SAND2024-05074C

Sandia National Laboratories

Exceptional service in the national interest

SANDIA AND SPACE NUCLEAR SYSTEMS LAUNCH SAFETY

Space Nuclear Systems Launch Safety Group

Sandia National Laboratories

SNSLS

Space Nuclear Systems Launch Safety

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

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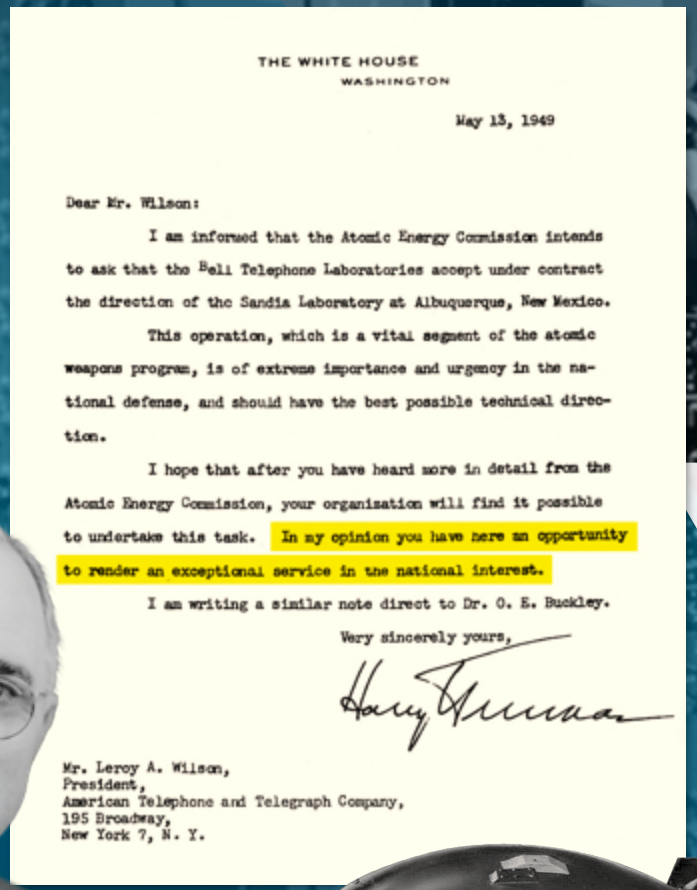
OUR HISTORY IS TRACED TO THE MANHATTAN PROJECT



THE WHITE HOUSE
WASHINGTON

May 13, 1949

Dear Mr. Wilson:

I am informed that the Atomic Energy Commission intends to ask that the Bell Telephone Laboratories accept under contract the direction of the Sandia Laboratory at Albuquerque, New Mexico.

This operation, which is a vital segment of the atomic weapons program, is of extreme importance and urgency in the national defense, and should have the best possible technical direction.

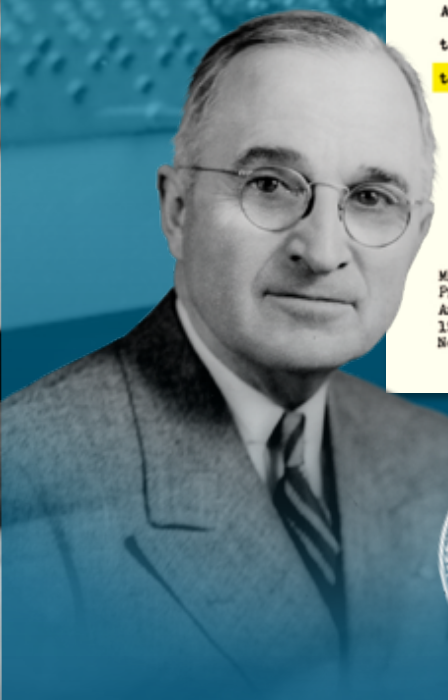
I hope that after you have heard more in detail from the Atomic Energy Commission, your organization will find it possible to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.

I am writing a similar note direct to Dr. O. E. Buckley.

Very sincerely yours,

Harry Truman

Mr. Leroy A. Wilson,
President,
American Telephone and Telegraph Company,
195 Broadway,
New York 7, N. Y.



- July 1945: Los Alamos creates Z Division
  - Nonnuclear component engineering & systems integration
    - Federally Funded Research and Development Center
      - November 1, 1949: Sandia Laboratory established
        - March 8, 1956: Sandia California officially opened
          - AT&T: 1949–1993
            - Martin Marietta: 1993–1995
              - Lockheed Martin: 1995–2017
                - Honeywell: 2017–present

SANDIA IS A FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTER MANAGED AND OPERATED BY

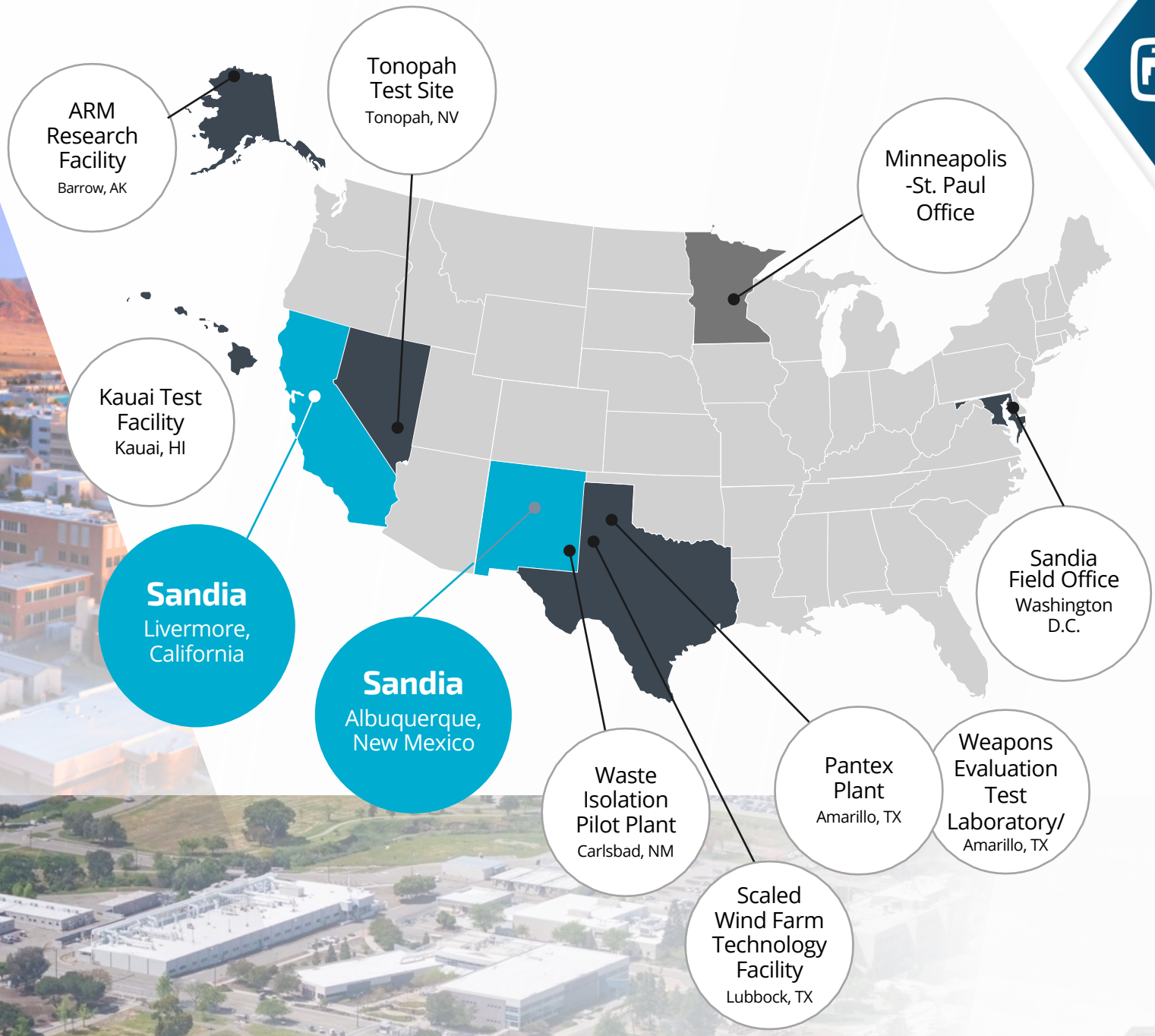
National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc.

Government-owned, contractor-operated

FFRDCs are long-term strategic partners to the federal government, operating in the public interest with objectivity and independence and maintaining core competencies in missions of national significance

WE HAVE FACILITIES ACROSS THE NATION

Main Sites
Albuquerque, New Mexico
Livermore, California



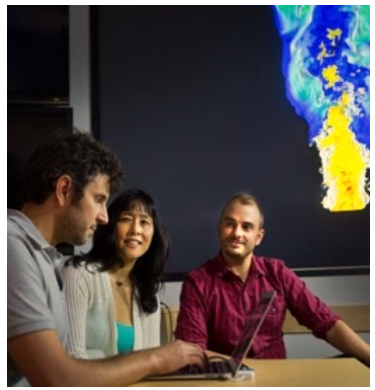
SANDIA HAS FIVE MAJOR PROGRAM PORTFOLIOS

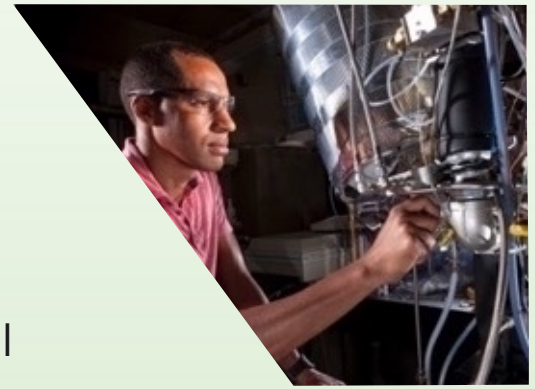
ENERGY & HOMELAND SECURITY

Secures the nation's critical infrastructures and environment against attacks, threats and climate change by performing world-class research and development

- Enable the full potential of renewable energy and subsurface resources
- Ensure the safety, security and resilience of nuclear power and the electric grid, and the safe management and disposal of radioactive wastes
- Advance efficient and sustainable energy use for a changing world
- Reduce the nation's vulnerability to chemical, biological, radiological and nuclear threats
- Increase our nation's digital and physical critical infrastructure security and resilience to natural and human-made threats







NUCLEAR ENERGY SAFETY AT SANDIA

SNSLS
Space Nuclear Systems Launch Safety

47 Years of History

1975 — BROWNS FERRY'S FIRE

FIRE RESEARCH PROGRAM STARTS AT SANDIA FOR NRC:

- Characterizing fire behavior in nuclear-specific applications
- Supporting NRC in Fire PRA development
- SNL publishes first NUREG/CR on fire protection systems
- Cable tray fire tests

CRAC (LATER MACCS)

NRC asks Sandia to develop CRAC to support WASH-1400- Reactor Safety Study, An Assessment of Accident Risks in US Commercial Nuclear Power Plants

1979

MELCOR - 1982

The MELCOR code was developed for the NRC shortly after and in response to the core-melt accident at TMI-2.

CRAC 2- SITING STUDY (NRC) - 1982

CRAC2 was released in 1982 to support the Sandia Siting Study (NUREG/CR-2239) that estimated radiological consequences of severe accidents.

1986 — CHERNOBYL

RADTRAN (NRC) - 1987

To ensure safe transport of radiological materials, Sandia developed RADTRAN as a unique environmental impact and risk assessment code

MIDAS - 1987

Sandia creates the Mobile Instrumentation Data Acquisition System (MIDAS) to provide on-site data acquisition and analysis capabilities for testing of radioactive and hazardous materials packages.

NUREG-1150 - 1990

NUREG assesses severe accident risks at five US nuclear power plants using advanced methods and improved data.

2001 — 9/11

AIRCRAFT VULNERABILITY ASSESSMENTS (NRC) - 2006

Following the attacks on the World Trade Center and the Pentagon in 2001, Sandia was tasked to assess the vulnerability of US nuclear power plants to aircraft attack by terrorists.

SPENT FUEL POOL ACCIDENT STUDIES (NRC) - 2006

Following the attacks of 9/11, Sandia was asked to perform analyses aimed at determining optimum loading patterns that would minimize the time period of vulnerability to fire between successive fuel offloads from the reactor

2006 — STUXNET

RISK INFORMED SECURITY ASSESSMENTS OF NRC MATERIALS LICENSEES - 2003

The cyber assessments performed by Sandia for this effort included the (1) characterization of critical IT system architectures, features and capabilities, (2) delineation and characterization of IT system controls, and (3) identification of potential IT system vulnerabilities and consequences

NRC - OFFICE OF NUCLEAR REGULATORY RESEARCH 2006-2012

Sandia has been working on multiple projects to support the NRC with the goal to raise awareness of the importance of adequate cyber security of nuclear safety systems.

NRC - OFFICE OF NUCLEAR SECURITY AND INCIDENT RESPONSE (NSIR)

Sandia starts providing the cyber based training of regional NRC inspectors.

2011 — FUKUSHIMA DAIICHI

FUKUSHIMA ACCIDENT ANALYSIS

Sandia's experience in severe accident is immediately applied to support DOE and NRC in evaluating the Fukushima's core-melt accidents, and in estimating the potential future risk posed by the reactors.

SOARCA – 2012

SOARCA, the State-of-the-Art Reactor Consequence Analysis, incorporated over 25 years of research to analyze the outcomes of postulated severe reactor accidents.

IAEA FUKUSHIMA DAIICHI INTERNATIONAL PEER REVIEW TEAM ASSESSMENT - 2013

Sandia is representing the US and leading this international benchmarking exercise

NUCLEAR CYBER SECURITY PROGRAM 2013

Focused research program begins

2021 — SOLARWINDS

MELCOR 2018

Expands to new reactor designs

HAZCADS 2019

Sandia develops the Hazard and Consequence Analysis for Digital Systems process.

ADVANCED REACTOR CYBERSECURITY LICENSING – 2021

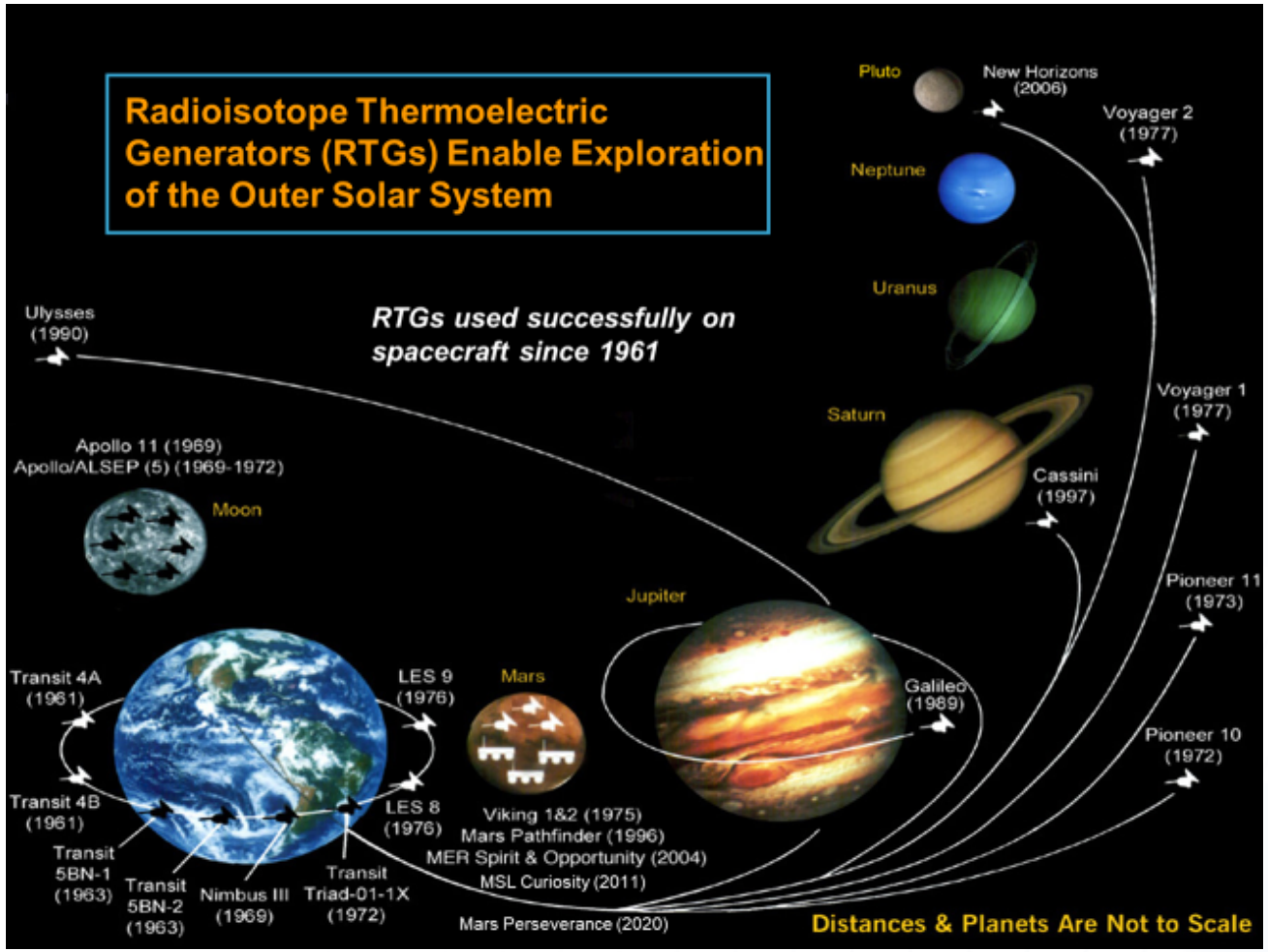
Sandia develops regulatory guidance and related analysis

- Feb 22 - First public meeting on Advanced Reactor Licensing Cyber Security Analysis. Approach developed by SNL.

2022 ONWARD

- Advanced Reactors
- Cyber and Physical Security
- Regulatory Environment
- Packaging, Storage and Transportation of Modular Reactors, New Fuels
- Autonomous Systems
- Integrated Hybrid Energy Systems

SPACE NUCLEAR SYSTEMS HISTORY-NASA/DOE



2006

Pluto New Horizons Mission

Supported DOE's review of Lockheed Martin's FSAR (2005)

2011

Mars Science Laboratory Mission

Produced Final Safety Analysis Reports (FSARs) (2008, 2010).

2020

Mars 2020 Mission

Produced Final Safety Analysis Report (FSAR) for Launch Approval (2019)

Produced Nuclear Risk Assessments (2013, 2019)

CURRENT ACTIVITIES

SNSLS
Space Nuclear Systems Launch Safety

Space nuclear is **growing** beyond NASA/DOE RTG systems to

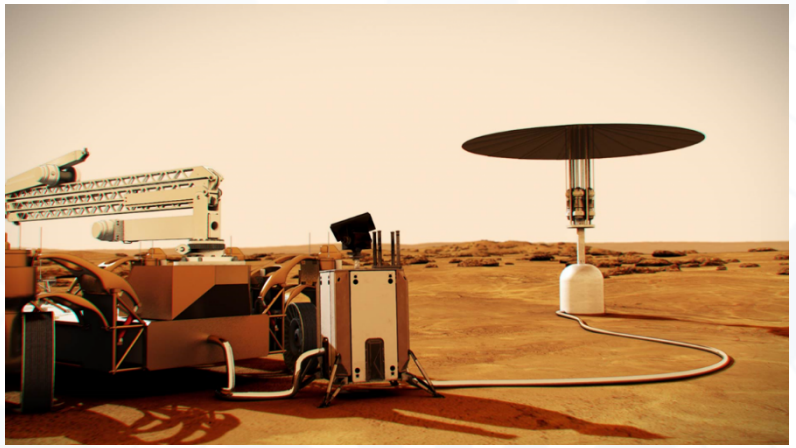
- Nuclear thermal propulsion missions
- Surface fission power
- DOD engagement
- Purely commercial enterprises

Providing **software** and **training** for launch approval

- Ultra Safe Nuclear Company – Technologies (USNC-Tech)

Sandia is currently Performing **analyses** and **documenting** for launch approval

- DARPA & NASA's DRACO mission
- Charles Stark Draper Laboratory mission
- Lockheed Martin Space Systems mission
- Zeno Power Systems missions
- Air Force Research Laboratories proof of concept
- City Labs mission



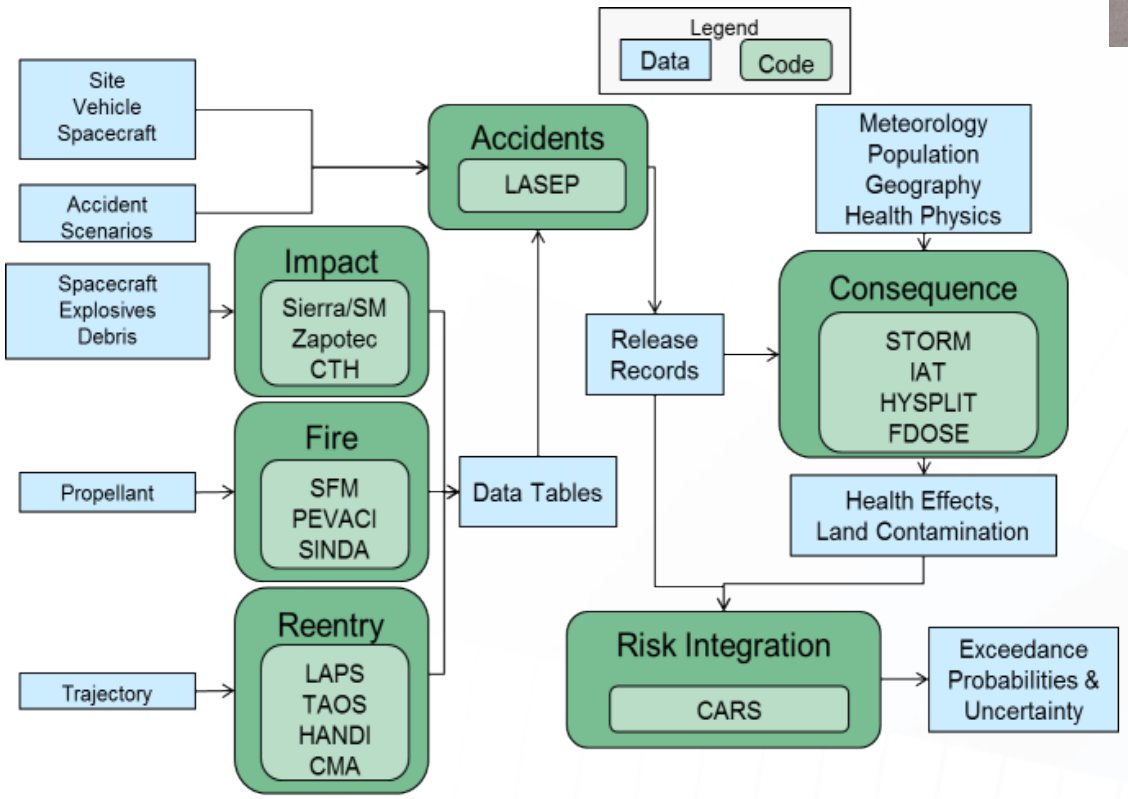
In process – Dark Fission, Air Force, and Applied Physics

Laboratory **also pursing** space nuclear missions /activities

LAUNCH SAFETY CODE SUITE AND FACILITIES

SNSLS
Space Nuclear Systems
Launch Safety

Sandia has a **broad array** of **tools** and **facilities** used to support space nuclear launch safety assessments.



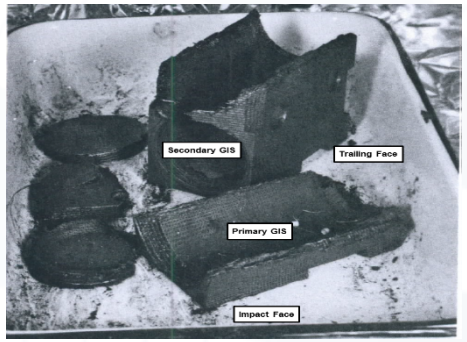
Launch Safety Code Suite

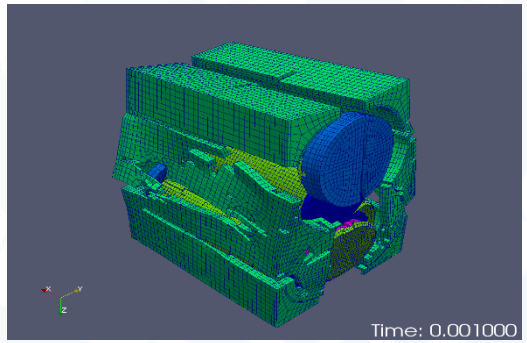
Rocket Sled Track

Drop site

Centrifuge

Thermal Test Facilities





Testing-Modeling Comparisons

SUMMARY

SNSLS
Space Nuclear Systems
Launch Safety

SNL has **supported launch approval** activities for almost **two decades**

Safety analyses are **required** by NSPM-20, and **enabling**, for the use of space nuclear systems

Detailed simulations are used to develop the **probabilistic risk analysis** by **multi-disciplinary** teams and expertise

This information is used to **guide** power system or spacecraft **designs**, mission **architecture** or launch **procedures**

- Potentially reduce risk
- Inform decision makers