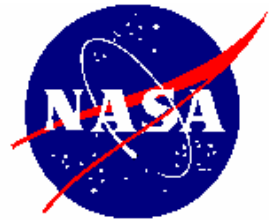




Air Force Atlas Mishap Due to Unintended Mixing of LOX and Hydrocarbons 1975

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The Mishap

- On April 12, 1975 an Atlas 71F vehicle suffered extensive engine damage due to an explosion at liftoff at Vandenberg AFB
- Range Safety destroyed vehicle at 303 seconds





Sequence of Events Leading to Explosion

- During the pre-launch sequence, booster engine fuel (RP-1) and GOX/LOX overflows drained into the flame deflector.
- During ignition, additional GOX and LOX were discharged into the flame deflector.
- No water spray or GN2 purge of thrust section occurred prior to the ignition sequence
- An explosion in the flame deflector occurred prior to liftoff.



Ensuing Events Sequence to Vehicle Destruction



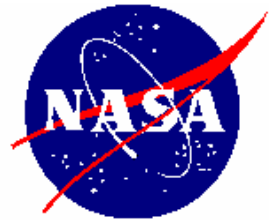
- Axial (vertical) accelerometer recorded a disturbance prior to liftoff.
- Pre-launch instrumentation staging disconnected prematurely resulting in loss of all booster data measurements.
- Sustainer and vernier engine shutdown occurred prematurely during flight.
- Range Safety destroyed vehicle at 303 seconds.





Corrective Actions Implemented After Mishap

- Fuel and oxidizer bleeds no longer drained into flame deflector.
- Flame deflector wash-down water system and other water injectors installed to prevent accumulation of combustibles.
- Flame deflector surface re-coated to eliminate eroded condition and prevent pooling of combustibles.
- GN2 purge system installed in booster engine compartment, providing inert atmosphere at liftoff.
- Delay in operation of the pad deluge system eliminated by priming water pipes prior to launch.



Lessons for NASA

- **Hydrocarbons mixed with LOX result in shock sensitive explosive gel.**
 - Dubbed oxyliquid; an explosive phenomenon discovered in Germany in 1895
 - More detonation strength than dynamite
 - Used commercially in US as late as 1968 as blasting agent for quarrying and strip mining until replaced by cheaper explosives (ammonium nitrate and fuel oil (ANFO))
- **Positive actions required to avoid unintended mixing of LOX and hydrocarbons**
 - Minimize oxidizer and fuel (and other hydrocarbon) system leakage
 - Identify and eliminate possible accumulation locations for combustible materials
 - Provide effective purge and/or deluge system to remove combustion components
- **Recent SLC-2 Launch Mount Mechanism mishap is reminder of importance of safety lessons-learned from 1975 Atlas vehicle mishap.**