Kennedy Space Center
Center Operations Directorate

Constellation Commodities Studies Summary

Presented to:

Ground Hydrogen Symposium

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February 25, 2011

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Constellation Program

- (was) NASA's long-term program for space exploration
- Heavy-lift Ares V rocket was planned to have LH2 tanks about 2x the volume of the Shuttle.
  - LH2 losses during loading and scrub would likewise increase
  - Requirement to support 5 launch attempts in 5 days
    - 5x loading and scrub losses

Simply increasing the capacities of legacy methods will magnify inefficiencies/losses to gross levels

CxP Studies

- Goal
  - Solicit industry expertise in production, storage, and transportation required for future use
  - Improve efficiency and life cycle cost over legacy methods

- Objectives
  - Consolidate KSC, CCAFS and other requirements
  - Extract available industry expertise
  - Identify commercial opportunities
  - Synergy with State of Florida partnerships

What We Already Knew

- Improve the System
  - Priority:
    - Reduce Losses
    - Losses that cannot be eliminated; capture and reuse
    - Improve efficiency of Supply
    - Improve Storage
  - Interdependence of Parameters
    - Example;
      for a given launch campaign; reduced vehicle loading losses reduces the required pad storage and required supply, which results in reduced storage and delivery losses

Results (what industry told us)

- Challenging requirements
  - Launch campaigns and associated losses cause a large difference between high short-term demand versus long-term average
  - Direct opposition to steady-state 24/7 production
  - Large cryogenic storage tanks required to handle short-term requirements
  - Access restrictions and narrow delivery time windows
- Constructing on-site industry standard production plants, storage tanks and purchasing standard distribution equipment could save money over long-term.
- No cost cutting or efficiency improving technologies were identified or proposed.
- Several supply architectures compared; no clear winner

Results (cont'd)

- Lessons learned
  - "Tight lipped" industrial gas companies
    - Little information on make-or-buy decision
    - Withhold details as proprietary until bidding on a funded project
  - Industry logistics optimized for typical customers, not space launch customers
    - No new technologies revealed
  - Future requirements too uncertain
- "Game changing" concept
  - Polygeneration by a Public Utility Authority
  - Utility would produce and deliver LH2, LN2, LO2, and electrical power