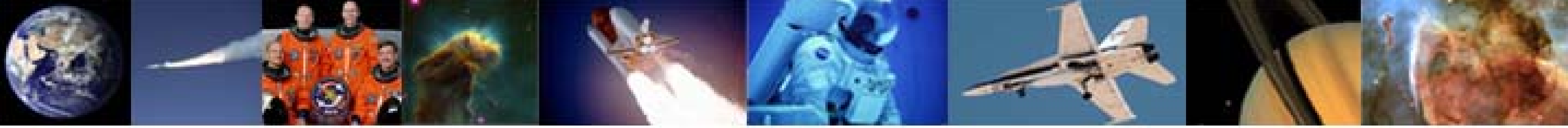


Supercritical:
SL-1 Nuclear Reactor Explosion

Leadership ViTS Meeting
September 2007

Bryan O'Connor
Chief, Safety and Mission Assurance

The Accident

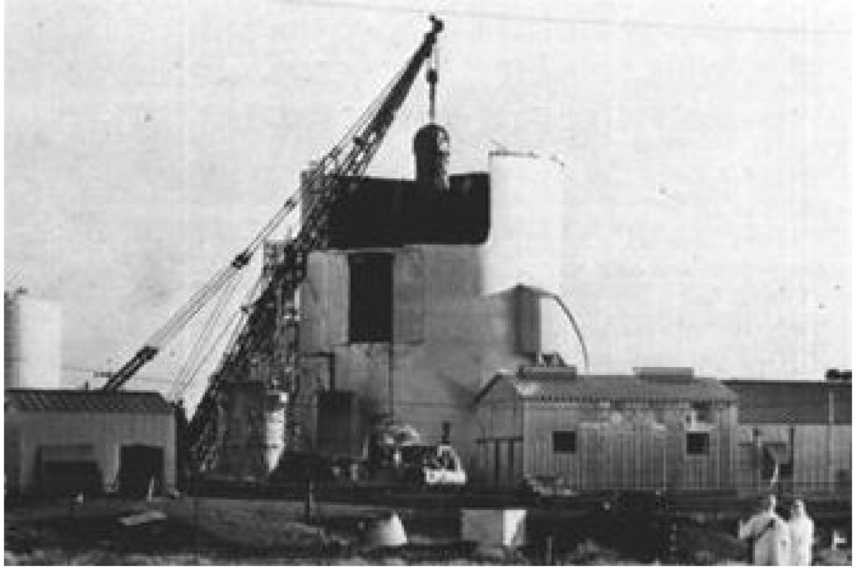
- In January of 1961, the SL-1 nuclear reactor exploded near Idaho Falls, Idaho, killing three engineering technicians on duty.
- While performing a basic maintenance procedure – attaching the control rods to the control rod drive mechanism – a technician lifted the central control rod to a height of 20 inches in 0.5 seconds.
- This withdrawal caused the reactor to go “supercritical” in just 4 milliseconds as the core power level surged to 20,000 megawatts or over 6,000 times the rated power output.

Control rod lodged in the ceiling of the SL-1 Reactor building

- The heat generated by the power surge vaporized the water, hammering steam into the top of the reactor and causing it to lift nine feet off the ground.

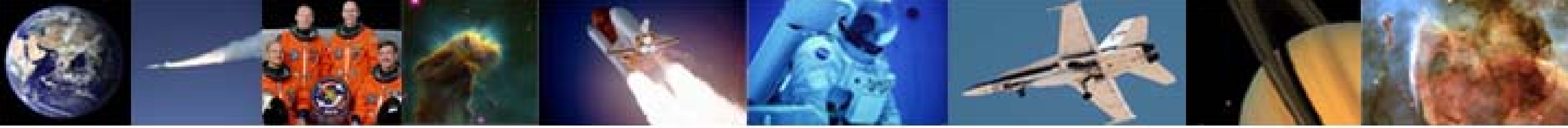
Background

- SL-1 Reactor was designed to provide heat and electricity for remote DEW Line (Defense Early Warning system) radar sites, which provided early warning of attack by Soviet aircraft or ICBMs.
- As such, reactors were designed to be small, lightweight, easy to maintain and capable of operating for three years without refueling.
- These boiling water reactors incorporated several new technologies including highly-enriched uranium fuel, burnable poison strips (BPS) to prolong core life, and only five control rods in order to simplify maintenance.
- Inadequately tested technology exhibited operational malfunctions such as control rod ‘stickiness’ during travel events.



Reactor being lifted from the National Reactor Testing Station

- It is believed that the accident occurred when technicians attempted a manual rod travel exercise after a control rod exhibited stickiness.

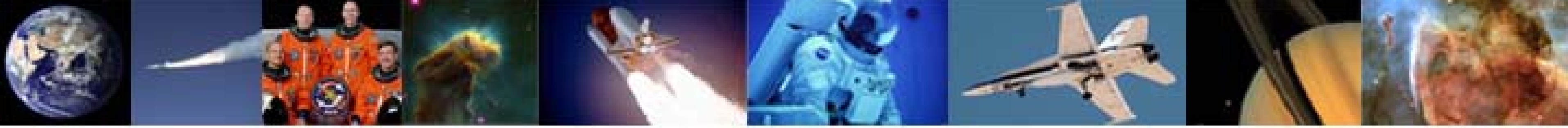


Proximate Cause

- Rapid retraction of the central control rod to a height or 20 inches resulted in an accelerated nuclear reaction condition known as a “prompt criticality.”

Causal Web – Underlying Issues

- Continued operation despite frequent operational control rod malfunctions
  - Rods had exhibited stickiness 2% (80 times) of the time movement was attempted.
- Rushed development and insufficient testing of new technologies
  - Cold War atmosphere resulted in sense of urgency to continue with operation, testing, and training despite immature technologies (e.g., burnable poisons, small number of control rods).
- Lack of rigorous training and detailed procedures
  - None of the technicians had any background in nuclear engineering.
  - On-the-fly procedural changes to compensate for “sticking control rod events” were accepted by management.
- Insufficient safeguards to prevent improper operation
  - Reactor design did not prevent rapid and extreme removal of control rods whether inadvertent or malicious.



NASA Applicability

- While the temptation or pressure to implement new technology can be great, premature use can end in premature failure. The Technology Readiness Level system exists to ensure that technology is ready for use in major systems.

- Uncertainties, credible failure modes, and associated risks must be identified, evaluated, and managed/mitigated from the earliest design stages.

- The development process is not a straight line. Lessons learned should be documented, circled back into the development process, and used to improve safety, design, policy, or procedures.

- Recurring anomalies should be addressed by management with thorough and effective solutions, not by on the fly procedural modifications.

- Managers should seek ideas and feedback from everyone, regardless of assignment or position, to help ensure mission success, and improve mission performance.