Constellation Commodities Studies Summary

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Ground Hydrogen Symposium

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KSC Space Life Sciences Laboratory
(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