ft/min Climb at 50 kts (lbs)
IPU	1900	3.25	4500
MMDO	1800	3.25	4000
HIFR	1700	3.25	3700

Maneuver: Accel./ Decel.

Configuration	Time to Accelerate to 50 kts (sec)	Time to Decelerate from 50 kts (sec)
IPU	113	174
MMDO	93	174
HIFR	82	210

Basic Cruise Maneuvers are Acceptable

Flying Qualities Summary
Hover Maneuvers

Maneuver: Reposition

Configuration	Longitudinal Reposition (seconds)	Lateral Reposition (seconds)
HIFR	84	95
MMDO	90	100

Maneuver: Light Turbulence

Configuration	0 kts Headwind Success Probability (%)	15 kts Headwind Success Probability (%)
MMDO	76	36

Maneuver: Hover Turn

Configuration	Max Yaw Rate (deg/sec)	95% of 5 deg/sec Steady State (seconds)	Heading Change in 2 Seconds from Rest (degrees)
Requirement	5.0	6.00	2.00
HIFR Capability	7.0	7.95	0.65
Mid-Mission Drop-Off Capability	7.5	6.50	0.73

Maneuver: Light and Variable Winds

Configuration	Maximum Drift (ft)
MMDO Hold Heading	19
HIFR Hold Heading	40
MMDO Turn Into Wind	19
HIFR Turn Into Wind	65

Maneuver: Wind Shift

Configuration	Headwind (kts)	Wind Shift (deg)	Wind Shift Rate (deg)	Maximum Drift (ft)	Thruster Orientation Angle (deg)
MMDO	15	45	1	27	25
HIFR	15	45	1	26	25

Hover performance has improved with remaining concerns when the aircraft is near zero fuel weight and when the combination of high winds and turbulence are present

Emergency Flight Conditions

- A preliminary hazard analysis identified the following configuration categories that were evaluated in the CSS phase
  - One Lifter Engine Inoperative
  - Lifter System Shutdown (one complete arm)
  - Two Main Thrusters Disabled
  - One Tail Surface Jammed Hardover

All Emergency Conditions Studied to Date Are Well Within Control Margin & Aircraft Capability

Aircraft Sizing Missions

Baseline Ambient Conditions

Ambient: 0 deg C

Takeoff/Payload Exchange/Landing: 1,500 ft

Cruise: 3,000 ft

Payload Variation

40 tons Out / 40 tons Back

40 tons Out / 0 tons Back

0 tons Out / 40 tons Back

0 Tons Ferry Mission

40 / 0 will be used as the primary mission to compare impact of ambient conditions

Low/Cold

Ambient: -30 deg C

Takeoff/Payload Exchange/Landing: Sea Level

Cruise: 1,500 ft

High/Hot

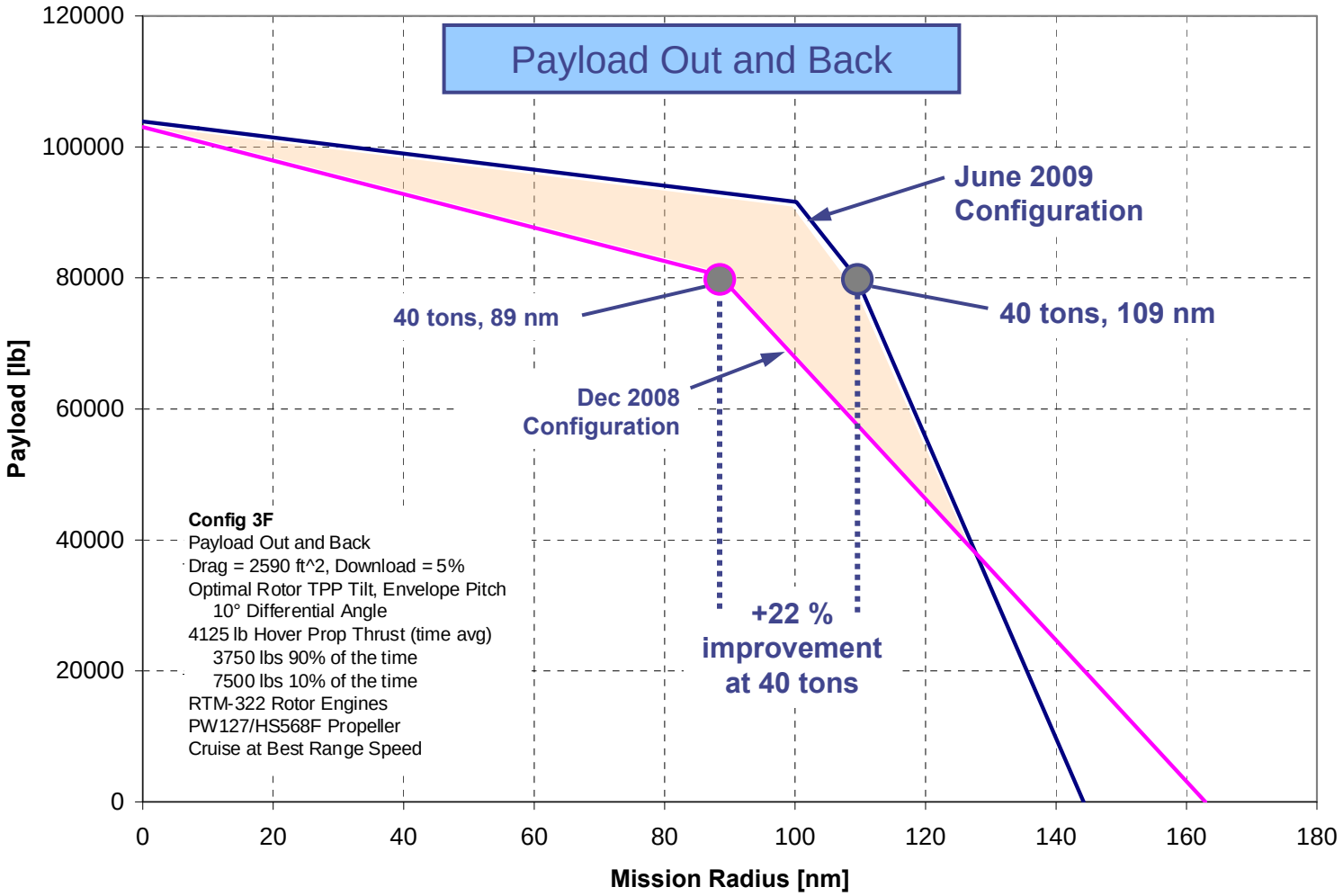
Ambient: +30 deg C

Takeoff/Payload Exchange/Landing: 3,000 ft

Cruise: 4,500 ft

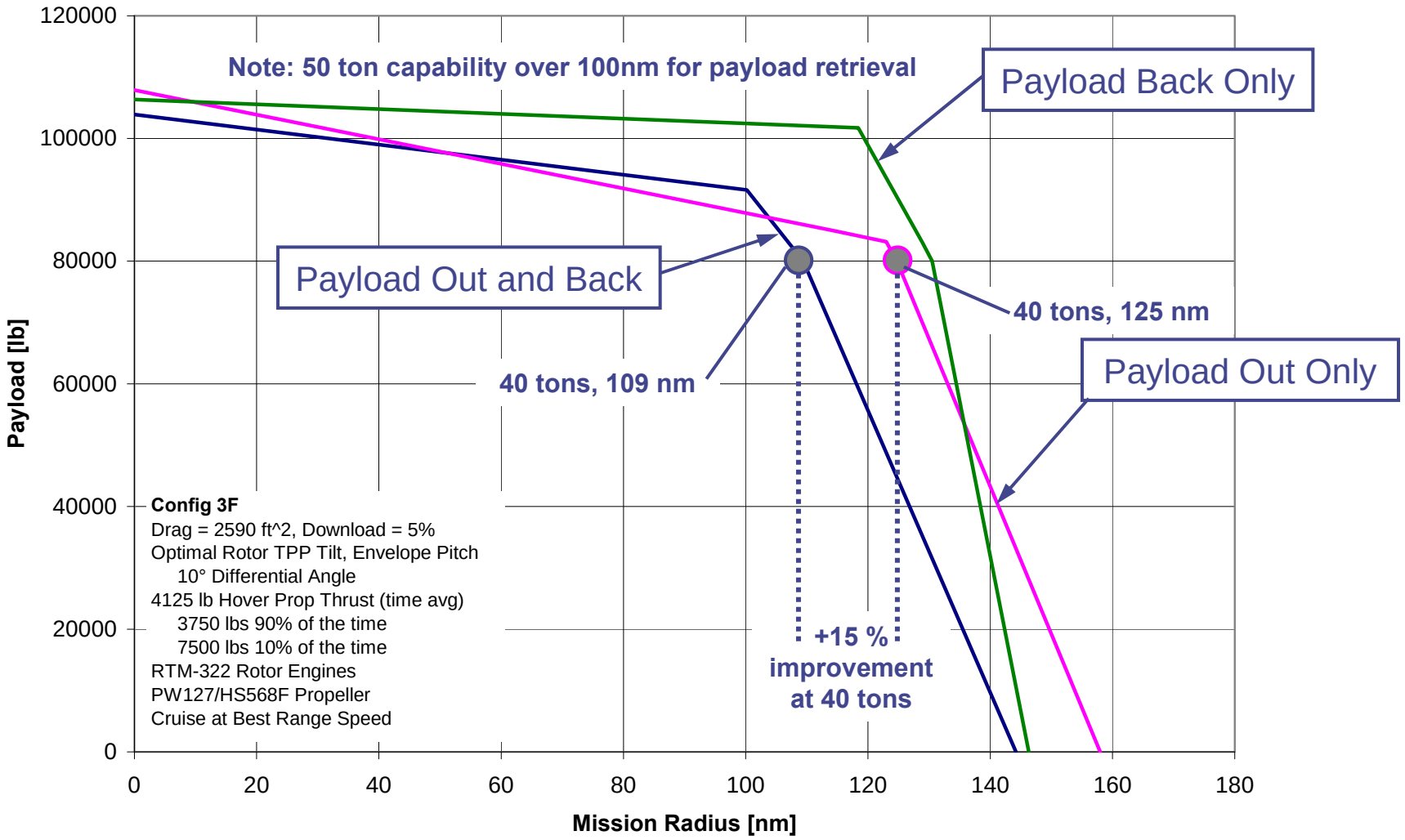
Most recent business case activity suggests 40 tons out and 0 tons back is the most representative vehicle sizing condition

Mission Performance
Dec 2008 to June 2009 Comparison



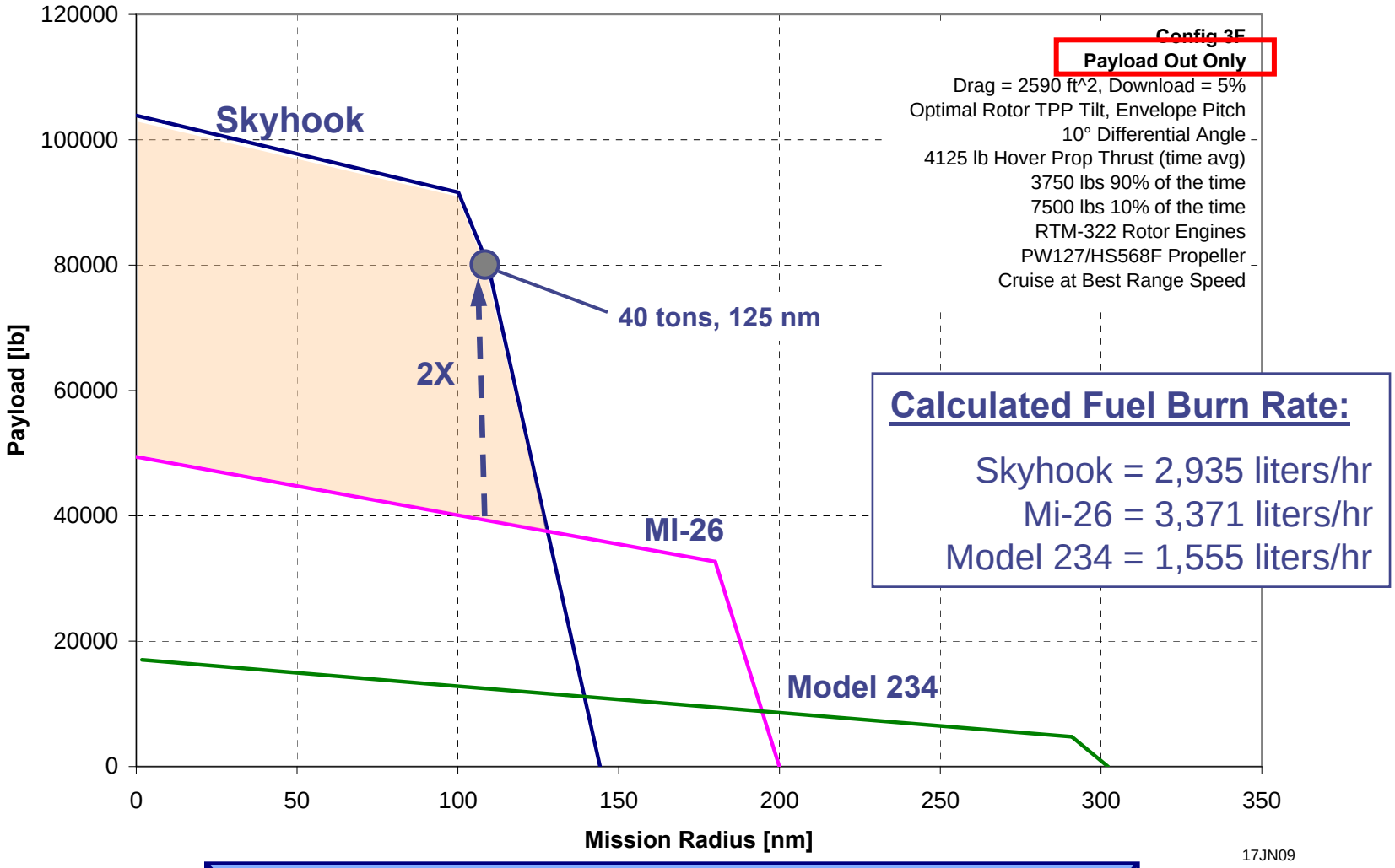
For all Payloads above 20 tons the vehicle performance has improved since December 2008 configuration

Mission Performance
Impact of Varying Payload Out & Back



40 Ton Out Only Payload Increases the Mission Radius to 125 nm

Mission Performance Comparison



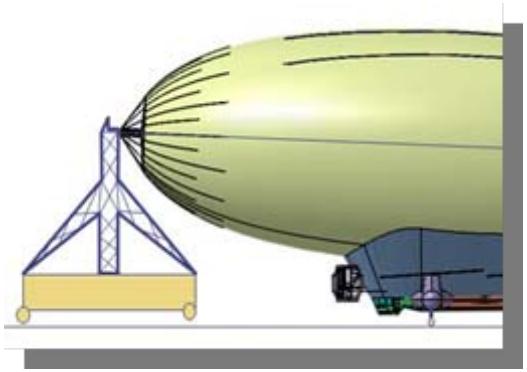
Calculated Fuel Burn Rate:

Skyhook = 2,935 liters/hr
Mi-26 = 3,371 liters/hr
Model 234 = 1,555 liters/hr

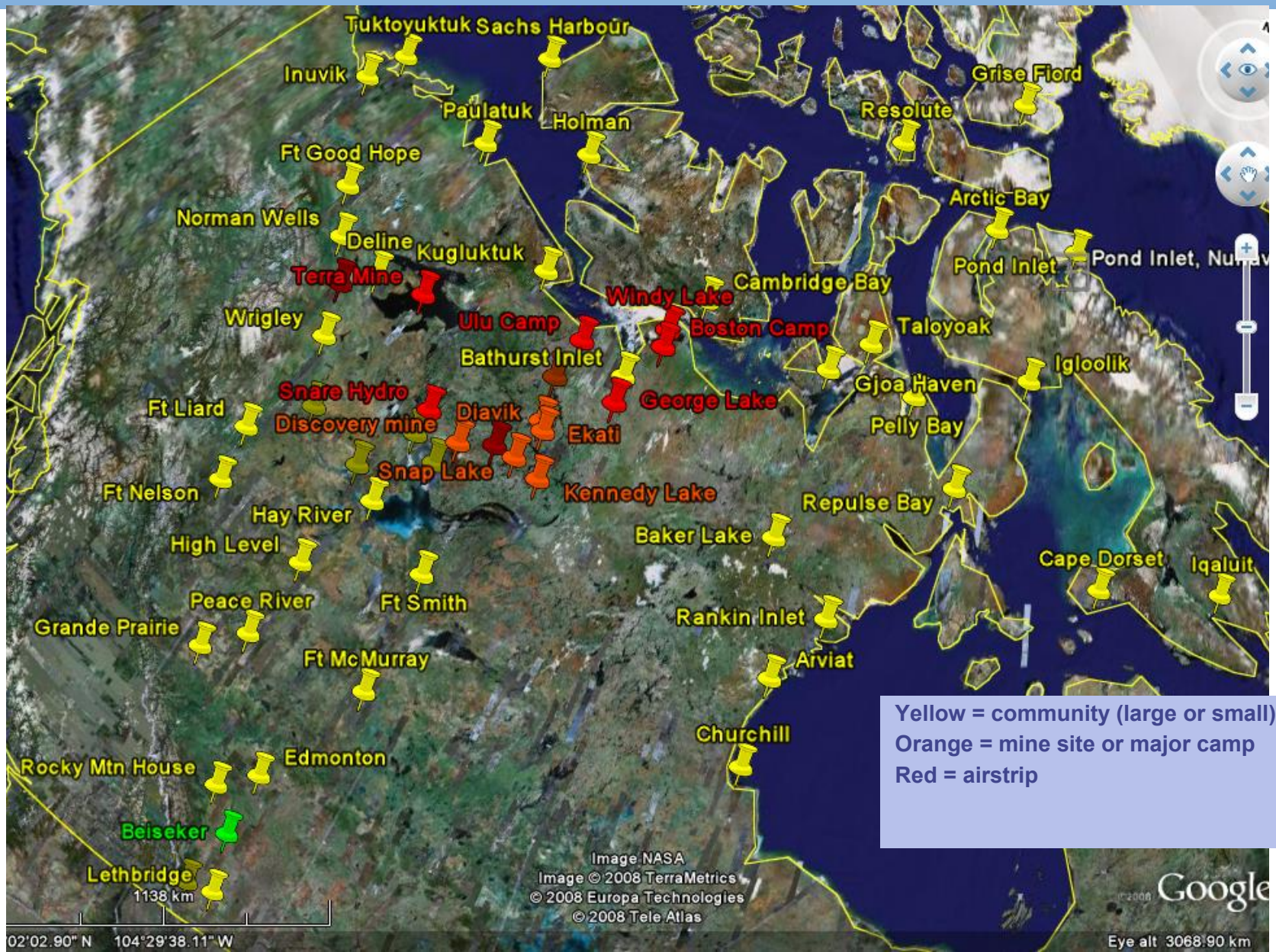
With Skyhook there is a 2X increase in payload out to 125 nm compared to the Mi-26

SkyHook CONOPS, Operating Bases and Transport Defined

- Main Operating Base (MOB)
  - Main Hangar Location
  - Annual Maintenance & Overhaul Capability (mid winter)
  - Possible Manufacturing / Production facility
- Forward Operating Base (FOB)
  - Leverage existing airports or dedicated staging areas
  - Typically 1000x1000 ft outdoor masting area with gravel surface
  - Refueling capability, ground power & jet fuel storage
  - Portable Nose Mast
  - Resupply with fuel via rail, road or river
- Transport to Operating Base
  - SkyHook HLV can ferry itself unloaded with extended range fuel tanks up to 800 nm
  - Aircraft can also be transported by barge over longer distances



Potential FOBs and Fuel Depots



Yellow = community (large or small)
Orange = mine site or major camp
Red = airstrip

FOB Example Inuvik Airport

Inuvik - YEV

General Information

Distance from Community: 12 km E
Population: 2001 - 2,894
Aircraft Movements: 2004 - 17,406
Operations Contractor: GNWT
Contractor Telephone: (867) 777-2467
Administered by: YEV

Facilities

Primary Runway: 06/24
Type: Asphalt
Size: 6000' x 150'
Secondary Runway: N/A
Type: N/A
Size: N/A

Air Trafic Services

For ATS information, see the Canada Flight Supplement or contact NavCanada

Air Terminal Building	Telephone	Aviation Fuel	Restaurant	Car Rental
Y	Y	Y	Y	Y

Visual Aids / NAVAIDS - Navigational Aids

Approach Lighting Runway 06 - SSALR High Intensity
Approach Lighting Runway 24 - Omni Directional (ODALS), VASIS-V2
High Intensity Runway Edge Lights / Threshold and Runway End Lights
Strobe Beacon
Windsock

Airport Inuvik

Business Case Example

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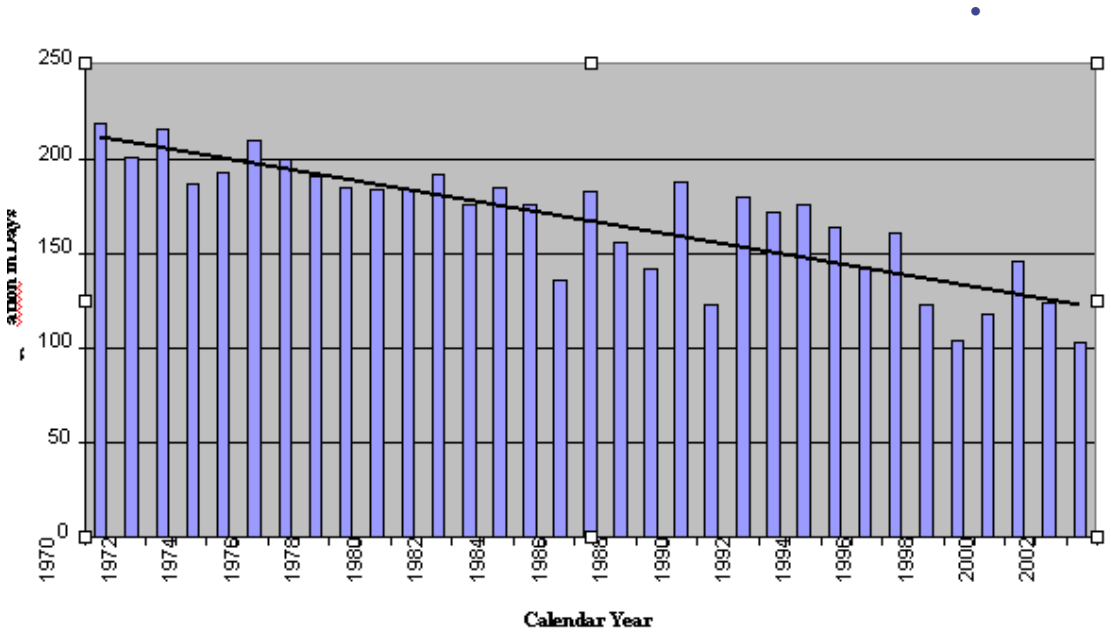
Shortening Ice Road Season

•Conventional ice road access season has been reduced substantially. The Alaska winter drilling season has been reduced from 200 days to 100 days since 1973 to 2003. The short winter drilling season means:

-A drilling program can only cover 1 well per rig/year when using ice roads

-Deep /long wells cannot complete in one season



Oil Rig Move-Payloads

- **For a single rig, need to move ~ 100 loads, drill and disassemble time measured in days**

Result

It may take about the following number of lifts to move each mobile rig

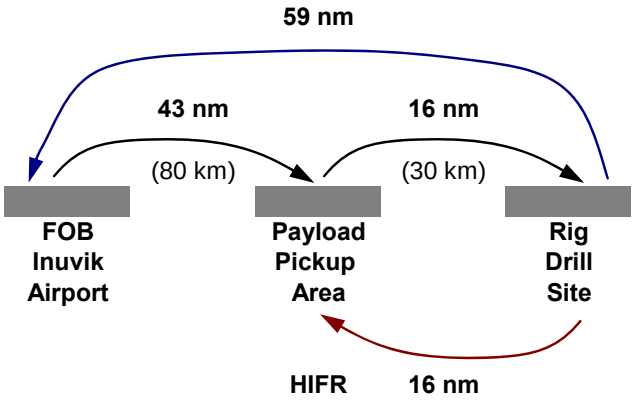
o	Rig	43 to 115 loads	Average 57
o	Camp	6- 18	Average 14
o	Materials		
o	Chemicals	8-10	Average 9
o	OCTGS	12	Average 12
o	Fuel	4	Average 4 every 5 days
o	Water	4	Average 4 every 5 days
Total		77 - 163	Average 100

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	29	30	31	32	33	34	35	36
Staging																																								
Setup (9) Days																																							
Construction																																							
Assume 25 loads required										6	6	6		6	1																								
Rig Move																																							
Assume 75 loads required																						6	6	6		6	6	6	6		6	6	6	6		6	3		
Aircraft Ferry Flight																																							
Hay River to Inuvik																																							
Inuvik to Hay River																																							
Assumed bad weather no fly day																																							
Completing site for delivery of oil rig																																							
Ferry Flight to FOB																																							

Inuvik Oil Rig Move
Key Parameters

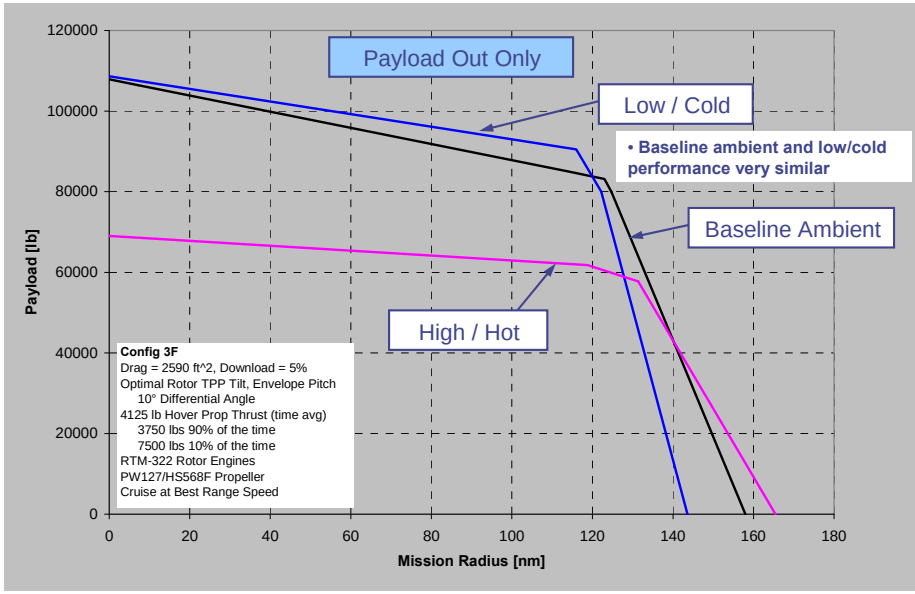
- **Assumptions**
  - **Aircraft FOB is located at Inuvik, 80km to Payload Pickup Area and 30km to Rig Drill Site**
  - **All hover segments will be at Sea Level and 0 degree C**
  - **Cruise at nominal height above ground**
  - **Aircraft does not land at the Payload Pickup Area**
  - **Assume mission profile as proposed does not exceed 9 hrs to accommodate crew rest requirements**
  - **Total Payload to be delivered – 100 loads at an average weight of 34 tons (40 tons X 85% load utilization factor = 34 tons)**

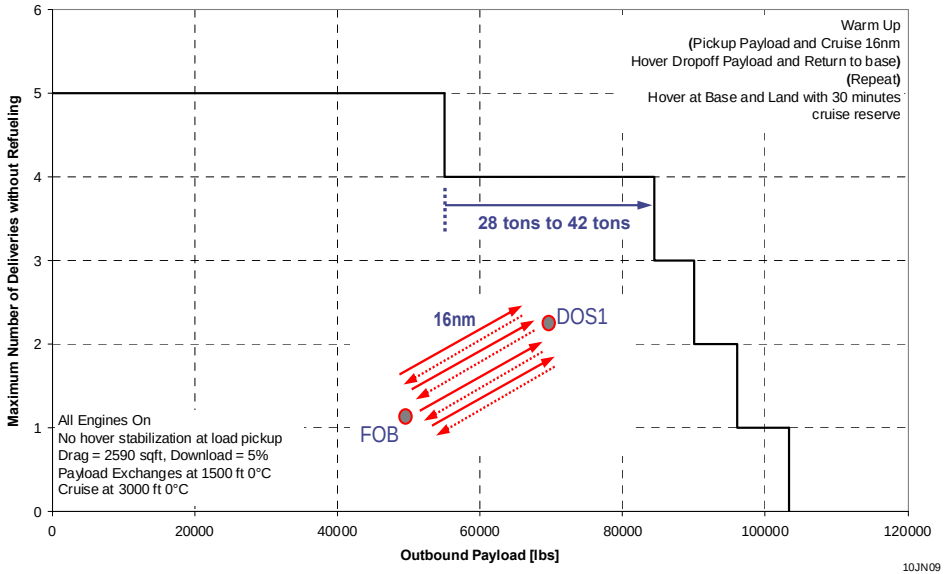
- **Questions**
  - **How many payload deliveries to the Rig Drill Site can be accomplished per day?**
  - **What is the total daily mission time?**
  - **What is the total fuel burned (less reserves)?**
  - **How many days will it take to move all 100 payloads?**



Inuvik Oil Rig Move Results

- **Aircraft Capability**
  - -Six (6) payload deliveries of 34 tons can be accomplished utilizing one flight crew with total "rotor turning" time of 6 hrs
  - -Total fuel burned of 39,000 lbs or 5,735 gal or 21,700 liters
- **Conclusion**
  - •A Single Skyhook HLV with 10 months per year availability has the potential to dramatically improve oil & gas exploration cycle times
  - •Capable of yielding up to 10X the number of exploratory & production rig moves per year vs. conventional arctic transportation methods





Next Steps

Next Steps 2009 -2010

- Continued Customer and Stakeholder Engagements
  - Major and Second Tier Oil and Gas Companies
  - Pipeline Companies
  - Mining Operators
  - Wind Farm Construction Companies
  - Heli-logging Operators
  - Government and Military

- Fund Raising through First Flight

- Execute Detailed Design & Order Long Lead Items