# AIR LAUNCH

# *AirLaunch's QuickReach™ Small Launch Vehicle: Operationally Responsive Access to Space*

*Presented to:*
**Utah State Small Satellite Conference**
*Session IX – Launch Systems*

*Debra Facktor Lepore*
*President, AirLaunch LLC*
*DFLepore@AirLaunchLLC.com*

*Joe Padavano*
*President, Delta Velocity*
*JPadavano@DeltaVelocity.com*

**Logan, Utah**
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# *QuickReach™* Small Launch Vehicle

→ QuickReach™ is an air-launched, containerized, self-pressurizing liquid two-stage rocket

- – Small satellite performance – 1,000 lbs Low Earth Orbit
- – Responsive – Less than 24hrs from call up to flight
- – Low Cost – Less than $5M per flight
- – Safe & Readily Available Propellant – Liquid oxygen, propane
- – Flexible – All launch azimuth "Flying Range" from cargo aircraft

→ Meets the DARPA / Air Force Falcon Small Launch Vehicle requirements

→ Leads to new spacelift capabilities for multiple customers



C-17 Aircraft

Airborne Support Equipment

LOX    $C_3H_8$    LOX
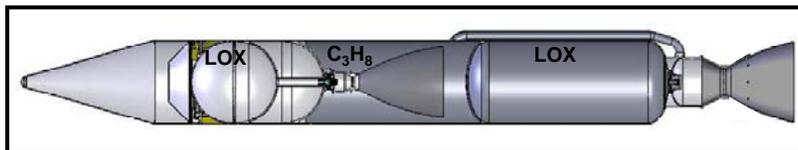
**Provide extraordinary capability with ordinary technology**

# Proven Team of Industry & Government Partners

**AIRLAUNCH**
Program Management
Systems Engineering
Design & Integration
*Kirkland, WA*

**AMES RESEARCH CENTER**
Small Payload Collaboration
*Moffett Field, CA*

**NASA**

**WESTERN TRAILERS**
Ground Transporters
*Boise, ID*

**Mojave Airport**
Test Facilities
*Mojave, CA*

**PROTOFLIGHT**
Instrumentation, Testing & Integration
*Mojave, CA*

C-17 Drop Tests
*Edwards AFB, CA*

**SPACE VECTOR**
Storage & Launch Carrier, Vehicle Components & Integration Support
*Chatsworth, CA*

**BOEING**
C-17 Performance Group
*Long Beach, CA*

**SCALED COMPOSITES**
Data Acquisition System, Truck Mounted Model Testing
*Mojave, CA*

Nose Cone
*Mojave, CA*

SMC/Deputy Program
*El Segundo, CA*

**USL**
Avionics
*Newport Beach, CA*

**UCDAVIS** UNIVERSITY OF CALIFORNIA
Extraction Dynamics & Computational Fluid Analysis
*Davis, CA*

**ITS** INNOVATIVE TECHNOLOGY SYSTEMS
Systems Engineering
*Gardena, CA*

**freeflight** ENTERPRISES
Parachute Risers
*Lake Elsinore, CA*

**IRVIN AEROSPACE**
Drogue Parachutes
*Santa Ana, CA*

**PRE AEROSPACE**
Thrust Chamber Assemblies
*Costa Mesa, CA*

**HMX**
Engine Design & Development
*Reno, NV*

**Compositex**
Thrust Chambers
*Sandy, UT*

**AIR FORCE SPACE COMMAND**
Space Command
*Colorado Springs, CO*

**AFRL**
Contract Management & C-17 Analysis
*Wright Patterson AFB, OH*

**U.S. AIR FORCE**
Joint Falcon Program Management
*Arlington, VA*

**DARPA**

**Spincraft**
Aluminum Tanks
*Billerica, MA*

**Z PIONEER AEROSPACE**
Drogue Parachutes
*South Windsor, CT*

**DELTA VELOCITY**
Payload Operations & Safety Support
*Purceville, VA*

**NASA WALLOPS FLIGHT FACILITY**
Range Coordination
*Wallops Island, VA*

SMC/Det 12 Drop Test T & E Support
*Kirkland AFB, NM*

**BMT**
Drop Test Article
*Albuquerque, NM*

C-17 HQ
*Scott AFB, IL*

**THE UNIVERSITY OF ARIZONA.**
Wind Tunnel & Model Testing
*Tucson, AZ*

**Orion** PROPULSION
Propulsion GSE Test Support
*Huntsville, AL*

# QuickReach™ Vehicle Development Proceeding Well

**Completed 13 successful Stage 2 engine test firings**



**Full-scale stage separation test**



**Vertical test stand completed**



**Integrated Stage 2 Tankset Complete**



Completed Fairing

Fairing Shown with Payload Adapter Cone

**Payload Fairing Elements Complete**



**Stage separation test of full-scale diameter test article**

# 3 Record Setting Drop Tests from C-17:
# Expanded Aircraft Envelope, Leading to Future Spacelift

**C-17 drop test of simulated QuickReach™ Small Launch Vehicle**
(photos from F-16 chase plane)



QuickReach™ drop test article loaded into C-17 aircraft



**AirLaunch's three C-17 drop tests set records for longest and heaviest single objects ever dropped from C-17**

**QuickReach™ simulated rocket in flight**



**Full-scale ground drop tests**

Parachute tow tests conducted: two viable systems for drop tests

*Video of AirLaunch C-17 drop tests available at:* **www.AirLaunchLLC.com**

# AirLaunch Notional Concept of Operations

→ QuickReach™ booster is air-launched from C-17 cargo aircraft, providing rapid, robust, and operationally responsive launch capability
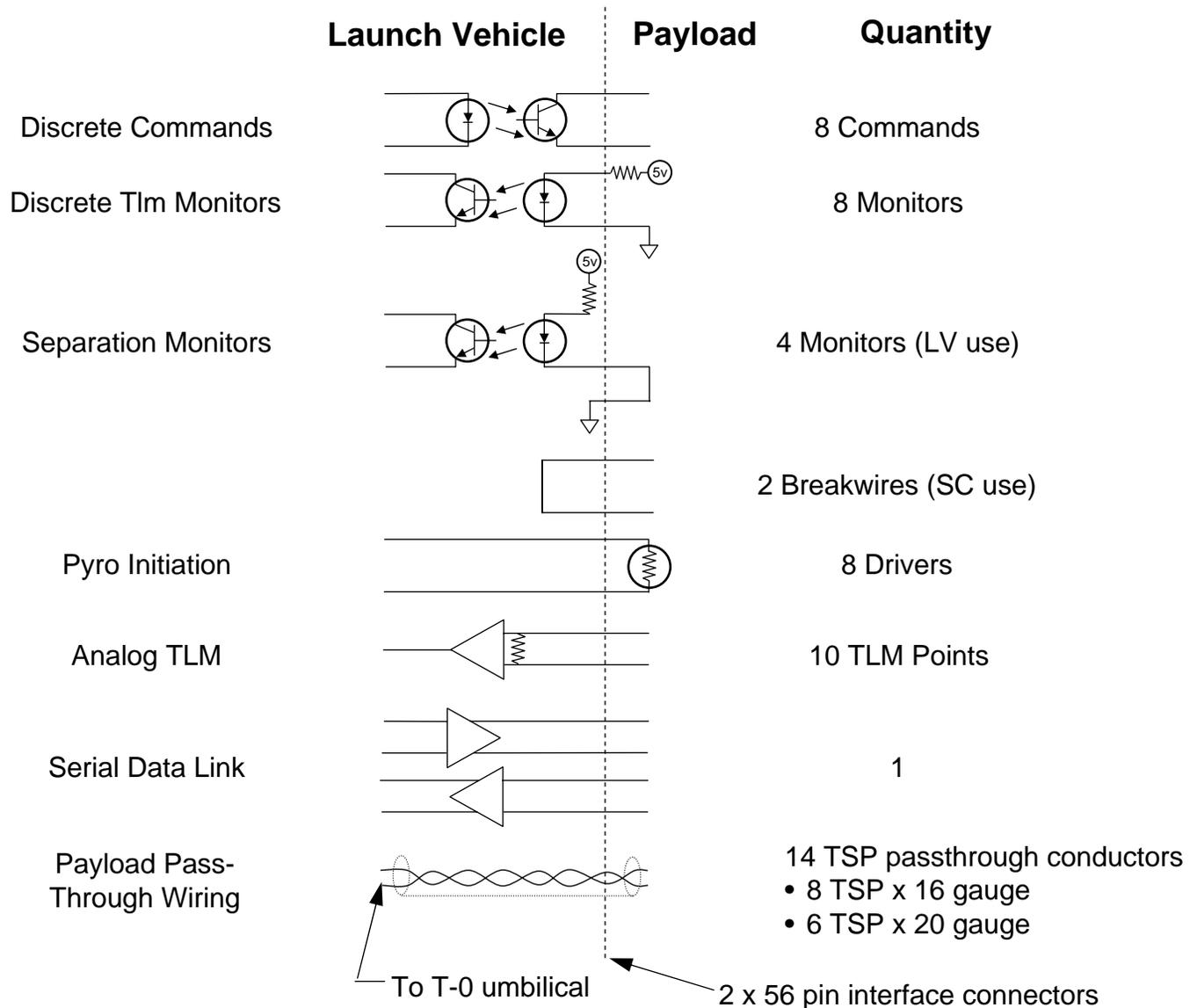


**Staging**
T ~ 110 sec
Alt ~ 160,000 ft

**Orbit Insertion**
T ~ 360 sec
Low Earth Orbit

**Launch**
T= 0 sec
Alt ~ 29,000 ft

**C-17**

**Optional In-flight Refueling**

**Ground Hold**
Takeoff within ~2 hours of call-up

**1st Stage Impact**
T ~ 390 sec
Range ~ 350 nmi

*Launch Anywhere… Global Reach ™* **Approved for Public Release, Distribution Unlimited**

163.00"

26.00"

12.00"
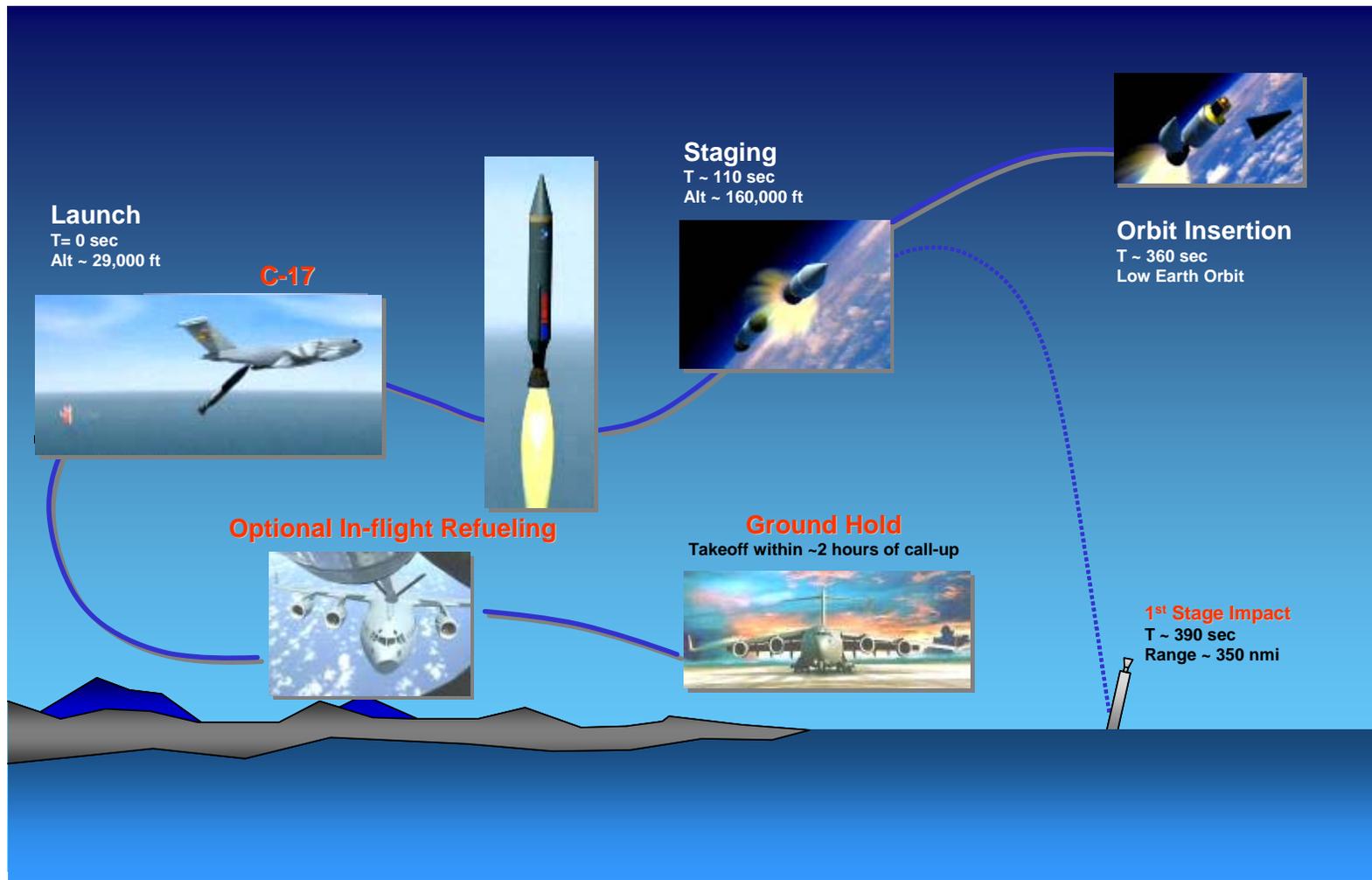
QuickReach™ payload envelope

DARPA/Falcon
req'd envelope

2.95" R

80.90"

SpaceX
Falcon 1

Minotaur

Pegasus

STARS
(Sandia)
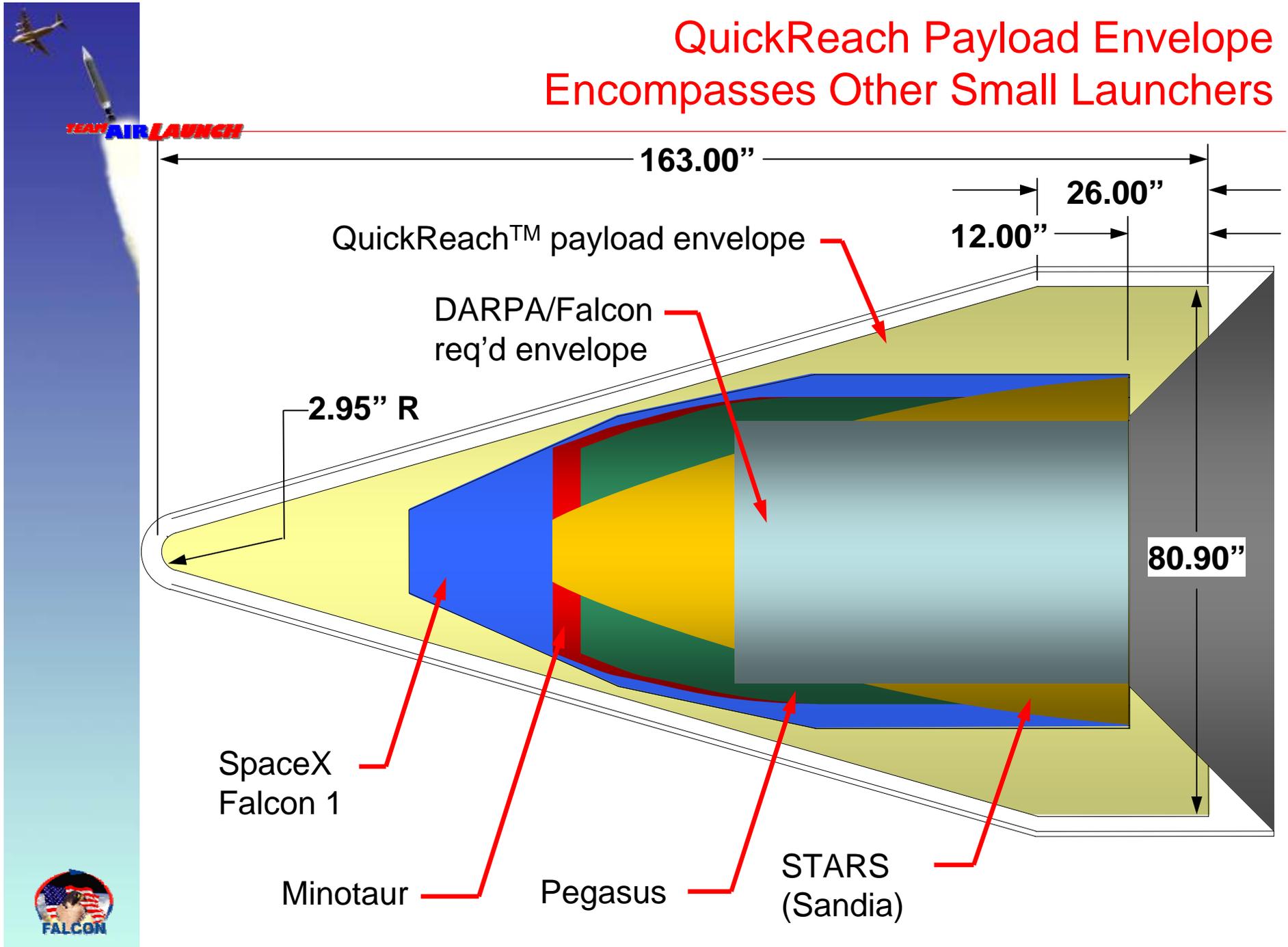
# Standard QuickReach™ Electrical Interface Provides Ample Capability for Most Payloads

| | Launch Vehicle | Payload | Quantity |
|---|---|---|---|
| Discrete Commands | | | 8 Commands |
| Discrete Tlm Monitors | | | 8 Monitors |
| Separation Monitors | | | 4 Monitors (LV use) |
| | | | 2 Breakwires (SC use) |
| Pyro Initiation | | | 8 Drivers |
| Analog TLM | | | 10 TLM Points |
| Serial Data Link | | | 1 |
| Payload Pass-Through Wiring | | | 14 TSP passthrough conductors<br>• 8 TSP x 16 gauge<br>• 6 TSP x 20 gauge |

To T-0 umbilical

2 x 56 pin interface connectors

1. Payload adapter and fairing halves cleaned and delivered to PPF
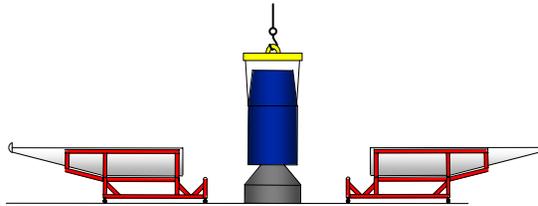
2. Payload mated to adapter
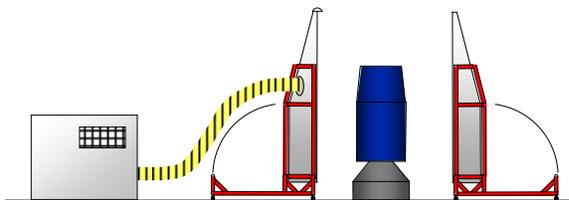
3. Fairing halves erected using GSE carts

4. Payload environmental control system (if used) connected to A/C duct and activated
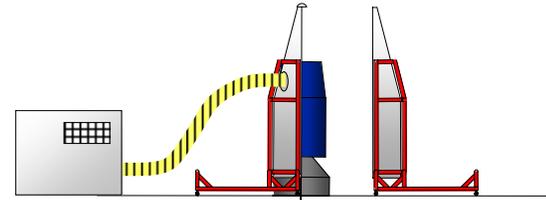
5. First fairing half mated to adapter; GSE carts provide alignment adjustability
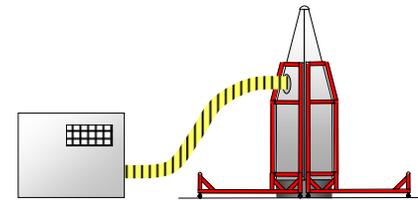
6. Second fairing half mated to complete encapsulation
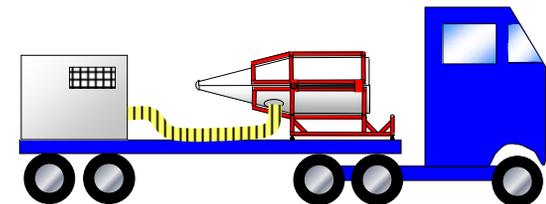
7. Encapsulated cargo element (ECE) mounted to rollover fixture and ready for transport

8. Environmental control system remains operational at all times

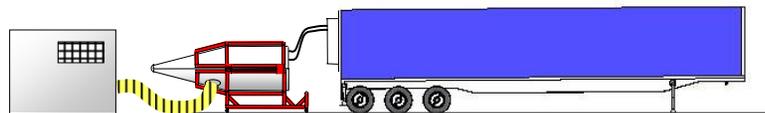9. RIU provides payload health and status while in storage

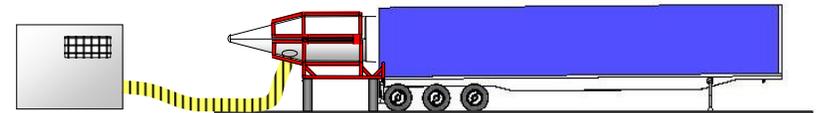# Encapsulated Cargo Element can be Mated Late in Launch Flow
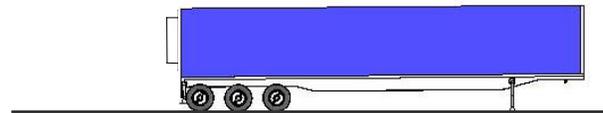


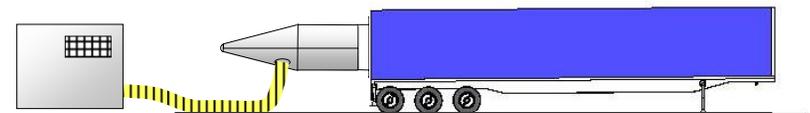1. QuickReach™ vehicle rolled to overhang end of SLC and transporter
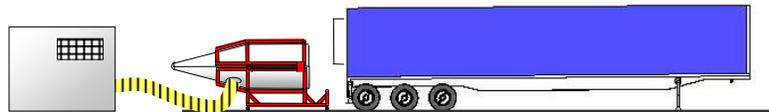
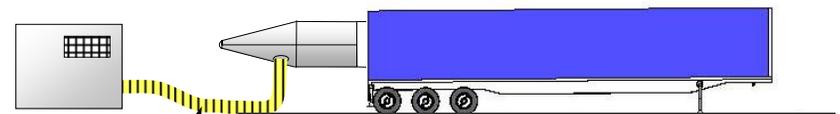2. Encapsulated Cargo Element (ECE) and handing fixture positioned for mating

3. Verify interfaces safe to mate

4. Electrically mate ECE to Avionics Section

5. Perform final interface testing

6. Mechanically mate ECE to Avionics Section

7. Remove ECE handling fixture

8. Load propellants

9. Install SLC in carrier aircraft

If required, payload environmental control system remains connected at all times prior to launch

# Steps Toward First Test Launch of QuickReach™

✈ **Complete Falcon Small Launch Vehicle Phase 2B this year**

– Integrated stage 2 engine test fires

– Payload fairing separation tests

– Incremental Critical Design Review (CDR)

✈ **Prepare for Falcon SLV Phase 2C**

– Phase 2C culminates with test launch in ~2008

✈ **Pursue potential customers**

– Payload ideas are welcome, especially for test flights

– Falcon SLV program will work with us on payload selection

*Launch Anywhere… Global Reach ™*