EXERCISE

2019 PDC Mitigation Mission Options

Conference Day 3

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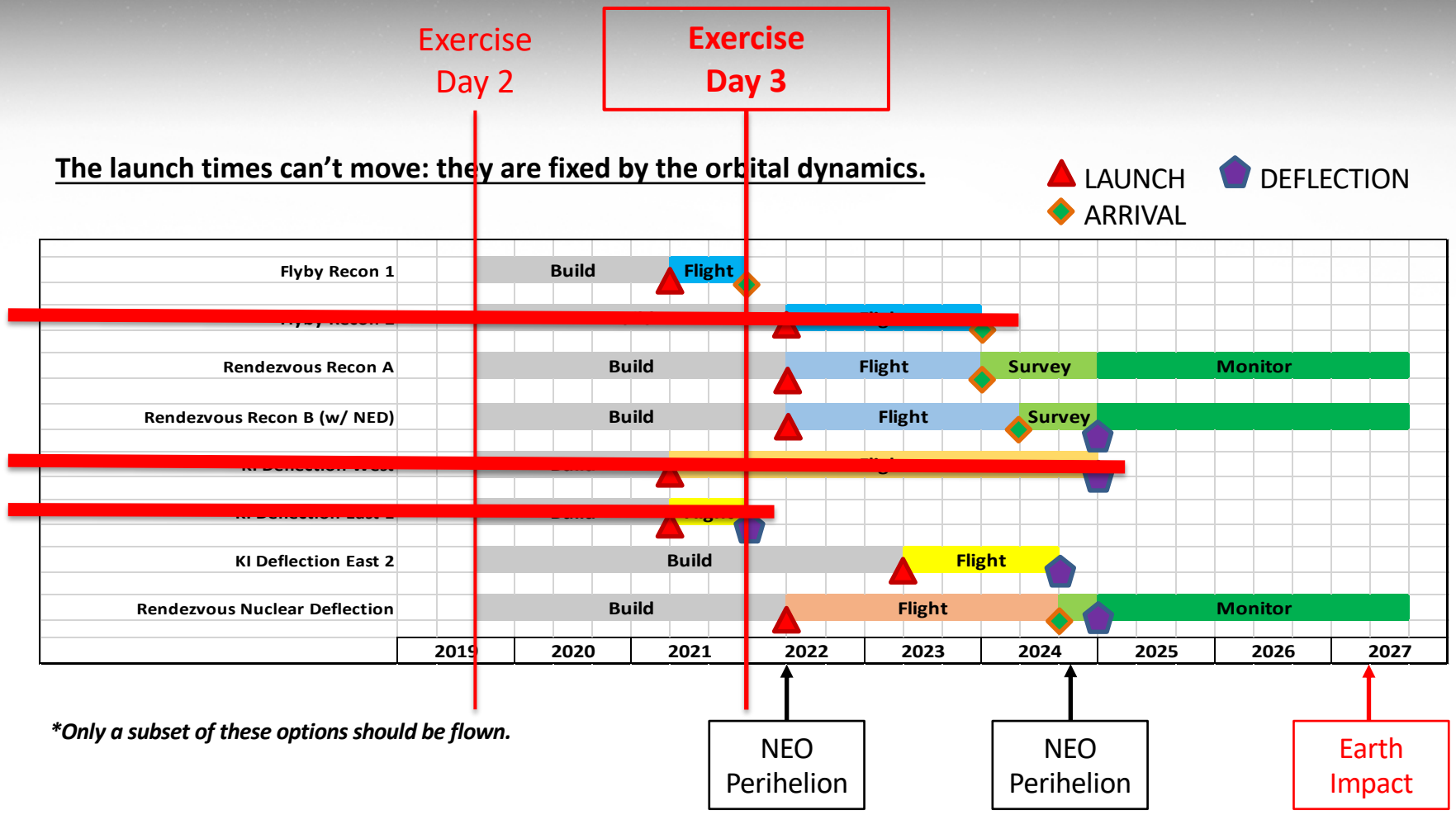
EXERCISE

Status of Mission Selection and Development

- Decisions from Day 2:
  - Begin build of Flyby Recon 1
    - Multiple versions to be deployed (US, ESA, etc.)
  - Begin build of Rendezvous Recon
    - Designed to be *capable* of carrying NED, but decision to install NED will be made later
      - If the larger version of this spacecraft is built, it could become the "Rendezvous Nuclear Deflection" mission listed in the timeline
  - Begin build of KI Deflection East 2 mission fleet
    - Multiple KI spacecraft on multiple launch vehicles from multiple nations
  - Forego KI East 1 (deemed too risky)
  - Forego Flyby Recon 2 (rendezvous recon available during same time frame, and rendezvous is preferred)
  - Forego KI West (not effective enough)

Timeline of Mission Options



**Only a subset of these options should be flown.*

Key Dates

- Current date: 2021-12-30
  - Flyby Recon 1 has just returned data about the asteroid on 2021-12-28
- Rendezvous recon (w/ or w/o NEDs):
  - Launch: 2022-04-04 (w/o NEDs) or 2022-05-09 (w/ NEDs)
  - Arrival: 2023-11-01 (w/o NEDs) or 2024-03-20 (w/ NEDs)
  - ~3--6 months to survey asteroid prior to deflection
- KI fleet:
  - Launch: around 2023-05-24 (before rendezvous recon arrival)
  - Arrival (deflection): around 2024-08-30
- Nuclear standoff deflection (if NEDs flown): 2024-10-21

Updated Asteroid Information

- Flyby Recon 1 has revealed:
  - The asteroid's actual impact location (Denver)
  - Required deflection DV for KI (east) = 4.5 cm/s
  - Required deflection DV for nuclear (west) = 0.632 cm/s
  - The asteroid's approximate size & shape (~260 x 140 m ellipsoidal)
  - 12 hour asteroid rotation period confirmed
- Asteroid density remains unknown:
  - Still ~ 1 to 3 g/cm^3
- The beta value that would manifest during a KI deflection attempt remains unknown

Updated Asteroid Information

- 260 x 140 x 140 m ellipsoidal volume:
  - Volume ~2.69 x 10^6 m^3
  - Equivalent spherical diameter = 172 m
- Range of possible asteroid mass values:
  - 1 g/cm^3 density: mass = 2.69 x 10^9 kg
    - Approx. surface escape velocity = 5.2 cm/s
  - 2 g/cm^3 density: mass = 5.34 x 10^9 kg
    - Approx. surface escape velocity = 7.8 cm/s
  - 3 g/cm^3 density: mass = 8.00 x 10^9 kg
    - Approx. surface escape velocity = 9.9 cm/s

KI Fleet Requirements

- Worst case (highest asteroid density, beta = 1):
  - 3 KIs, each 13,372 kg
    - 1.88 cm/s per KI (19% of asteroid escape velocity; some risk of accidental asteroid disruption)
  - So: 3 x Falcon Heavy (FH) launches, or 1 SLS Block 1B launch + 1 FH
- Build and launch such 6 KI spacecraft, to provide redundancy
  - This can be a mixed fleet, with some of the spacecraft provided by nations other than the US
  - 6 x FH, or 4 x FH + 1 SLS
- If asteroid is lower mass, and/or if beta is greater than 1, there is increased risk of accidental asteroid disruption
  - Additionally, 1.88 cm/s x 3 = 5.64 cm/s, which is more than the 4.5 cm/s required
- Recommend designing KI spacecraft to be capable of ejecting inert mass during flight, to reduce DV imparted to asteroid if rendezvous recon spacecraft discovers the asteroid is less massive than worst case
  - Provides an opportunity to avoid accidental asteroid disruption

Standoff Nuclear Deflection Requirements

- Standoff nuclear detonation distance for required deflection DV of 0.632 cm/s (west) w/ one 100 KT NED:
  - Density of 1 g/cm^3: 497.8 m standoff distance
  - Density of 2 g/cm^3: 444.5 m standoff distance
  - Density of 3 g/cm^3: 388 m standoff distance
- 0.632 cm/s DV as percentage of asteroid escape velocity (low risk of accidental disruption):
  - Density of 1 g/cm^3: 12%
  - Density of 2 g/cm^3: 8%
  - Density of 3 g/cm^3: 6%

Appendices