



# **Governance Model in Action: The New Horizons RP-1 Tank Decision**

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NASA Academy Case Study Initiative

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# New Horizons Overview



- First mission to Pluto
- Planned launch in mid-January 2006

Project management challenge:  
Schedule driven by short launch window – Jupiter gravity assist in February 2007 will shave years off mission



## Launch Date (2006)

Jan. 17-27  
Jan. 28  
Jan. 29-31  
Feb. 1-2  
Feb. 3-8  
Feb. 9-12  
Feb. 13-14

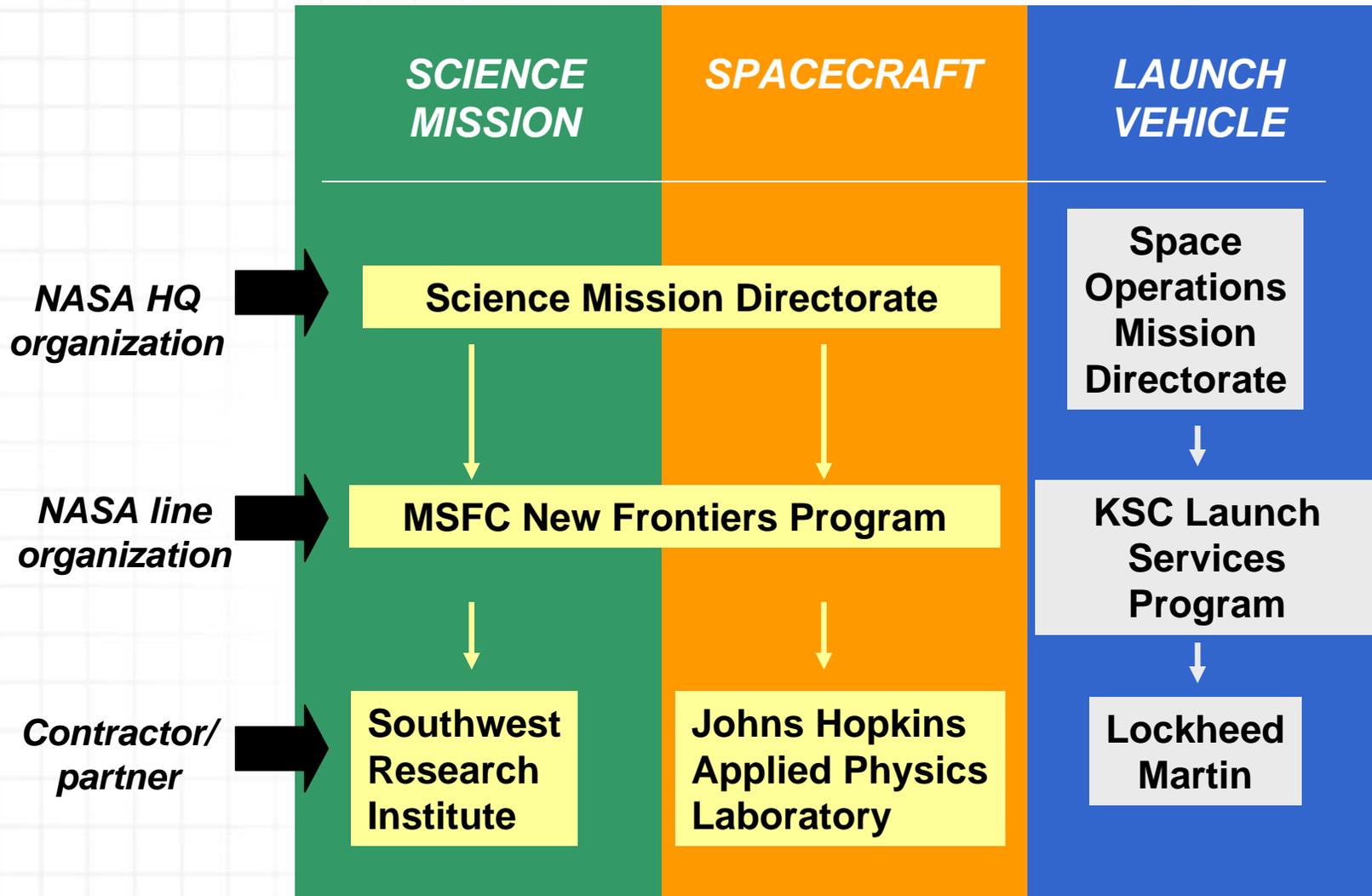
## Pluto Arrival (close approach)

July 14, 2015  
August 15, 2015  
July 12, 2016  
July 11, 2017  
July 10, 2018  
June 7, 2019  
July 20, 2020

(Chart source: JHU/APL Mission Guide)



# Complex Organizational Structure





# RP-1 Tank Fails during Qualification Testing



## Mid-September 2005

- Atlas V launch vehicle – first NASA use of heavy configuration requires re-qualification of flight hardware
- Catastrophic failure during final stages of qualification testing of Atlas V RP-1 fuel tank





# Multiple Lines of Inquiry



Failure investigated by contractor, KSC Launch Services Program (LSP), KSC S&MA, and NASA Engineering Safety Center (NESC)

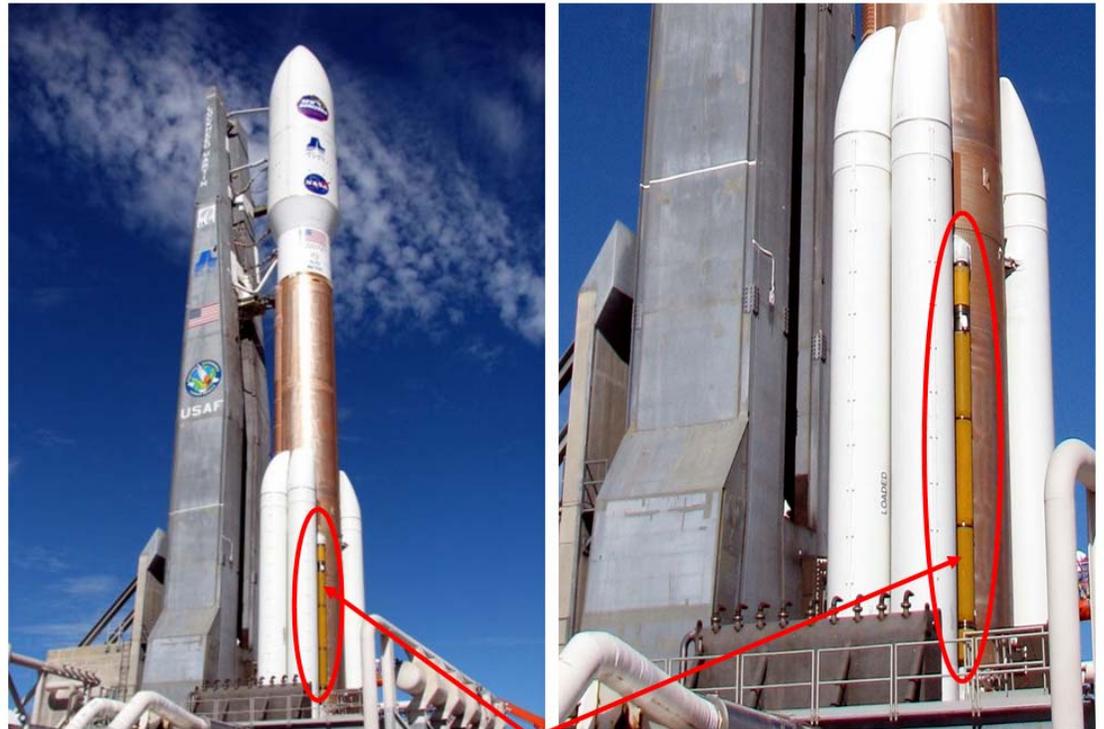
| <b>Administrator/Associate Administrator</b> |   |                                       |   |
|--|---|---------------------------------------|---|
|  | <b>PROGRAM AUTHORITY</b>                    | <b>SAFETY &amp; MISSION ASSURANCE</b> | <b>ENGINEERING TECHNICAL AUTHORITY</b>      |
| <b>Headquarters</b>                          | <b>Space Operations Mission Directorate</b> | <b>Safety &amp; Mission Assurance</b> | <b>Office of the Chief Engineer</b><br>↓    |
| <b>(Cross-agency)</b>                        |   |                                       | <b>NESC</b><br>matrixed to support KSC S&MA |
| <b>Center level</b>                          | <b>KSC Launch Services Program</b>          | <b>KSC S&amp;MA</b>                   |   |



# The Technical Problem



- Problem isolated to inner tank wall near  $\text{LO}_2$  feed line
- Cracks discovered in pre-test photos of qualification tank
- All existing RP-1 tanks in fleet investigated
- Extensive materials and structural analyses conducted



$\text{LO}_2$  feed line



# Same Problem, Different Answers



Nov-Dec. 2005: Shared preliminary conclusions

- RP-1 tank employed marginal design
- Not possible to fly fully qualified flight hardware in Jan. '06

## KSC LSP proposes mitigations

- Borescope investigation of flight tank show no signs of problems
- Proposes altered flight profile to minimize loads at key points during ascent

## KSC S&MA and NESC want more time to investigate

- Problems with most other tanks in fleet – cracks
- More data required from contractor
- Risk to mission success unacceptably high



# The Nuclear Factor



## Nuclear Power Supply Affects the Equation

- *Almost no chance of public safety hazard*
  - Extremely resilient design with long track record
  - Most likely failure would occur over ocean with no radiation release
- *High certainty of public relations disaster if launch fails*



Requires White House approval



# Final Flight Planning Board Meeting



- Differences of opinion presented at 1/10/06 Flight Planning Board meeting
  - AA for Space Ops (Chair)
  - Chief Engineer
  - Chief Officer of Safety & Mission Assurance
  - AA of Science Mission Directorate
  - Director of Kennedy Space Center
- Nearly 30 attend meeting, others via telecon
- Administrator and Associate Administrator invited — dissenting votes anticipated.



# Go/No-Go



## GO

- Flight tank visually inspected twice and found flawless.
- Mission profile tailored to minimize possibility of launch failure over land.
- Failed qualification tank already cracked when testing process began.
  - Survived until final stages of testing with cracks.
- Perfect tank would have adequate margin under the specific flight conditions for this mission.

## NO-GO

- Tank not fully qualified flight hardware.
- Inadequate design that had failed catastrophically
- Flight rationale offered based solely on flight tank evidence
- Failure mechanisms and margin not established by traditional validation practices.
- Not been enough time to develop necessary models to determine failure mechanisms and margin.



# Governance Model in Action



- Launch Services, S&MA, and NESC present points of view
- Opinions solicited from others in attendance
- Chair polls Flight Planning Board voting members –  
2 “delay” votes
  - Chief S&MA Officer
  - Chief Engineer
- Dissent triggers automatic appeal by Chair to Administrator...



# Decision Time

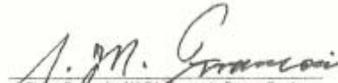


- **Administrator reviews the situation:**
  - Lack of qualified flight hardware: from a formal process standpoint, NASA flies only qualified hardware.
  - Good engineering requires judgment: is this particular tank suitable to fly?
- **and the evidence:**
  - Qualification tank had survived very rigorous testing with cracks up to ~95% of its final test.
  - Flight tank exhibited superior material properties to qualification tank, and had been inspected and found crack-free.
  - Flight tank would withstand much lower pressures than qualification tank in testing.
  - RTG release of nuclear material in the event of launch failure not a credible concern.
- **Decides in favor of program's position to proceed.**



## Launch Readiness Certification AV-010 Pluto New Horizons Launch Vehicle

*At the AV-010 Pluto New Horizons Launch Readiness Review, the following organizations certified that the necessary prelaunch operations related to their areas of responsibility have been satisfactorily completed to date. As of this Launch Readiness Review, there are no launch constraints related to their areas of responsibility. The launch vehicle, spacecraft, and all supporting systems as applicable, are ready for flight, pending satisfactory closure of remaining tasks and open items identified in this review.*

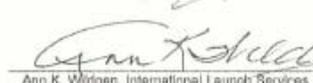
  
Steve Francoia, NASA Kennedy Space Center  
Launch Services Program Manager



  
Mike Jensen, International Launch Services  
Vice President, Technical Operations

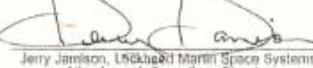
  
Omar Beaz, NASA Launch Services Program  
Launch Director

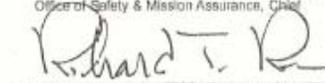


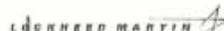
  
Ann K. Widdgen, International Launch Services  
PNH Program Director

  
Bryan O'Connor, NASA  
Office of Safety & Mission Assurance, Chief



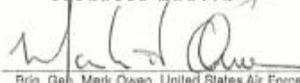
  
Jerry Jamison, Lockheed Martin Space Systems  
Atlas Launch Operations Director

  
Dr. Richard Roca, Applied Physics Laboratory  
Johns Hopkins University, Director



  
Robert J. Reynolds, Lockheed Martin Space Systems  
Atlas Recurring Launch Operations Director

  
Dr. Alan Stern, Southwest Research Institute  
New Horizon Principal Investigator

  
Brig. Gen. Mark Owen, United States Air Force  
45th Space Wing Commander

  
Anthony Nardo, Lockheed Martin Space Systems  
PNH Integration Manager





The Flight Planning Board understands the residual risk associated with the AV-010 RP-1 tank and the mitigations taken by the Launch Service Contractor and Launch Services Program's engineering staff. In the view of the Flight Planning Board Chairman, the risk from the RP-1 tank is understood and acceptable. The Flight Planning Board recognizes the independent risk ratings provided by the Program's technical team and the SMA/NESC. The efforts in mitigating the risk and rationale for the flight provide for the highest practical probability of mission success for the New Horizon mission.

NASA Administrator

10 Jan 2006

10 JAN 2006



# Conclusions



## The governance model worked

1. Dissenting opinions presented in atmosphere of mutual respect.
2. All views aired at final Flight Planning Board meeting, even those of non-voting members.
3. Transparent decision-making process.
4. Set governance precedent for similar decisions (STS-121 ice/frost ramp).

