Sandia National Laboratories

Exceptional service in the national interest

ANS Spotlight on Sandia

SAND2021-5695 PE

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.

U.S. DEPARTMENT OF ENERGY

NNSA

Welcoming Remarks

James Peery
Director of Sandia National Laboratories

Welcoming Remarks

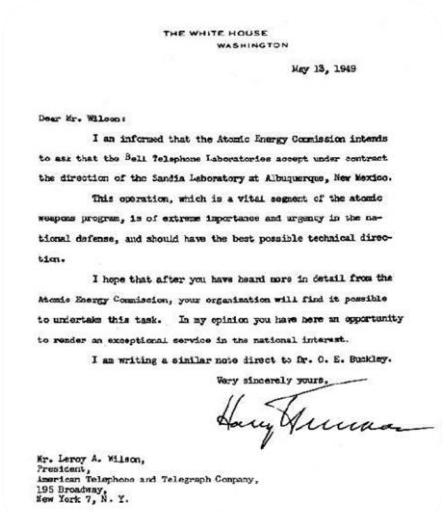
James Peery – Director of Sandia National Laboratories

Sandia History

Rebecca Ullrich
Corporate Historian, Sandia National Laboratories

Sandia History: 1945-1960

1945 1950 1955 1960



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.

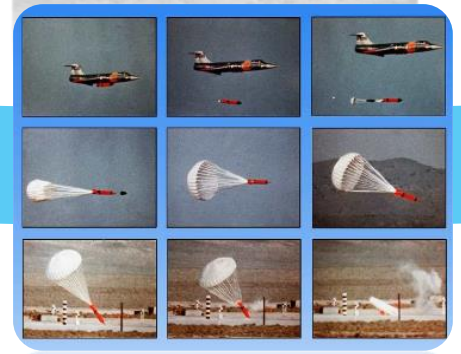
I hope that after you have heard more in detail from the Atomic Energy Commission, your organization will find it possible to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.

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

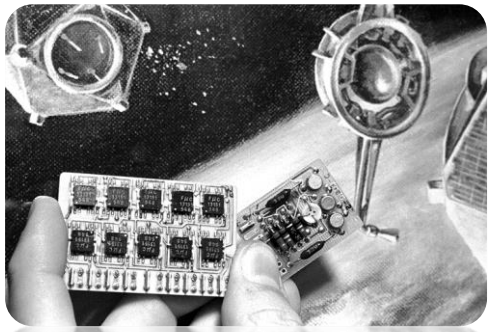
Very sincerely yours,

Harry S. Truman

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



Sandia History: 1960-1980



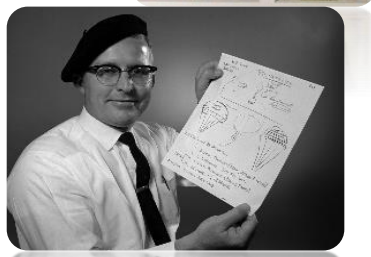
1960

1965

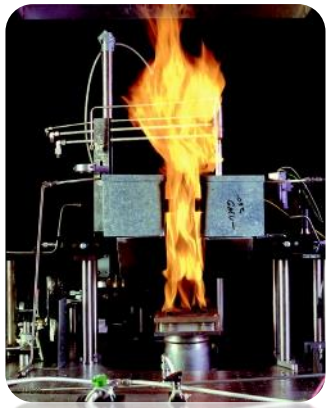
1970

1975

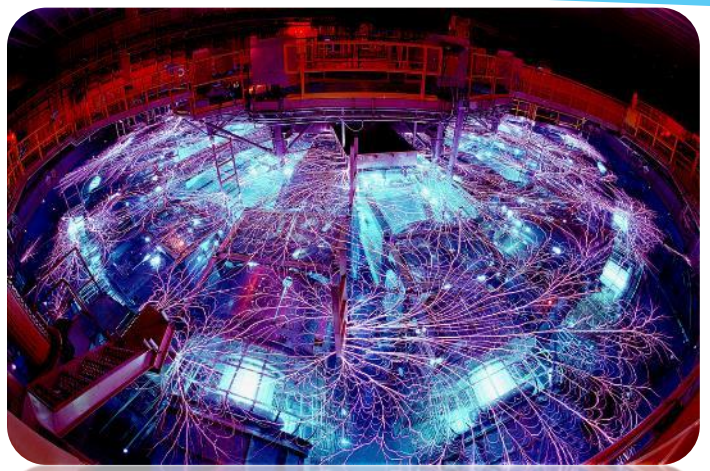
1980



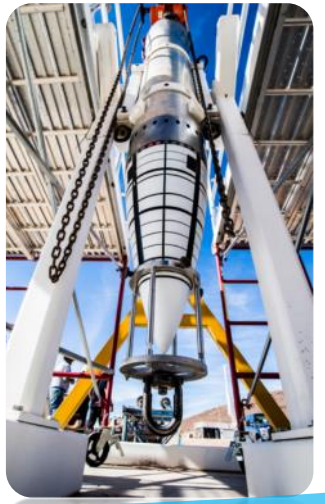
Sandia History: 1980-2000



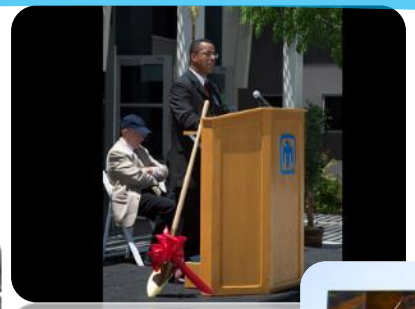
1980 1985 1990 1995 2000



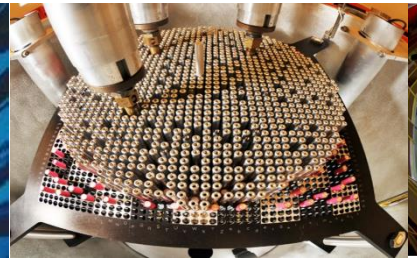
Sandia History: 2000 – Here we are

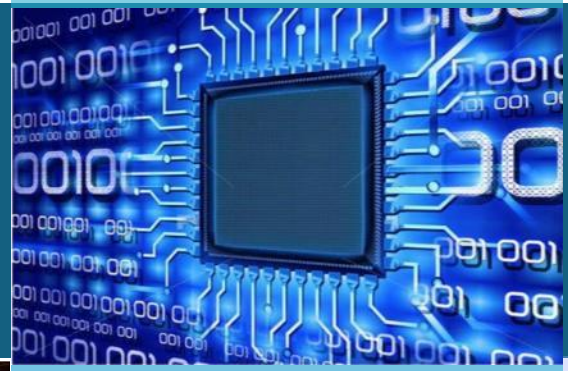


2000 2005 2010 2015 2020



Radiation & Electrical Sciences at Sandia National Laboratories



PRESENTED BY

J. Charles Barbour

Director of Radiation & Electrical Science Center

Unique Science & Engineering Expertise

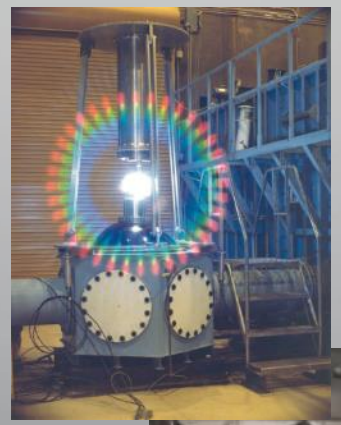
Scientists and Engineers are Essential to the Capability

- Radiation effects in materials, devices, and systems:
  - Displacement-damage effects
  - System-generated electromagnetic effects
  - Shock and mechanical response
  - Radiation-induced high voltage breakdown
- Nuclear engineering and operations
- Pulsed-power and nuclear reactor technologies
- Nuclear, radiation, and plasma diagnostics
- Radiation transport
- Plasma modeling
- Accelerator physics
- Electromagnetic environment theory & modeling
- Radiation-hardened device & circuit simulation

Unique Experimental Facilities for Research

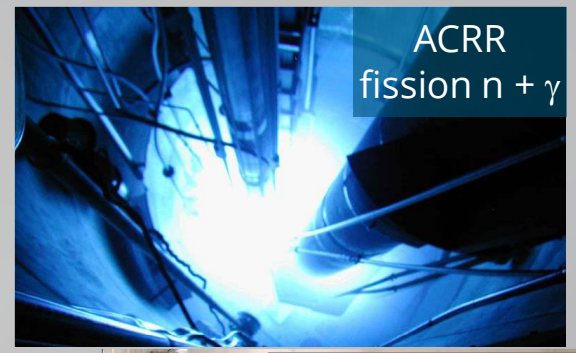
Accelerator Facilities

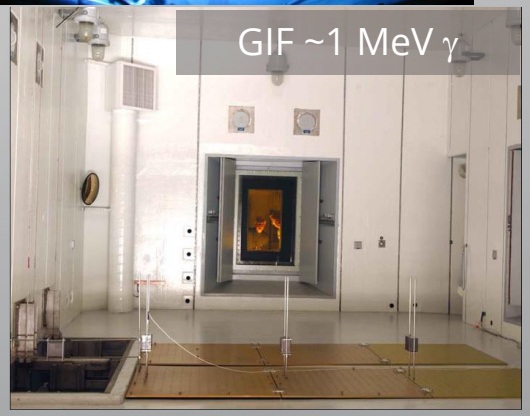
Electromagnetic Facilities



Lightning Simulator

Nuclear Facilities

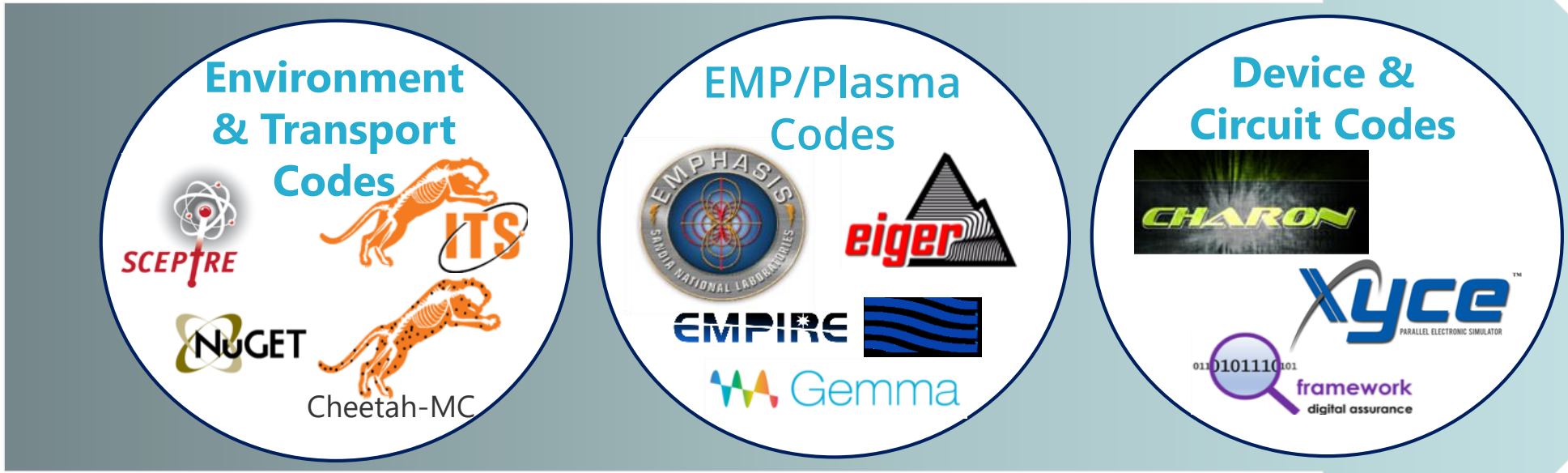




Unique Modeling and Simulation Tools

RAMSES Codes: Radiation Analysis Modeling and Simulation of Electrical Systems

Multiscale modeling from environments to circuit performance

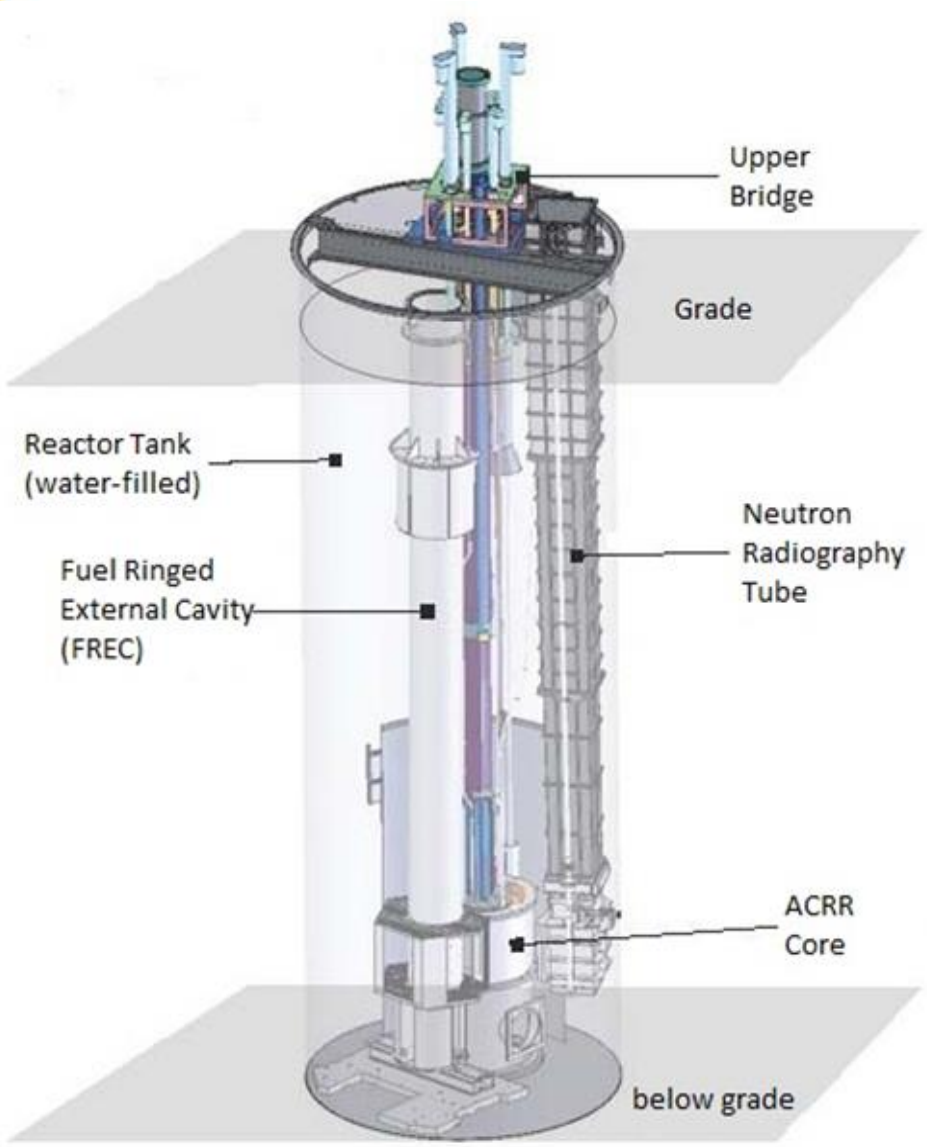


Microsystems Engineering Science and Application – MESA

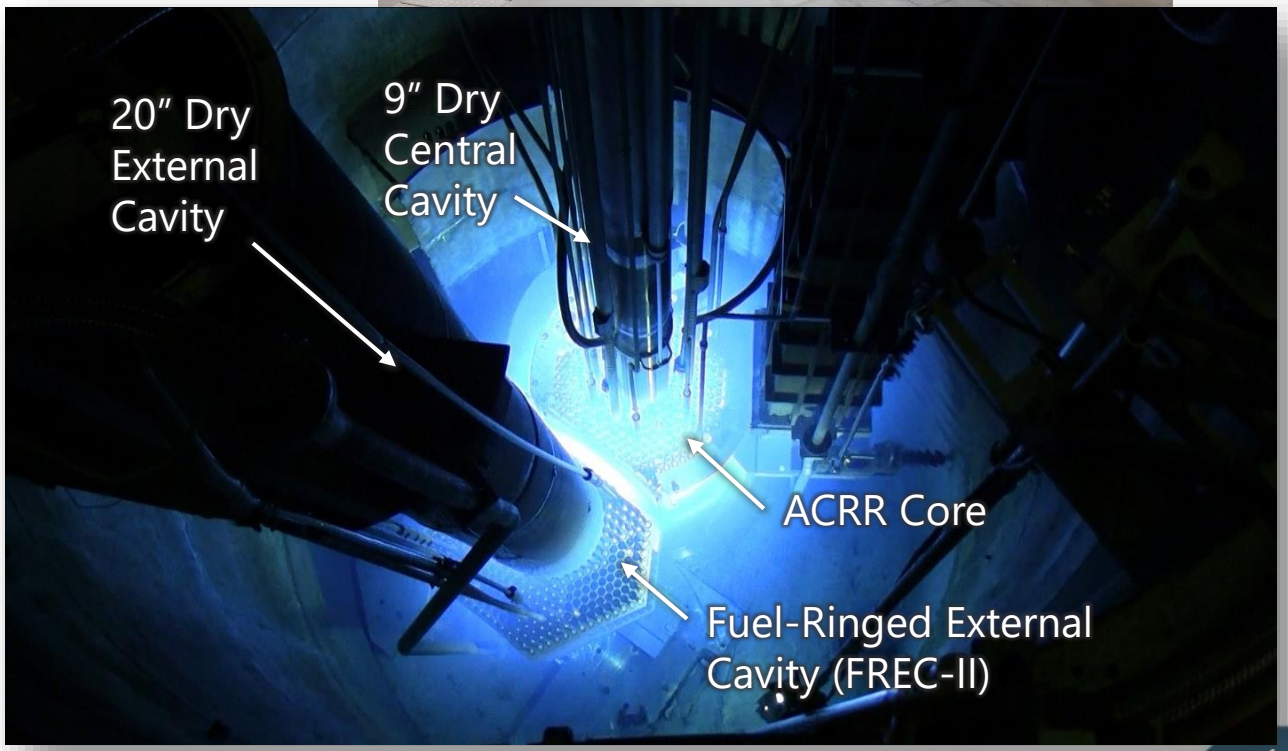
Nanodevices &
Microsystems

MESA has the mission to develop beyond leading edge trusted microsystems technologies to enable new and increasingly powerful macro-system capability and functionality for critical national security platforms.

Annular Core Research Reactor - ACRR

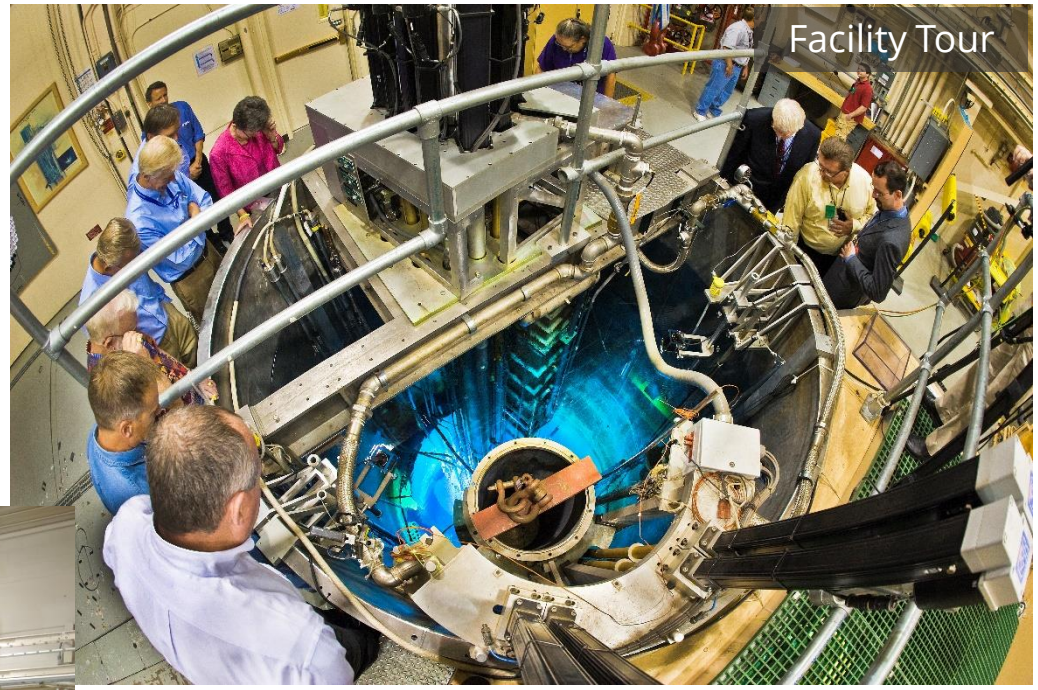


TRIGA reactor



Working at ACRR


Control Room


Facility Tour


Reactor Maintenance, From Inside


Experiment Set-up

ACRR 10000 shot
https://youtu.be/pa0Fmcv83nw

Sandia National Laboratories

NUCLEAR DETERRENCE AND WEAPONS SUPPORT

Exceptional service in the national interest

Presented By: Erik McIntyre, R&D SE
Dept 0524 Weaponeer Professional Development

Sandia National Laboratories

Weaponeer Professional Development

MISSION OVERVIEW

America's Nuclear Weapons Engineering Laboratory

Sandia's primary mission is ensuring the U.S. nuclear arsenal is safe, secure, and reliable, and can fully support our nation's deterrence policy.

The nation's nuclear weapons must *always* work when commanded and authorized by the president of the United States yet must *never* detonate otherwise.

They may remain dormant yet immediately available during high alert/readiness levels.

Sandia National Laboratories

Albuquerque, NM
Livermore, CA

- Warhead system engineering and integration
- Design, development, and qualification of non-nuclear components
- Production of non-nuclear components (neutron generators, microelectronics, thermal battery backup, and other trusted specialty components)
- Development and application of science and technology to solve other national security challenges

Sandia National Laboratories

70 YEARS

Exceptional Service in the National Interest

Weaponeer Professional Development

MISSION OVERVIEW

SNL's traditional, long-term nuclear deterrence mission includes nuclear weapons research, design, development, qualification, testing, certification, and systems integration of all components to arm, fuze, and fire a weapon to military specifications and ensure safety and security.

The integration role is evident in three key areas:

- Internal integration of all non-nuclear components, systems, and subsystems
- Integration between a weapon's non-nuclear portion and its nuclear explosives package
- Integration of a weapon with its military delivery platform

KDP
KNOWLEDGE DEVELOPMENT PROGRAM

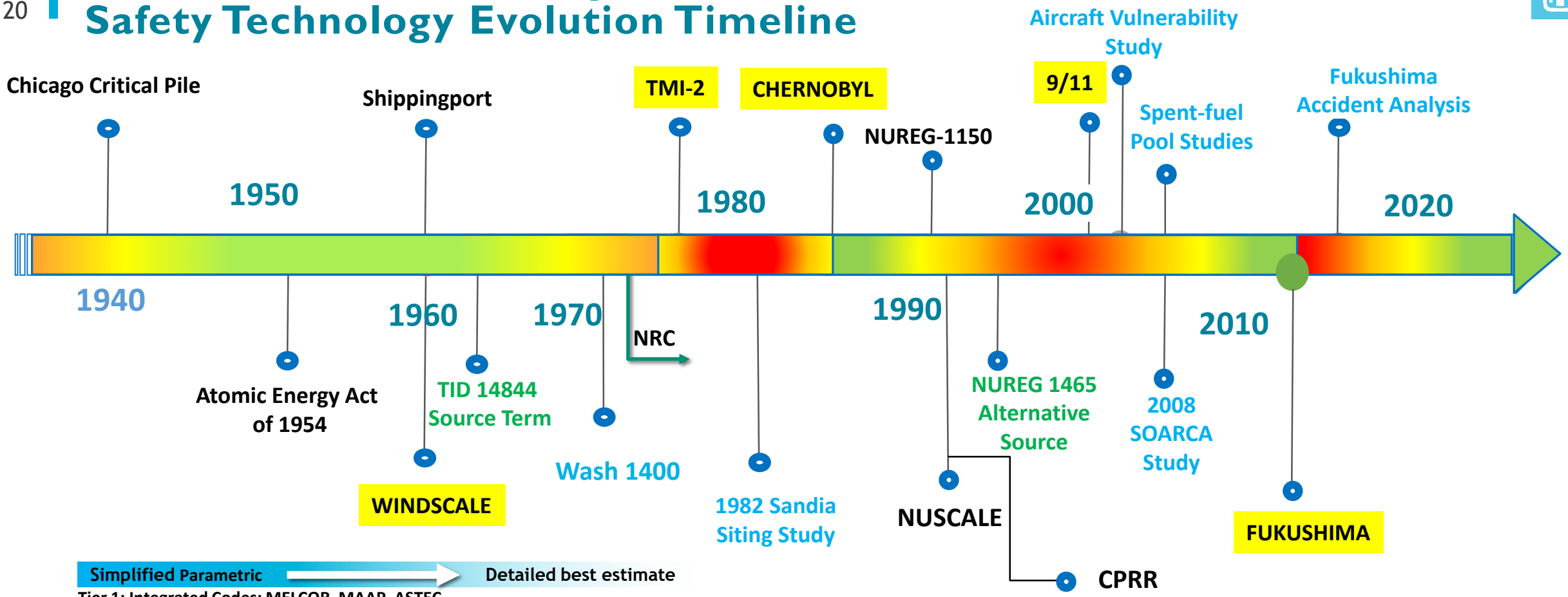
NWMOC Nuclear Weapons Management Orientation Course

520 | Technical Governance and Transformation
Anne Benz | Arnold Muyshondt

Advanced Nuclear Energy and Severe Accident Research

David Luxat
Manager, Severe Accident Modeling and Analysis

Sandia Nuclear Safety Research
Safety Technology Evolution Timeline



Simplified Parametric → Detailed best estimate

Tier 1: Integrated Codes: MELCOR, MAAP, ASTEC

Tier 2: Mechanistic Codes
SCDAP, CONTAIN, VICTORIA

US Research → International Research

Phenomenological Experiments
(PBF, ACRR, ACE, HI/VI, HEVA)

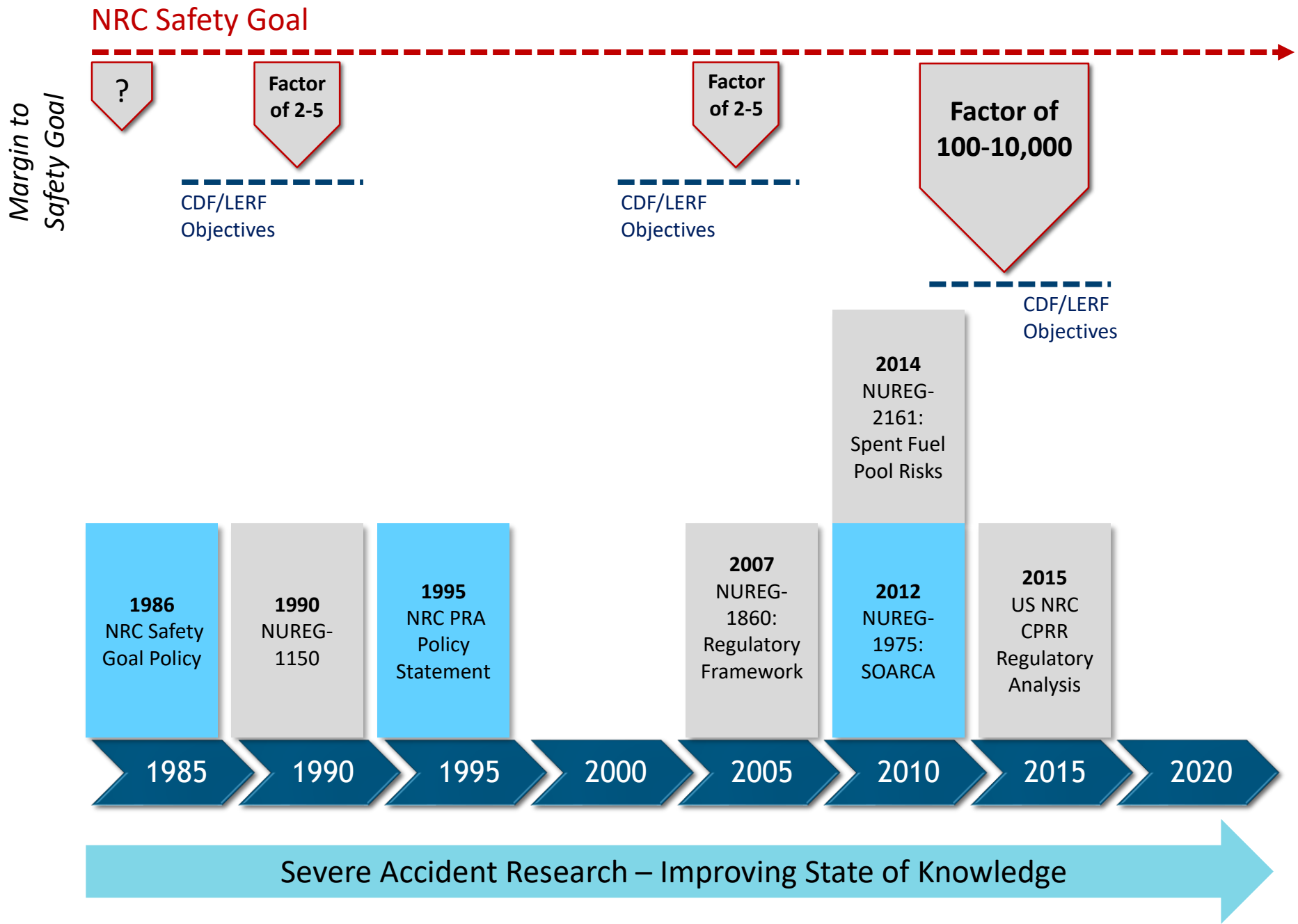
QUENCH, Phebus FP,
VERCORS, VERDON

Deterministic Bounding Analysis

↓ Risk-informed Regulation

Probabilistic Risk Informed Analysis

Sandia Nuclear Safety Research



Technology Neutral Safety Technology Platform

SCALE (ORNL)

Neutronics Modeling

- Criticality
- Shielding
- Depletion analysis
- Burnup credit

MELCOR (SNL)

Integrated Accident and Source Term Modeling

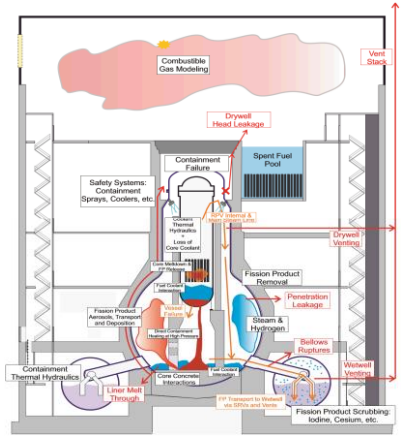
- Hydrodynamics for range of working fluids
- Accident response of plant structures, systems and components
- Generalized fission product transport modeling inside facilities

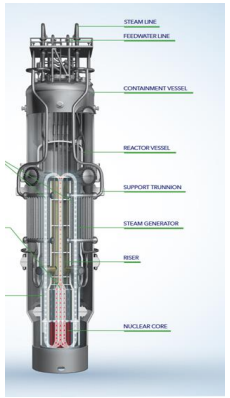
MACCS (SNL)

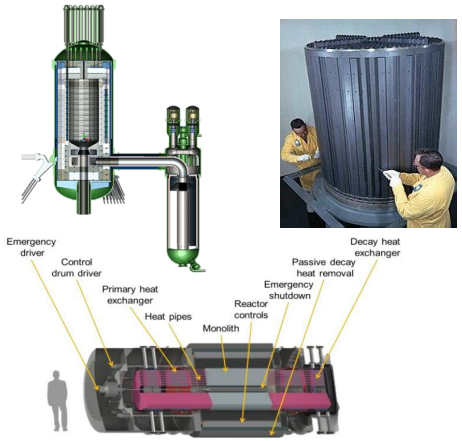
Consequence Assessment

- Near- and far-field atmospheric transport and deposition
- Assessment of health and economic impacts of radiological accidents

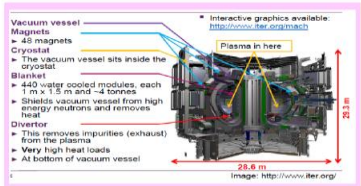
Nuclear Reactor System Applications







Non-Reactor Applications



Fusion

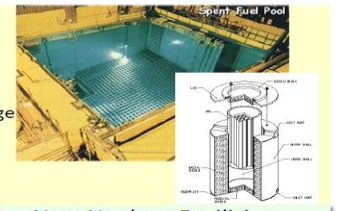
- Neutron Beam Injectors (LOVA)
- Li Loop LOFA transient analysis
- ITER Cryostat modeling
- Helium Lithium
- Helium Cooled Pebble Bed Test Blanket (Tritium Breeding)

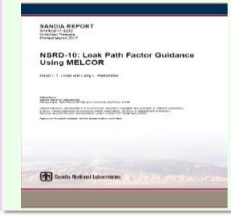
Spent Fuel

Spent fuel pool risk studies

Multi-unit accidents (large area destruction)

Dry Storage





Non-Nuclear Facilities

- Leak Path Factor Calculations (LPF)
  - Release of hazardous materials from facilities, buildings, confined spaces
- DOE Safety Toolbox code
- DOE nuclear facility users
  - Pantex
  - Hanford
  - Los Alamos
  - Savannah River Site

MELCOR Pedigree

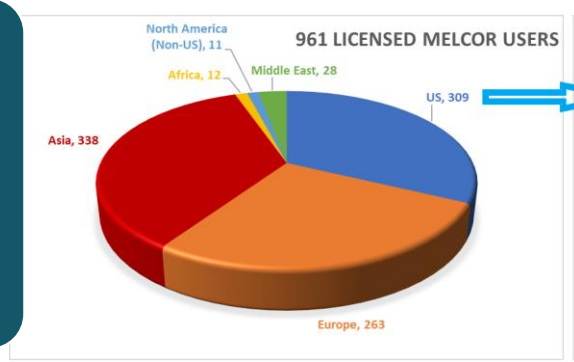
Validated physical models

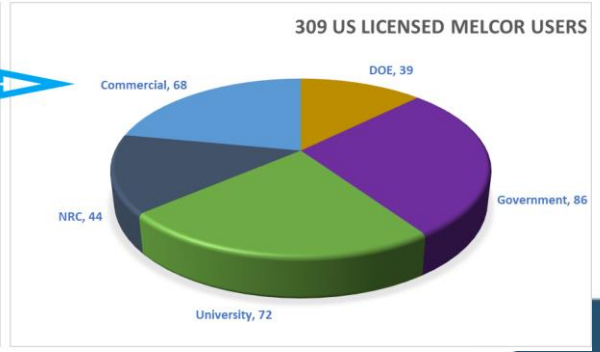
- International Standard Problems, benchmarks, experiments, and reactor accidents
- Beyond design basis validation will always be limited by model form uncertainty that arises when extrapolated to reactor-scale

CSARP (Cooperative Severe Accident Research Program) is a large international, collaborative community supporting the validation of MELCOR

International LWR fleet relies on safety assessments performed with the MELCOR code

International Collaboration
Cooperative Severe Accident Research Program (CSARP) – June/U.S.A
MELCOR Code Assessment Program (MCAP) – June/U.S.A
European MELCOR User Group (EMUG) Meeting – Spring/Europe
European MELCOR User Group (EMUG) Meeting – Fall/Asia

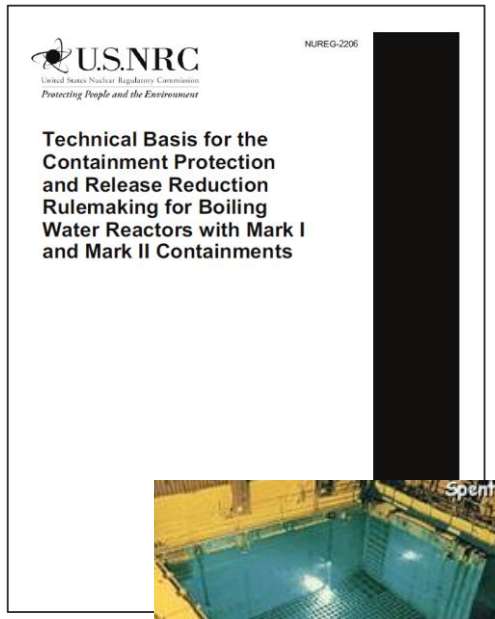


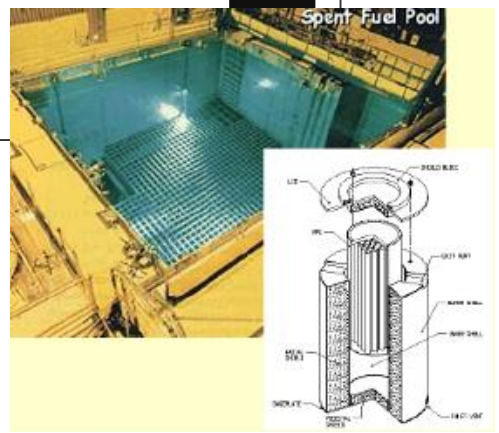


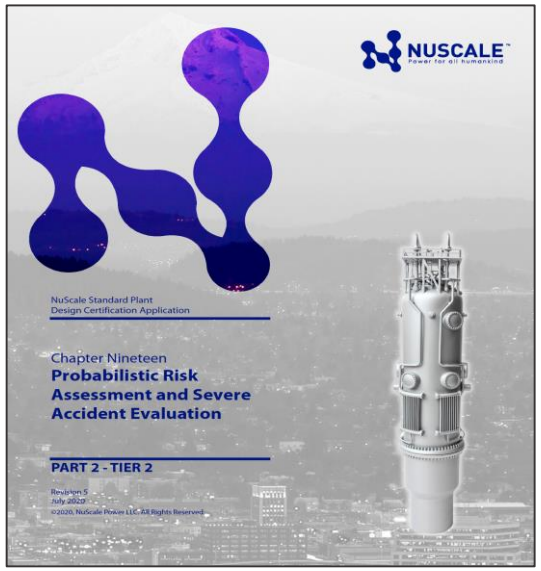
Enabling Nuclear Energy in the Fight Against Climate Change

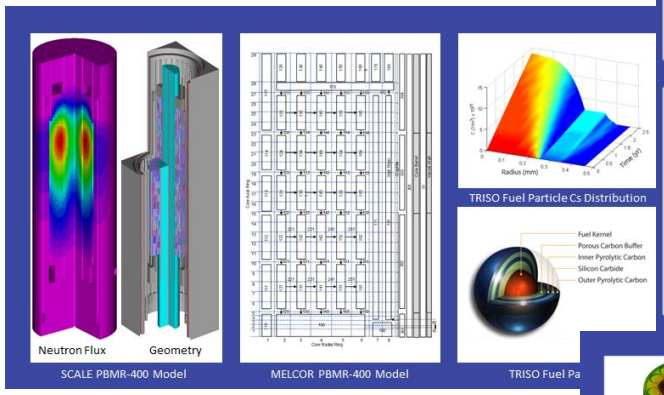
Safety Technology in support of risk-informed decision-making

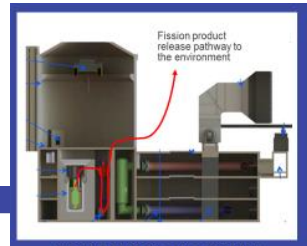
Current Light Water Reactors | **Near-term Advanced Reactors** | **Advanced Reactors**

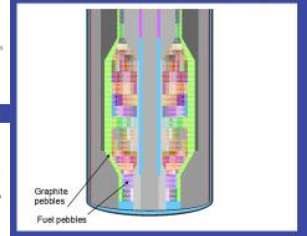


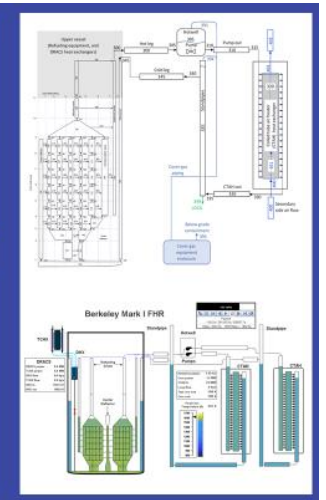


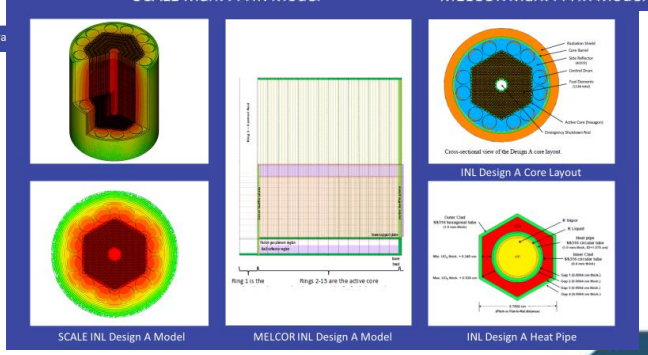






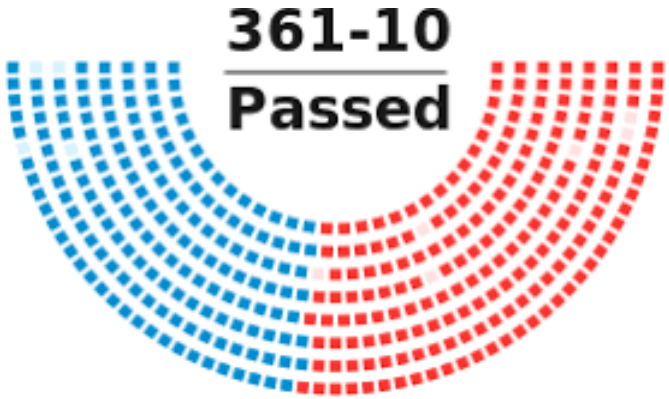






MELCOR

Enabling Regulation of Advanced Reactors



S. 512

One Hundred Fifteenth Congress
of the
United States of America

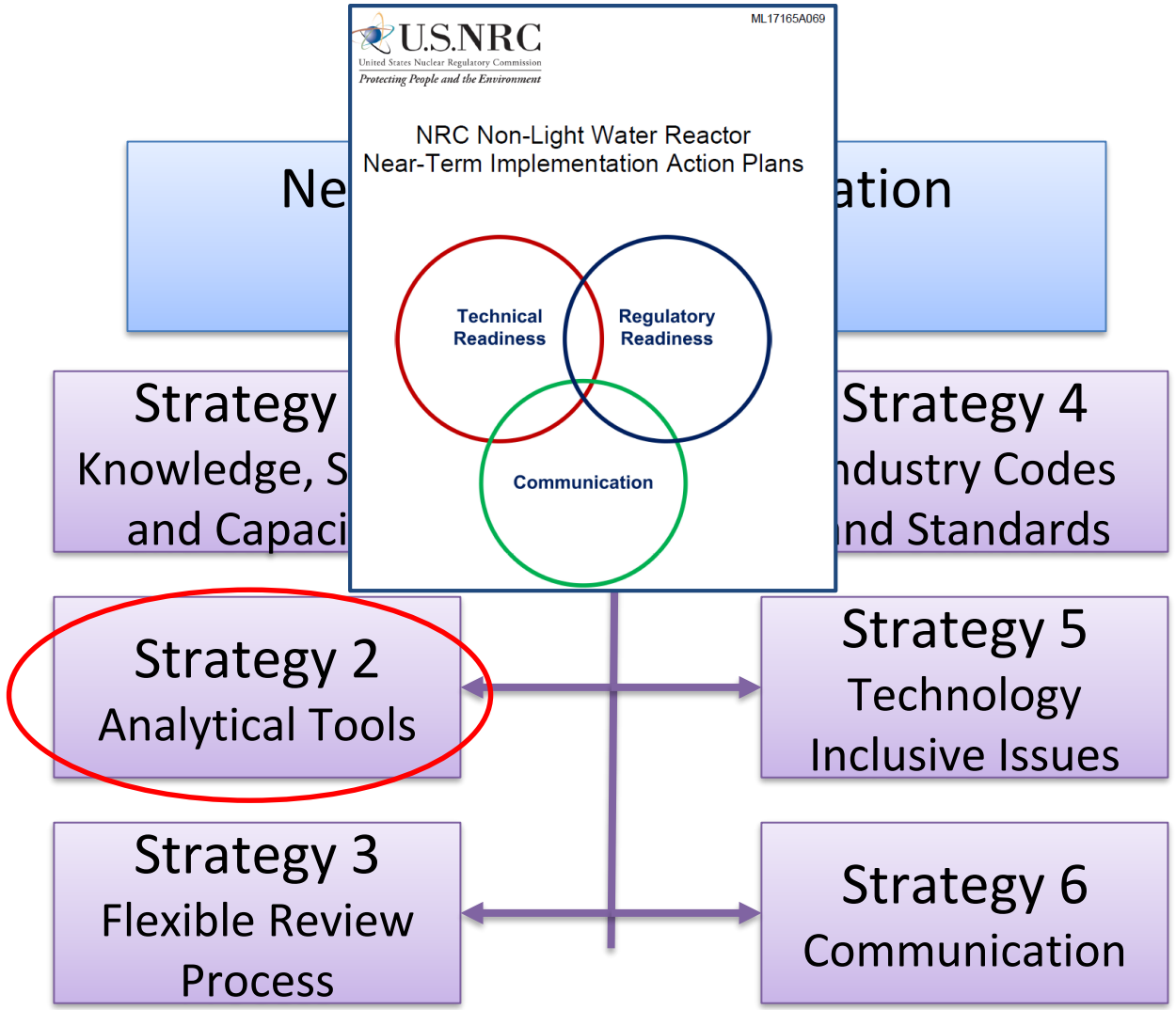
AT THE SECOND SESSION

Begun and held at the City of Washington on Wednesday, the third day of January, two thousand and eighteen

An Act

To modernize the regulation of nuclear energy.

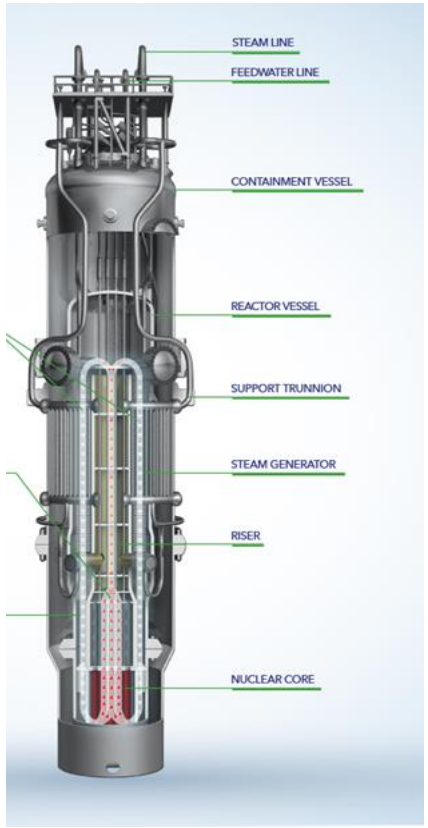
Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

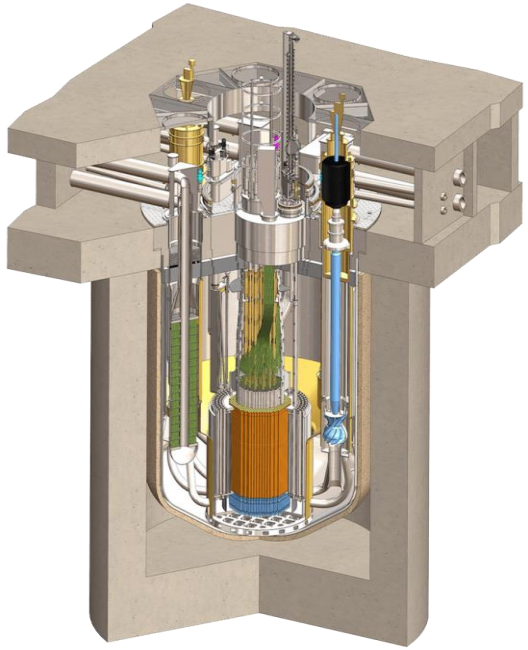


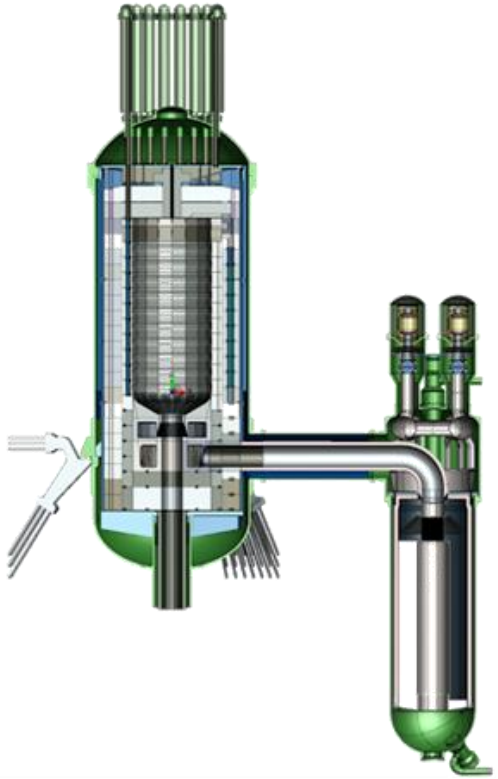
Advanced Reactor Landscape

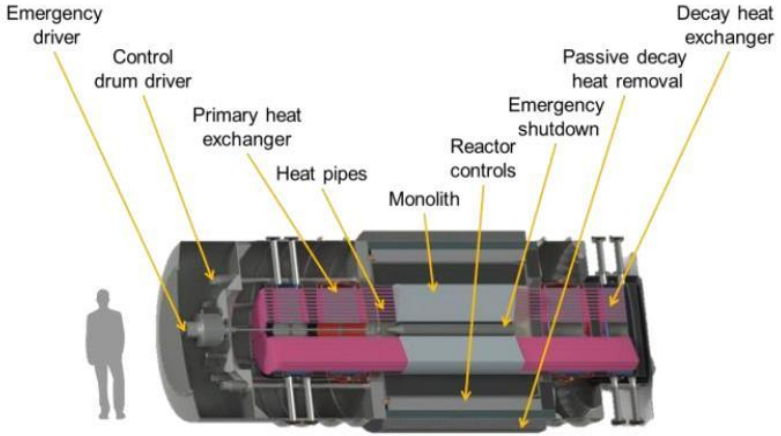
For 40 years Sandia has been the main lab to focus on nuclear energy safety and security work for NRC

NuScale: SMR	TerraPower: Traveling Wave Reactor	X-Energy: High-Temperature Gas Cooled Reactor	Westinghouse eVinci: Heat pipe reactor









SNL Role's in Nuclear Waste Management Projects

Evaristo J (Tito) Bonano
Senior Manager, Nuclear Energy Fuel Cycle

45+ Years of Leadership in Nuclear Waste Management

- SNL is recognized as a **world leader** in the development of the science and engineering related to nuclear waste management. Our expertise and experience includes, among others:
  - R&D in **Storage, Transportation and Disposal** of Nuclear Wastes
  - **Geologic Disposal** of Nuclear Waste
  - **Policy Informing Technical Analyses**
  - **Safeguards and Security for Existing and Advanced Fuel Cycles**
- SNL has had key roles in the management and completion of several major programs, which led to the opening of the **Waste Isolation Pilot Plant**, initiation of licensing proceedings for the **Yucca Mountain repository**, and the disposal of certain specialized nuclear wastes at the **Nevada National Security Site**.
- SNL also assisted the **U.S. Nuclear Regulatory Commission** and **U.S. Environmental Protection Agency** in the design and promulgation of the federal regulations that establish **environmental standards**.
- SNL has numerous technical analyses used by the **U.S. Department of Energy** to develop policy positions regarding the management and disposition of nuclear wastes, and to provide technical briefings to Congressional Staff, input on draft legislation, and testimony to both State and Federal legislators.
- SNL provides technical advice to international nuclear waste management agencies, such as the **International Atomic Energy Agency**, **Nuclear Energy Agency**, and nuclear waste management organizations in Spain, United Kingdom, South Korea, Japan, Australia, Israel, etc.

Major Role in Every National Nuclear Waste Management Project

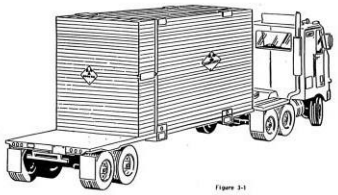
1973	Sandia begins exploring how we could contribute solutions to the problems associated with management of radioactive wastes.
1973 – 1987	International Subseabed Disposal Project
1975	Named by the Atomic Energy Commission (predecessor to the Department of Energy) as the Lead Laboratory for further site characterization of a proposed repository site in bedded salt in southeastern New Mexico and for development of a conceptual repository design and an environmental impact statement (EIS).
1975-Present	Science Advisor for the DOE Waste Isolation Pilot Plant in southeastern NM for the disposal of transuranic radioactive waste from defense activities. WIPP is the only operating deep geologic repository for permanent disposal of nuclear waste in the world.
1976-1993	Designated as Lead Laboratory by Nuclear Regulatory Commission to develop a probabilistic Performance Assessment methodology for deep geologic repositories that could demonstrate compliance with the requirements contained in the proposed NRC and EPA regulations, 10 CFR Part 60 and 40 CFR Part 191, respectively. Starting in 1981, provided technical support to the NRC and EPA in the development of radioactive waste disposal health standards and regulations.

Major Role in Every National Nuclear Waste Management Project (Continued)

1984-2006	Lead for Post-Closure Total System Performance Assessment for the DOE's Yucca Mountain Project for the permanent disposal of spent nuclear fuel from commercial reactors, and spent nuclear fuel and high-level radioactive waste from defense activities
2006 – 2010	DOE's Office of Civilian Radioactive Waste Management's Lead Laboratory for Repository Systems. Led and coordinated the work of multiple national laboratories, universities, and private sector contractors to develop the post-closure safety analysis contained in Yucca Mountain license application submitted to the NRC in 2008
2009 – Present	International Leader for the development of deep boreholes as disposal concept for specialized waste forms
2010 – Present	Lead for the DOE Office of Nuclear Energy's Spent Fuel and Waste Science & Technology R&D Campaign. Lead and coordinate current R&D program on storage, transportation and disposal performed by multiple laboratories, universities and private sector contractors

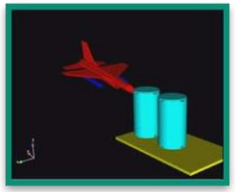
Storage & Transportation – SNL Technology Development History

TRUPACT-I Testing



TRUPACT-II

TRUPACT-III



9/11 Vulnerability Assessments for NRC

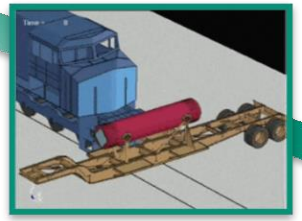
NUREG-0170
- Transportation EIS
- RADTRAN

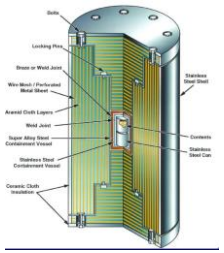
SANDIA ASSIGNED LEAD TRANSPORTATION LAB FOR DOE/DP

PAT-I →

PAT-II

Locomotive Sled Track Test





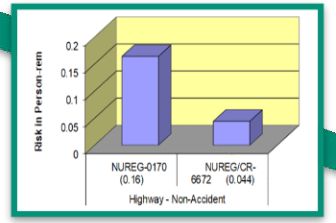
PMATP →

AWG 711

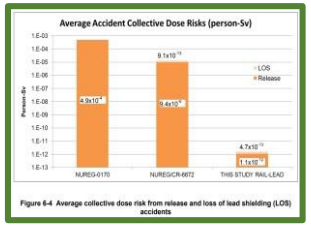
Spent Fuel Release Fraction Test

F-4 Sled Track Test

Sabotage



NUREG/CR-6672 Risk Analysis



NUREG-2125 Risk Analysis

DOE/NE LEAD LAB FOR STORAGE & TRANSPORTATION

1980s | 1990s | 2000s

ERDA & DOE/DP&EM → DOE/EM&RW → DOE/NE

NRC/Research, NMSS, and NSIR →

Security System Design and Evaluation for Nuclear Facilities

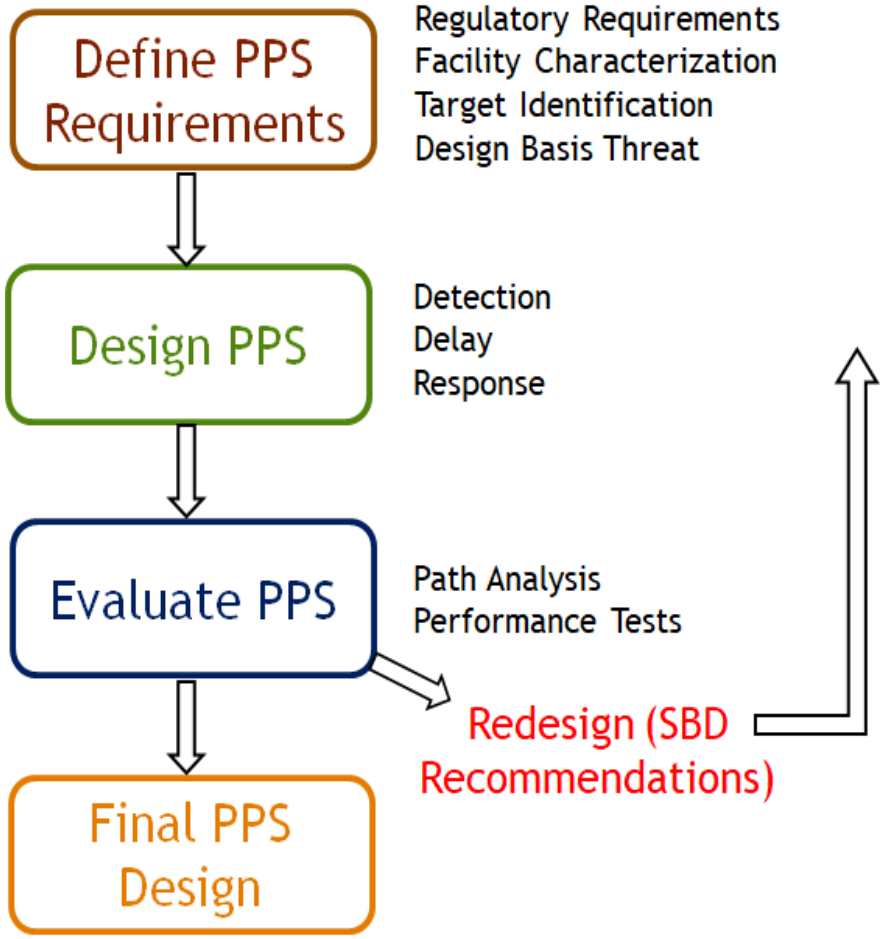
Doug Osborn, PhD
Nuclear Engineer, International Nuclear Security Engineering

Design Evaluation Process Outline (DEPO) Methodology

Define physical protection system (PPS) requirements - Study the existing facility and its plans to learn all of the operations, conditions, and important physical features that affect the PPS. Then conduct a detailed study of the range of adversaries that the physical protection system must successfully counter. Finally, identify the most important areas or materials that must be protected from the adversary.

Design a PPS - Either identify the existing physical protection elements for potential upgrading or design a new protection system using elements of detection, delay, and response that are effective against the capabilities of the potential adversary.

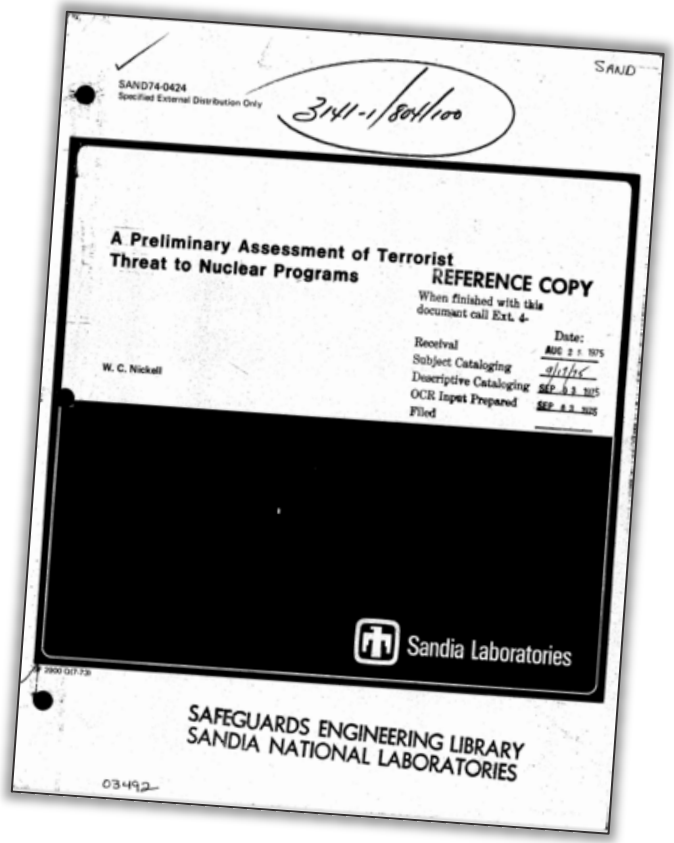
Evaluate the PPS design - Given the information about the facility, threat, targets, and physical protection system, use accepted analysis techniques to obtain a measure of the protection system's effectiveness. Redesign and reanalysis may be required if the measure of effectiveness is not satisfactory.



https://nstc.sandia.gov/training/smr-depo-course

Evolution of Nuclear Security & DEPO

- Atomic Energy Act of 1946 removed nuclear operations from military to civilian control – including nuclear security
- Sandia took fundamental Systems Engineering concepts and applied them to Nuclear Security. That process led to the need to answer:
  - What to protect?
  - Who to protect it from?
    - These questions led to the concepts of protecting against Theft and Sabotage at nuclear materials and facilities, and basing physical protection system designs against a defined adversary threat
- DEPO is a methodology for the definition, design and evaluation of physical protection systems that was created by Sandia in the 1960's and has been actively used globally over the past 60 years across all nuclear fuel cycle facilities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3141-1/8041100

A Preliminary Assessment of Terrorist Threat to Nuclear Programs

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When finished with this document call Ext. 4-

W. C. Nickell

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Basic Physical Protection System Functions

Essential to the DEPO methodology

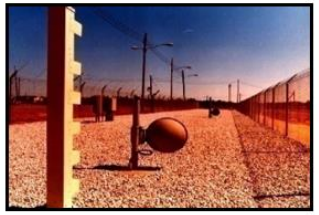
Must be modeled correctly

Assumptions must be made explicit

Physical Protection System Functions

Detection

- Intrusion Sensing
  - Exterior Sensors
  - Interior Sensors
- Contraband Detection
- Entry Control
- Alarm Assessment
- Alarm Communication and Display



Delay

- Passive Barriers
- Active Barriers

Response

- Guards, Response Force
- Interruption
  - Communication to RF
  - Deployment of RF
- Neutralization

Performance Evaluation Metrics

Three metrics are commonly used for evaluating the performance of PPS:

- Probability of Interruption (P_I)
  - Probability that the response force arrives in time to stop the adversary
- Probability of Neutralization (P_N)
  - Probability, given interruption of the adversary, that the response force kills or captures the adversary or causes the adversary to flee
- System Effectiveness (P_E)
  - Probability that the PPS will prevent the adversary from completing the undesired event
  - $P_E = P_I * P_N$

How Performance Evaluation Metrics Relate to Design

Path Analysis: P_I

Does the PPS design adequately provide:

- Timely detection?
- Defense-in-depth?
- Balanced protection?

Scenario Analysis: P_N and P_E

Does the PPS design provide the required level of protection against an adversary attack (scenario) consistent with the Design Basis Threat (DBT)?

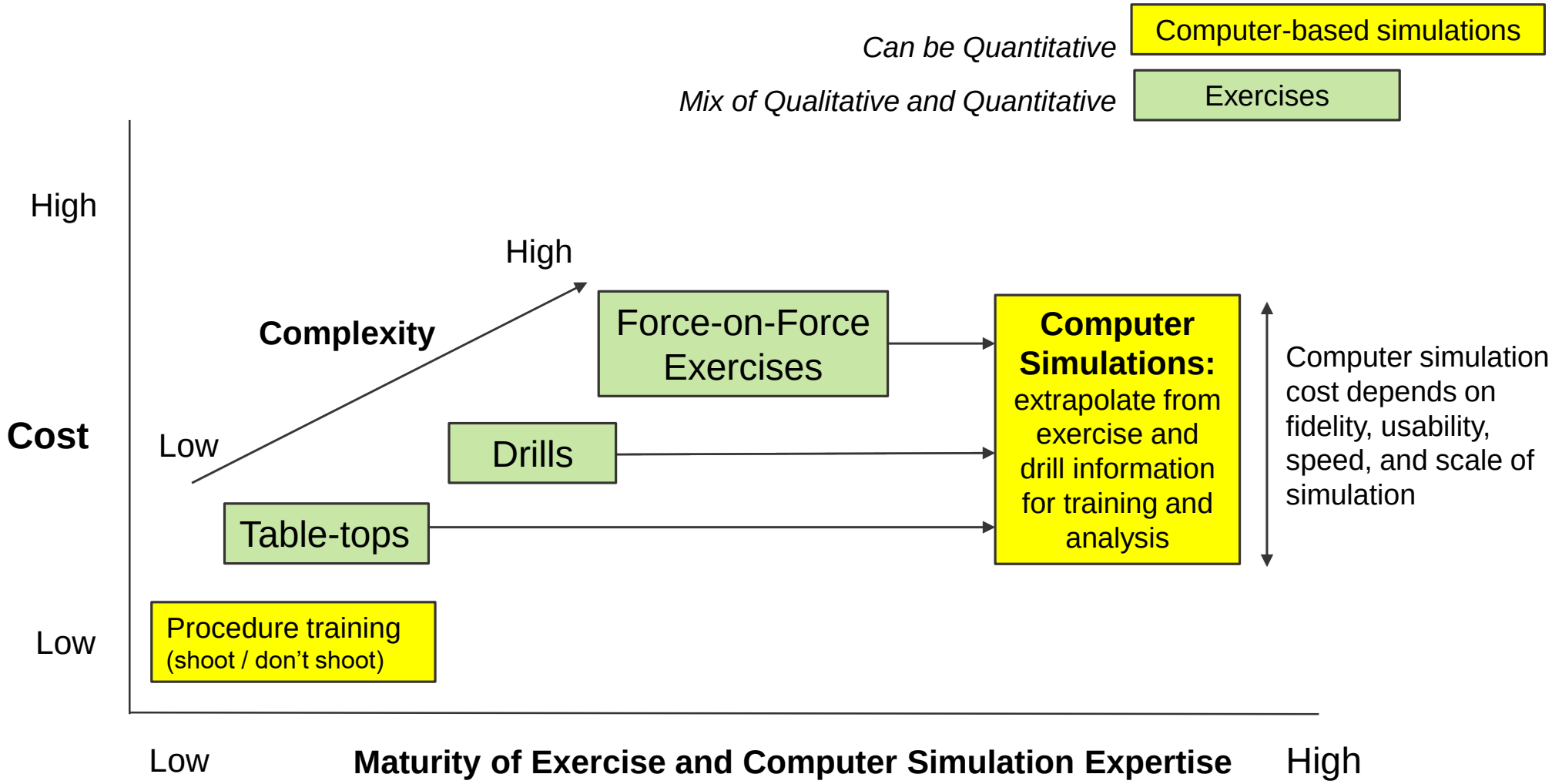
Regulator Thresholds

Often, protection requirements are in terms of P_E being above a threshold, such as 85%

- $P_E = P_I \times P_N > 0.85$

Competent Authority specifies required performance against DBT

Relationship Between Exercises and Computer Based Simulations



Integrating Security with Safety at Nuclear Facilities

Security and safety models each model part of the problem

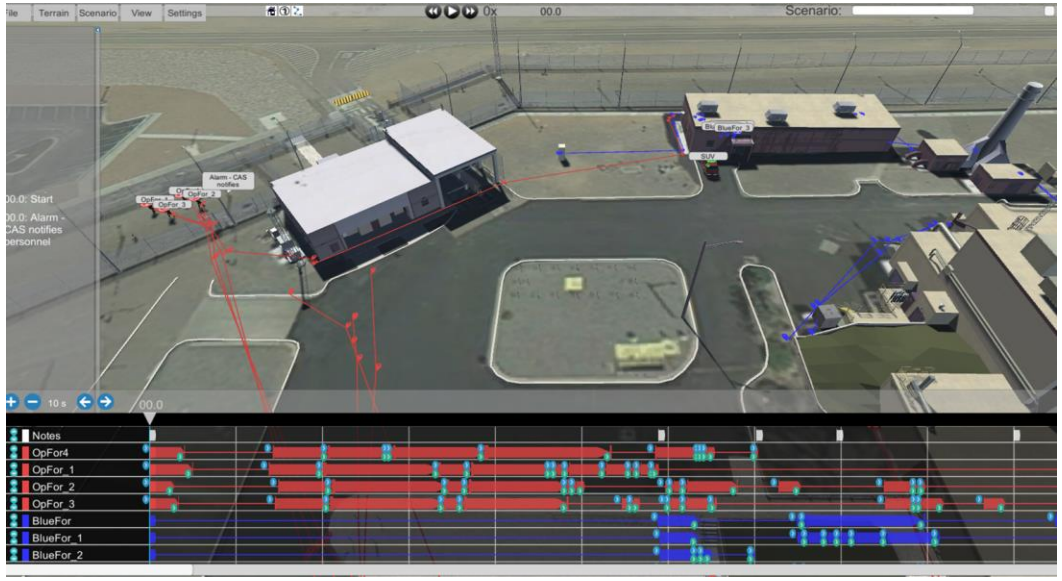
- Security models determine which systems are lost and when
- Safety models predict the effects of those system losses

Integrated safety-security analysis capture events from initial adversary intrusion through sabotage

- Can consider radiological sabotage (direct and indirect), non-radiological sabotage, or both

Requires combining safety analysis with security analysis

- Promote communication between otherwise separate departments



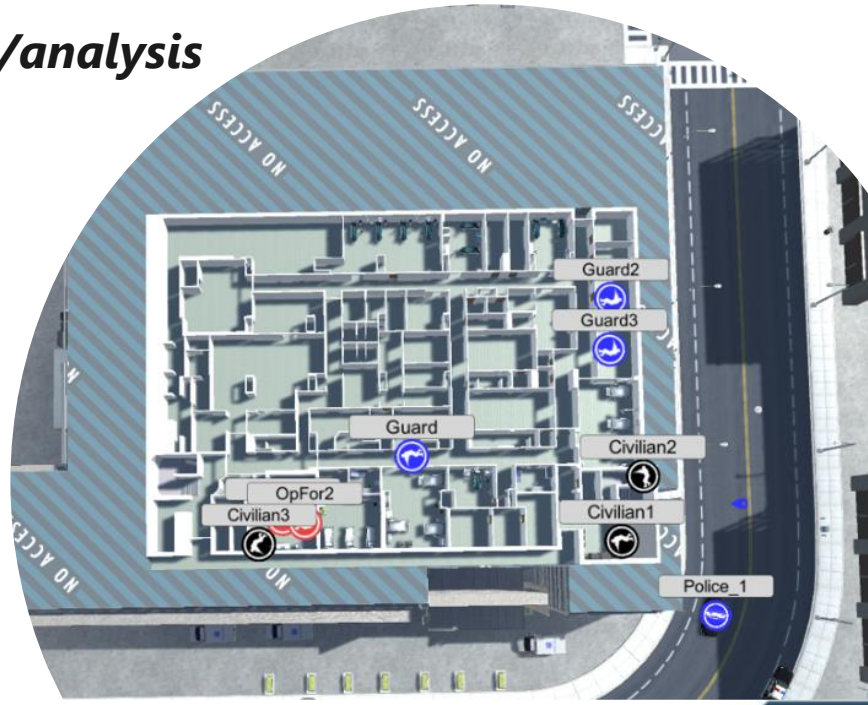
Nuclear Security Engineering Program

Sandia and Los Alamos in partnership with University of New Mexico

- **Professional Development**: Accreditation options for nuclear security
  - Mechanism to support professional development through educational courses
  - Offer Continuing Education Units upon completion of academic courses and professional courses

- **Research**: Advance fundamental nuclear security research
  - Provide a platform into new nuclear security ***technologies & design/analysis*** methods

- **Education**: Based on a holistic approach to nuclear security
  - Core courses as the ***foundational knowledge*** of nuclear security
    - Nuclear Security Theory & Practice
    - Advanced Nuclear Security System Design and Analysis
  - Elective courses to address ***broad range*** of related topics
    - Advanced Nuclear Material Accounting and Control



Thank You

Our ANGLE to the Future





Presented By:

Caroline Winters, PhD
ANGLE Chair, 2021

Sandia National Laboratories

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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Advancing the Next Generation of Leadership Excellence (ANGLE)

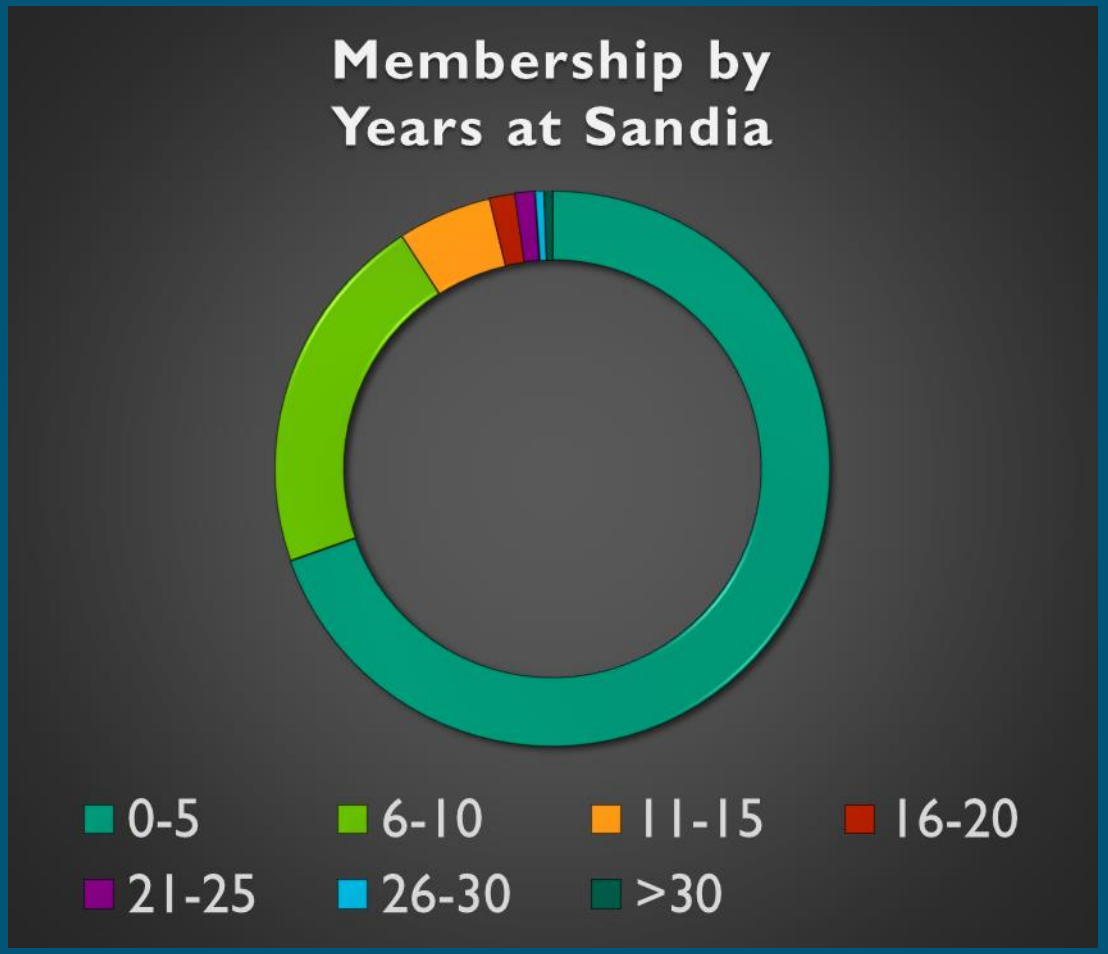
2021 ANGLE Snapshot

Board Officers

- ~15 volunteers from SNL New Mexico and SNL California
  - Research Staff
  - Communications
  - IT Contractors
  - Environmental Health & Safety
  - Mechanical, Biological, and Production Engineers, etc.

Highlighted Events

- +30 Events with +1000 participants
  - "Thriving in Chaos"
  - Performance Management Workshop Series
  - Homeward Bound Drive for Shelter Animals
  - Big Brothers Big Sisters Science Fiesta



About Me

Hometown: Los Angeles, CA

2011- BS Mechanical Engineering from
Rose-Hulman Institute of Technology

2015- Joined Sandia as a Graduate Intern

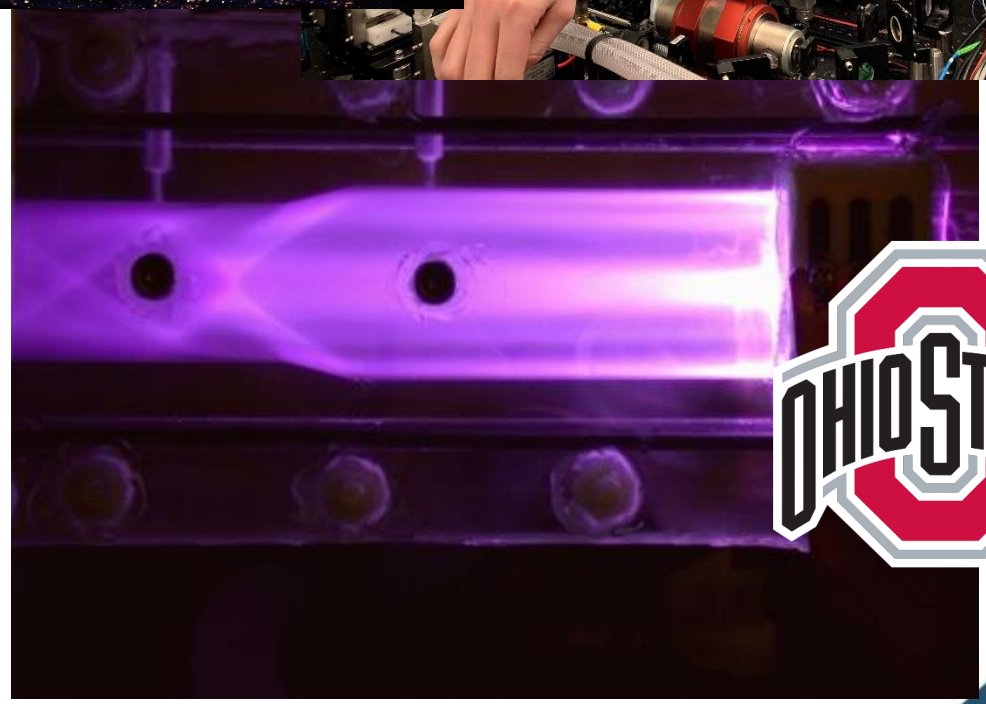
2017- PhD in Aerospace Engineering from OSU
Post-doc in Engineering Sciences, SNL NM

Joined ANGLE as Community Service Chair

2019- Research Staff in Fire Sciences & Technology

2020- Became Vice Chair of ANGLE

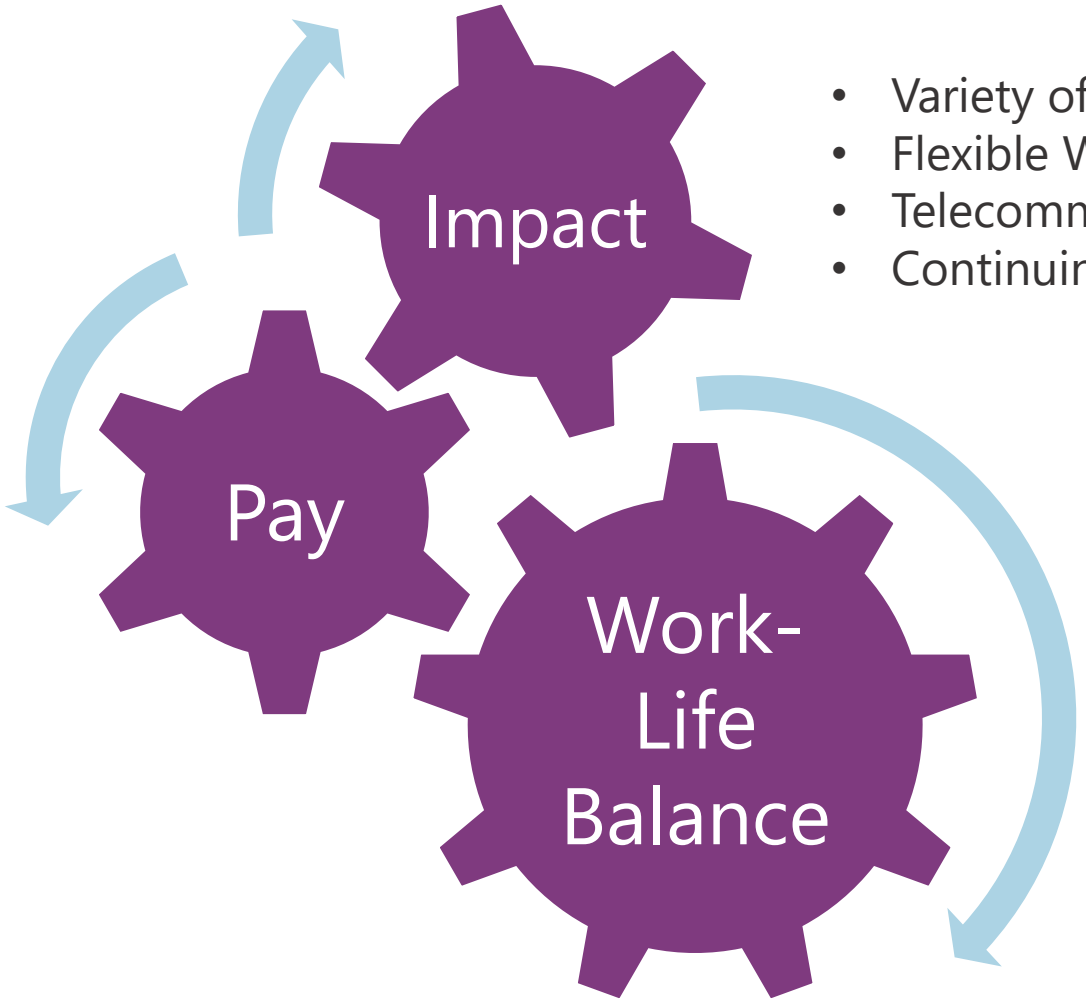
2021- Serving as Chair of ANGLE



Of all the paths you take in life, make sure a few of them are dirt"
~John Muir

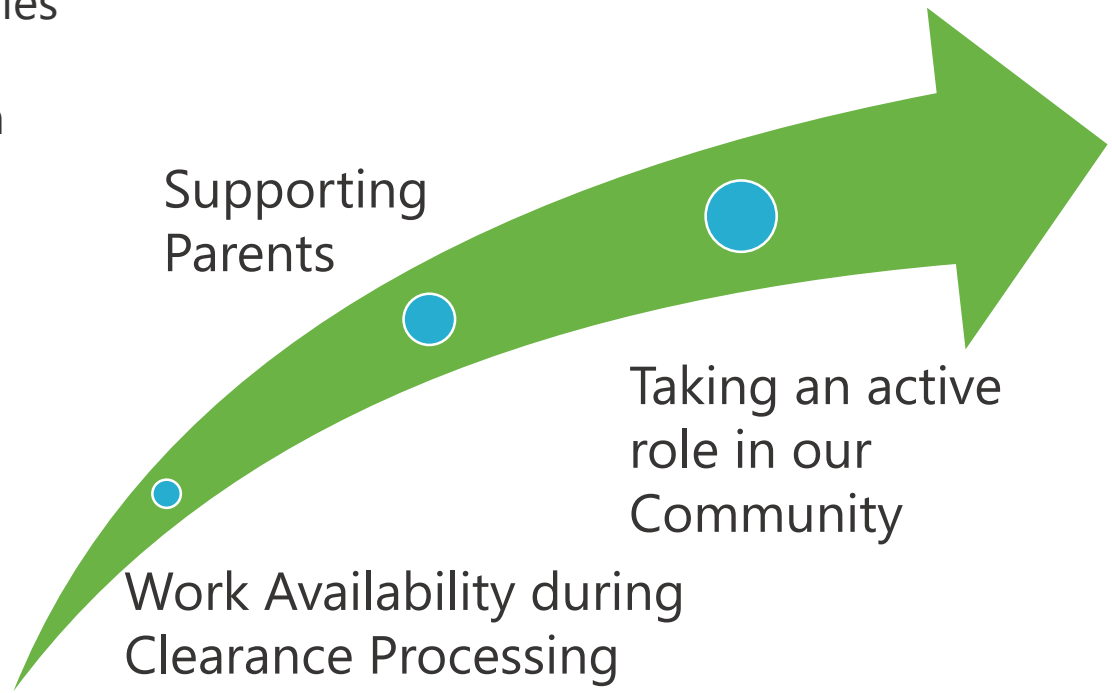
ANGLE's Early Career Value Proposition

Why Sandia



- Variety of Career paths
- Flexible Work Schedules
- Telecommuting
- Continuing Education

*How Can We Improve?**



*Collated from 800+ responses to ANGLE's Recruitment and Retention Working Group, 2018-2019

Sandian Culture and Employee Resources

IDEA
Inclusion & Diversity, EEO & AA Organization

Sandia's diverse workforce values inclusion. We engage energized and inspired people who spark innovation and achieve mission success.

GIVE SERVE & INSPIRE
Sandia National Laboratories

Community Involvement Office
- Donation drives
- Volunteering opportunities
- Outreach programs

9/80, 4/10, or a part-time work schedule

WHIL and Mindful Meditation

Health Action Plans focusing on health, fitness, and nutritional counseling
- Earn money towards your Health Reimbursement Account (HRA)

SERP
Sandia Employee Recreation Program

Sandia Employee Recreation Program (SERP)
- Recreational Tickets & Leagues
- Arts & Crafts
- Music & Dance
- Kid's Camps
- Family fun

ONE Sandia: ***What does it mean to be a Sandian?***

SANDIA parents group

Abilities Champions of Sandia (ACS)
Bringing Access to Sandia

SANDIA PRIDE ALLIANCE NETWORK

Employee resource groups (ERGs) support Sandia's mission by promoting a welcoming, diverse, respectful, and inclusive environment that encourages the growth, development, and full contributions of all members of the workforce, as well as promoting awareness in cultures and communities.

AMERICAN INDIAN OUTREACH COMMITTEE

MSC MILITARY SUPPORT COMMITTEE

ANGLE

HOLA

SWAN Sandia Women's Action Network

BLACK LEADERSHIP COMMITTEE *Make Your Mark*

Asian Leadership Outreach Committee

ONE Sandia: ***What does it mean to be a Sandian?***

SANDIA parents group

SPG's purpose is to engage and retain Sandia's workforce by fostering a culture of work/life balance so all employees can thrive in their careers.

- Founded in 2015 → 50 members
- As of 2021 → 450+ members

Benefits & Leave
- Connecting parents with Leave Administrators & Medical Case Managers
- **Special Vacation Donation Program**

Flexible Work Policies
- Encouraging flexible work policies

Lactation Accommodation
- Championing lactation accommodation at Sandia including lactation rooms
- Monthly nursing mother's resource and support group

Child Care & Education
- Childcare reviews by members in the ABQ and Livermore metro areas
- *Discovering Education Choices* Fair (annually, 30 area schools in the ABQ area)

Always a Sandian: Community Involvement and Outreach

GIVE SERVE & INSPIRE
Sandia National Laboratories

Sandia Gives: ~$5 Million donated annually

- COVID-19 Relief Aid
  - $245k to Native American Communities, New Mexico
  - $100k to Roadrunner Food Bank New Mexico
  - $20k to United Way Bay Area, California

Inspiring Through Education: TRC-280 Education Service Time off

- Unique employee benefit to participate in local K-12 education activities and virtual education.

From Our Home to Yours! ***Tours.Sandia.Gov***

Learn about us, then and now

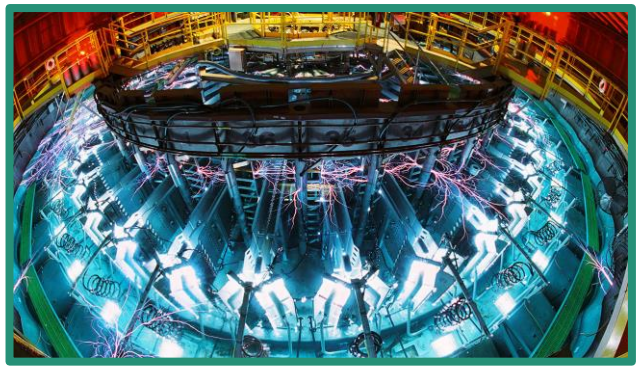
**Search Sandia National Laboratories on YouTube, Facebook, Twitter*

Discover our Facilities through Virtual

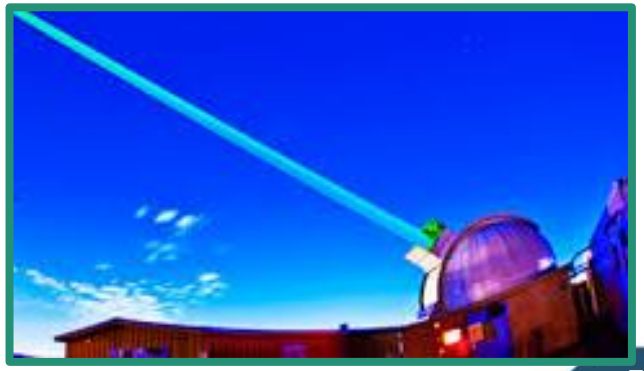
Robotic Vehicle Range

Thermal Test Complex

Z-Machine



Laser Applications Facility (LAZAP)



Thanks for Your Attention!

Q & A