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Title:	Source Physics Experiment Phase II, Dry Alluvium Geology (DAG) Experiments Using Nitromethane
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Intended for:	Need to provide briefing to the State of Nevada as part of the Permitting process for the Nevada Chemical Accident Prevention Program (CAPP) for use of nitromethane at the NNSS. This document will be accessible to the public as part of the CAPP program.
Issued:	2016-12-21

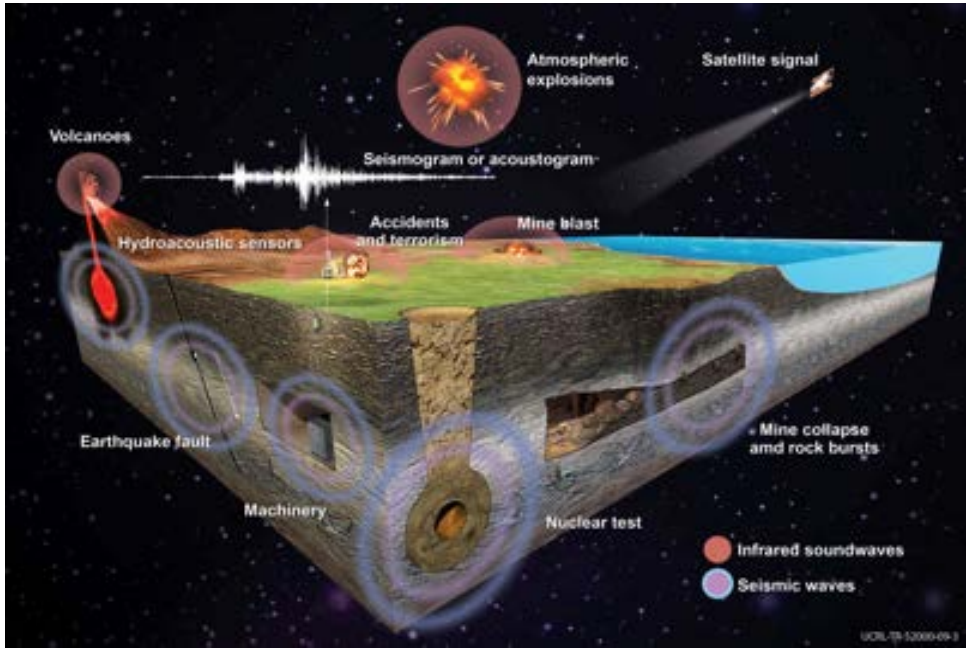
Source Physics Experiment Phase II

Dry Alluvium Geology (DAG) Experiments using Nitromethane

Scott Traeger, DAG Experimental Campaign Manager, LANL

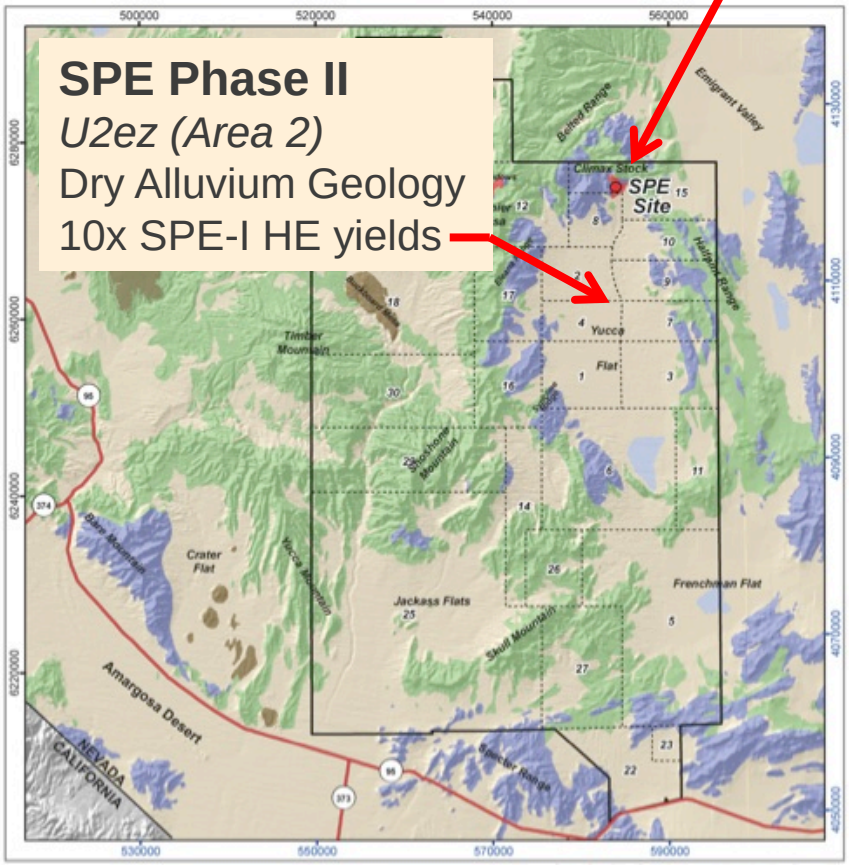
The Source Physics Experiment (SPE)

- **SPE is a National Nuclear Security Administration (NNSA) project to improve U.S. confidence in our ability to detect and verify low yield nuclear explosions in a noisy geophysical environment.**
- **SPE Phase I was completed in October. We are now moving to Phase II, called Dry Alluvium Geology (or DAG)**



SPE Phase I
Climax Stock (Area 15)
Granite geology

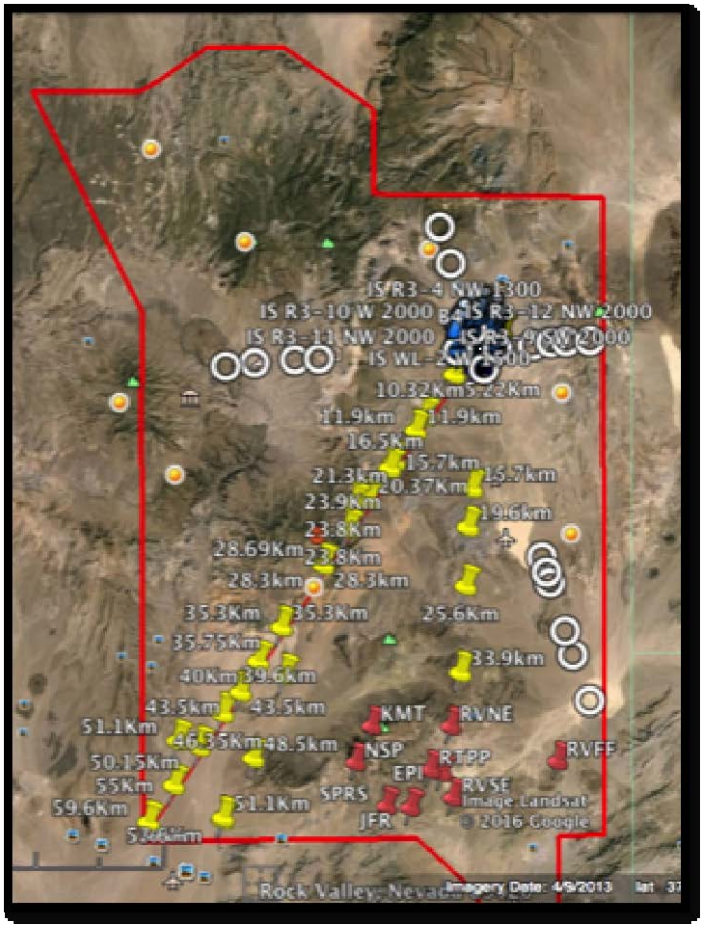
SPE Phase II
U2ez (Area 2)
Dry Alluvium Geology
10x SPE-I HE yields



The DAG series will generate a comprehensive data set

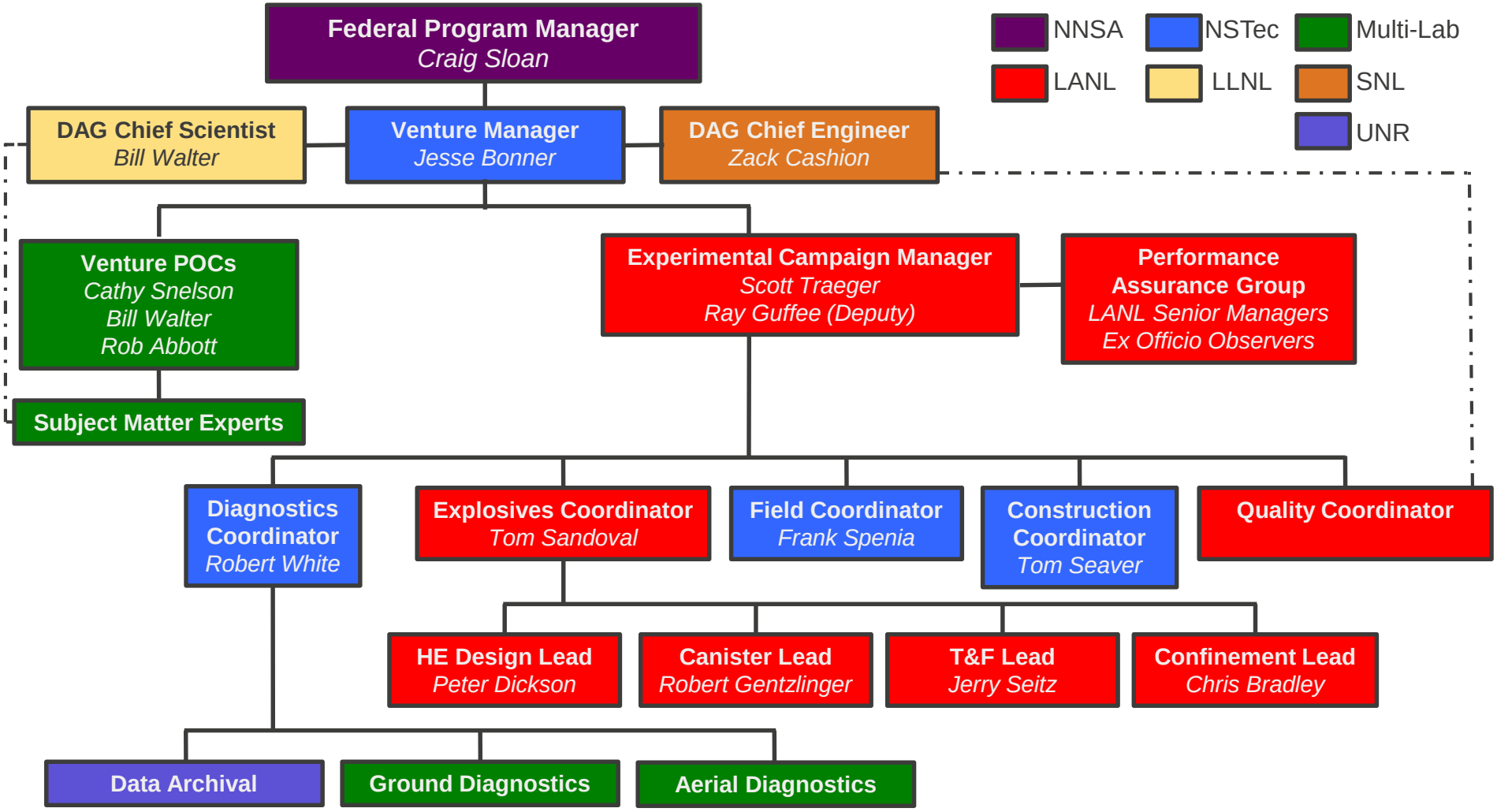
Acquire High-Quality Data

- **DAG detonations will be recorded by:**
  - Accelerometers
  - Seismic networks (local & regional, ~100 stations, hundreds of km range)
  - Infrasound arrays
  - High-speed video
  - Electromagnetic sensors
  - Remote sensing methods
- **Seismo-acoustic data acquired year-round to produce an extensive database of earthquakes and explosions**
- **Data is released to the scientific community no later than 2 years post-shot**
- **Data is also useful to other NNSA entities efforts to improve explosion monitoring**



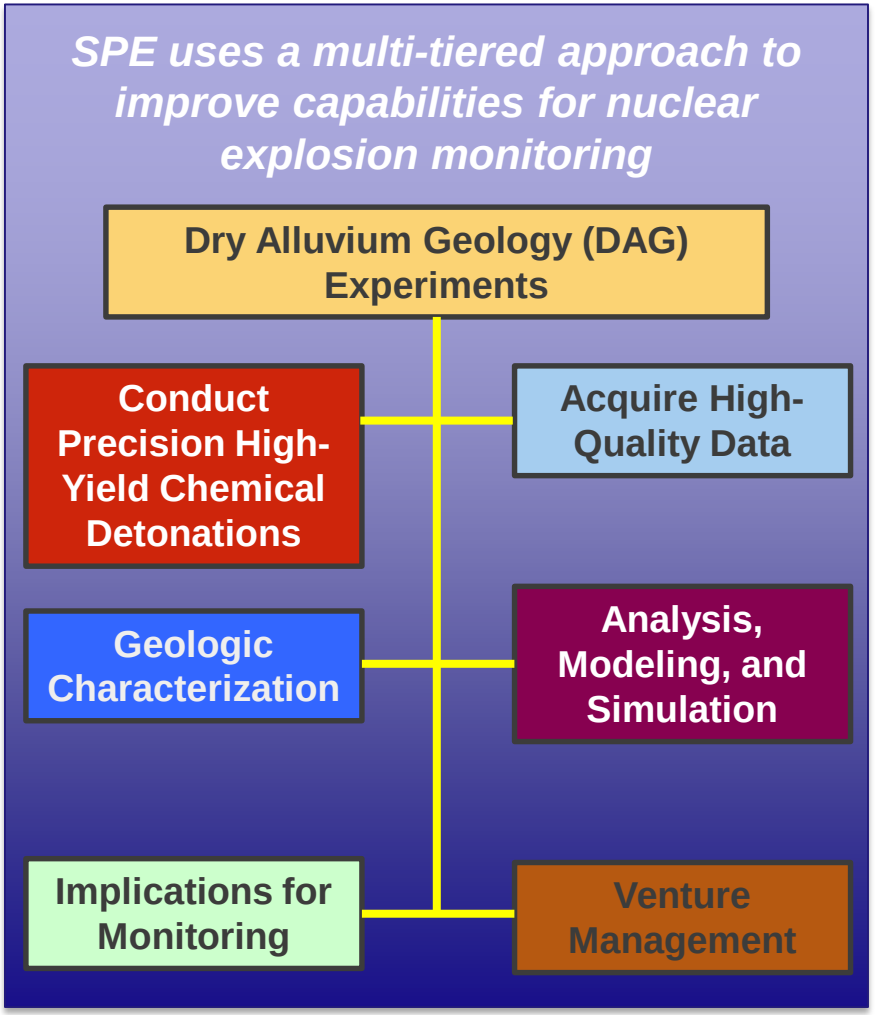
NNSS Seismic networks for DAG shots

DAG Venture Management Team

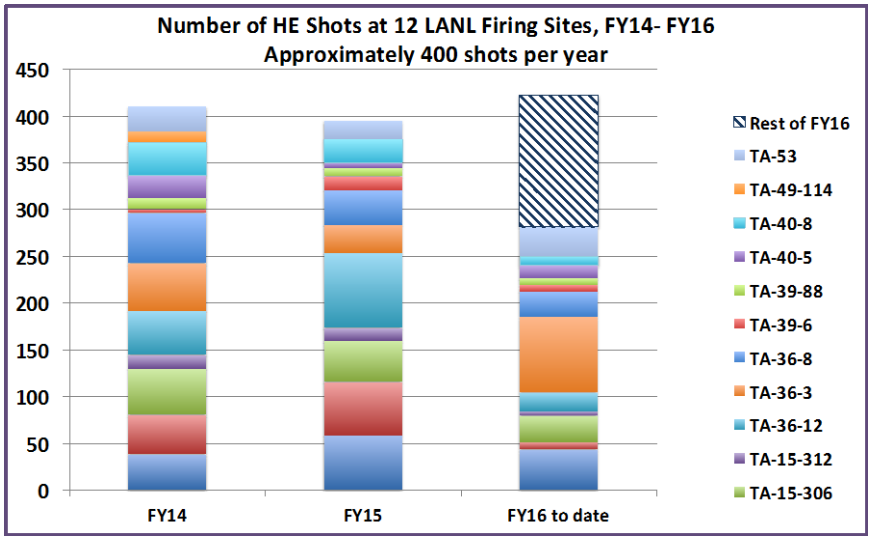


SPE is a complex venture accomplished by a closely coordinated team

- **SPE is sponsored by the Office of Defense Nuclear Nonproliferation Research and Development (NA-22)**
- **The SPE Program Participants include:**
  - Los Alamos National Laboratory
  - Lawrence Livermore National Laboratory
  - Sandia National Laboratories
  - National Security Technologies
  - Air Force Technical Applications Center
  - University of Nevada, Reno
- **Communication and coordination to integrate the expertise and capabilities of all SPE team members is the key to program success**



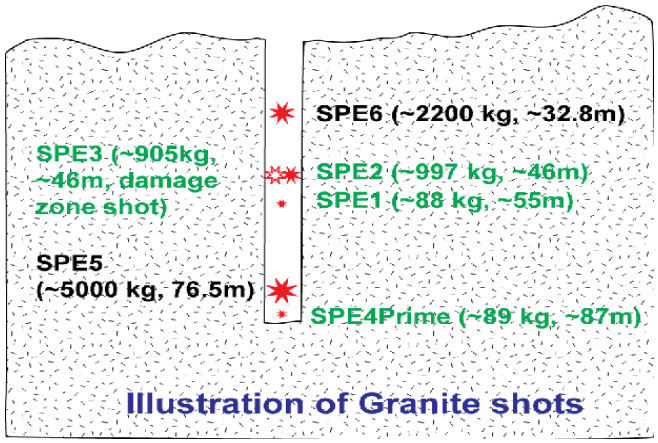
- **The source execution team is formed from the LANL Weapons Program dynamic testing community partnering with NSTec**
  - $135M FY16 dynamic testing budget @ LANL
  - 216 LANL qualified high explosive handlers, 12 firing facilities
  - The team is home to LANL's Integrated Weapons Expts, Explosive Science, and HE manufacturing capabilities
  - DOE-STD-1212-2012 compliant Explosive Safety Program and supporting infrastructure
  - ~ 400 dynamic HE experiment shots per year
- **Routinely conduct large, complex experiments similar to the DAG shots**
  - Sub-critical experiments at NNSS/U1a and Unicorn (U6c)
  - Hydrodynamic experiments at DARHT
  - Special Explosive Applications projects
  - Above ground experiments at LANL and NNSS
  - Often collaborative tests with partners
- **We have decades of experience and a permanent presence at NNSS**
  - J-NV (JLON) is part of the proposal team



Overview of SPE Experiment Series

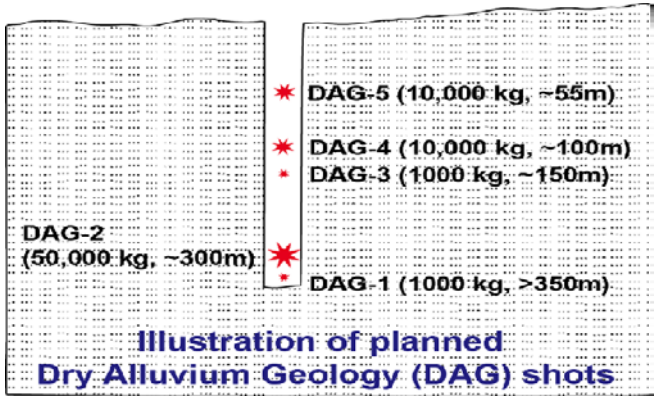
Phase-I

(conventional explosives)



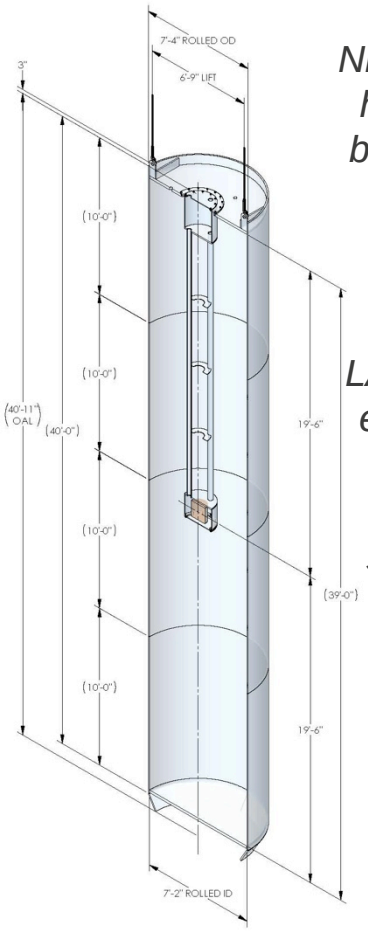
Phase-II

Dry Alluvium Geology (DAG) (using nitromethane)



The DAG Source will be a PBX 9501 Boosted Nitromethane Main Charge

Parameter	Nitro-methane
Cost	$1.25/lb *~$0.2M for all shots*
Relative Effectiveness Factor (wrt TNT)	1.1
Shock sensitivity	Insensitive *8-12 GPA*
Density	1.13 g/cc
L/D ratio (50-ton, 86" dia)	4.9:1
Max. borehole sleep time	Indefinite *-20F to 214F*
49 CFR 172.101	PG II ("medium") **Flammable Liquid**
Handling at site	COTS transfer
JWL parameters	Well known, single component

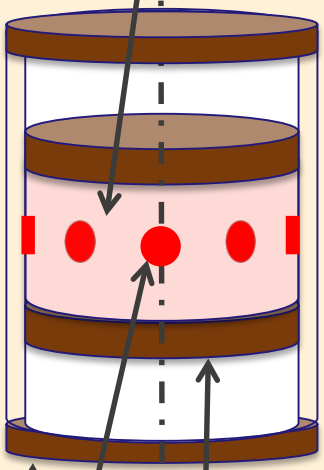


ISOMETRIC VIEW SECTIONED

Nitromethane handling will be guided by industrial practice. 940-kg already at LANL for first experiments

Recent 92" ID x 150ft long, LANL structure is the basis for Source Canister

PBX9501 initiation charge



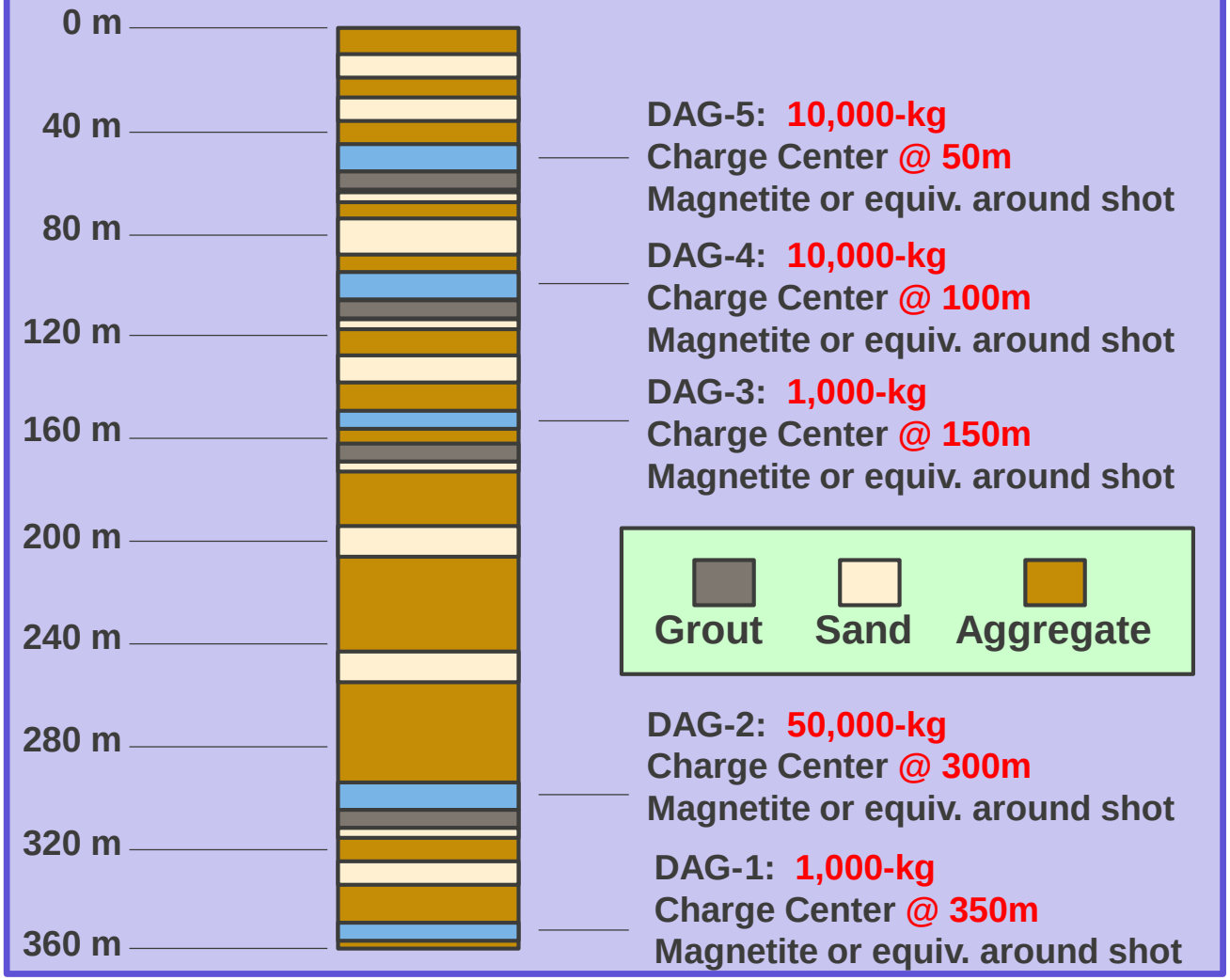
Flyer plates top, bottom, radial

2 sets of 4 dets

Sealed insertion assy.

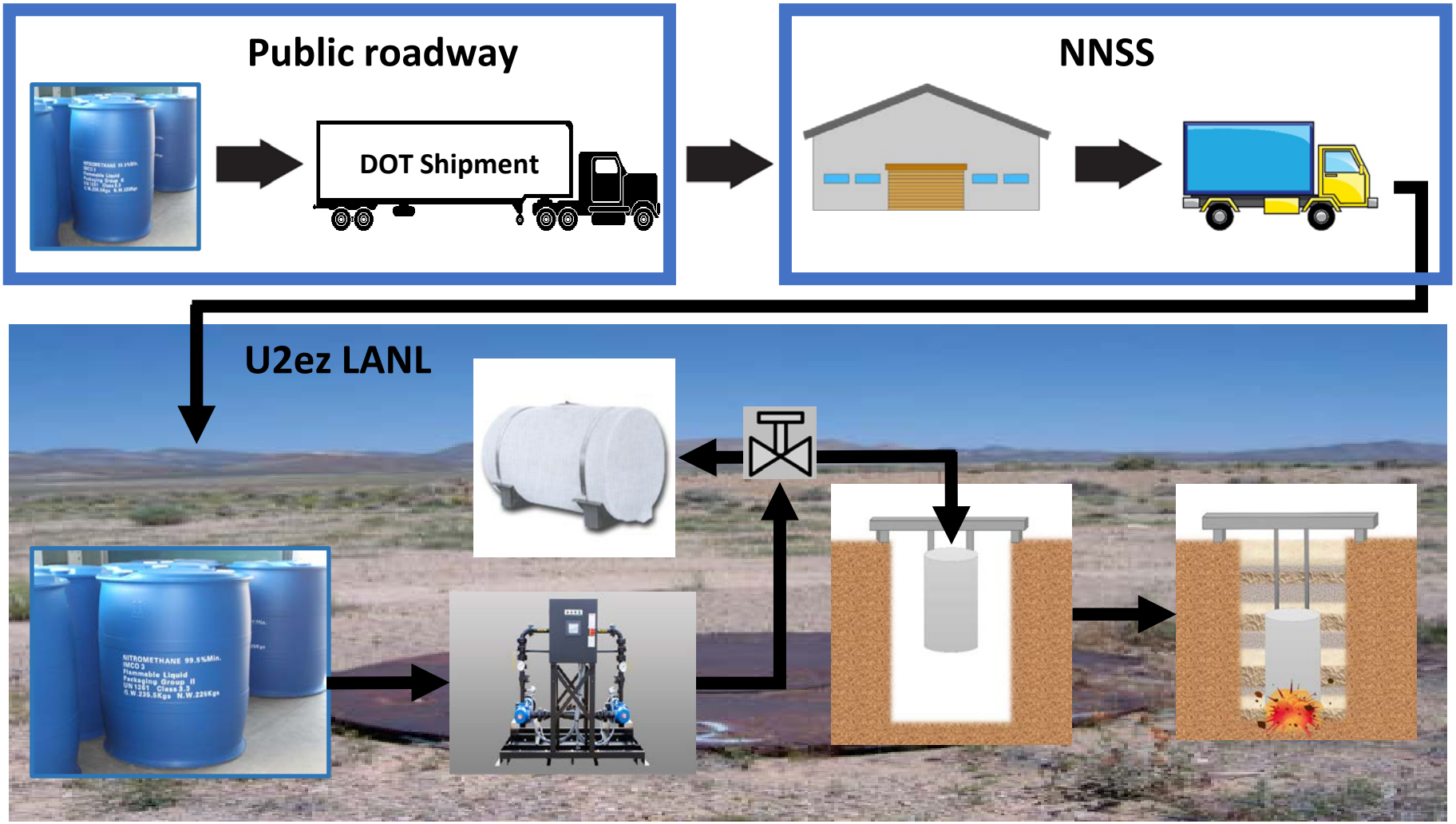
Initiation Concept

DAG Series Confinement Plan

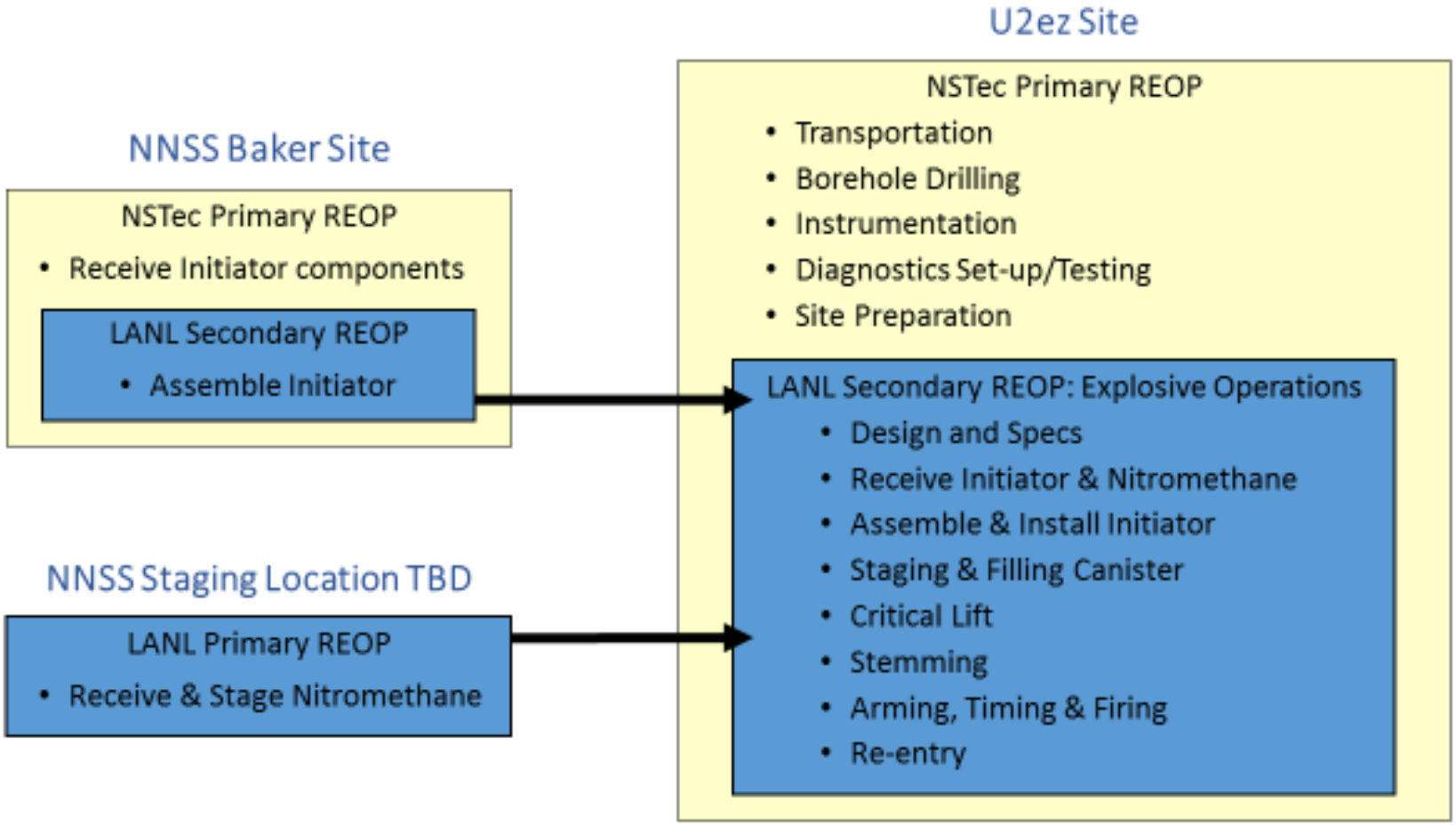


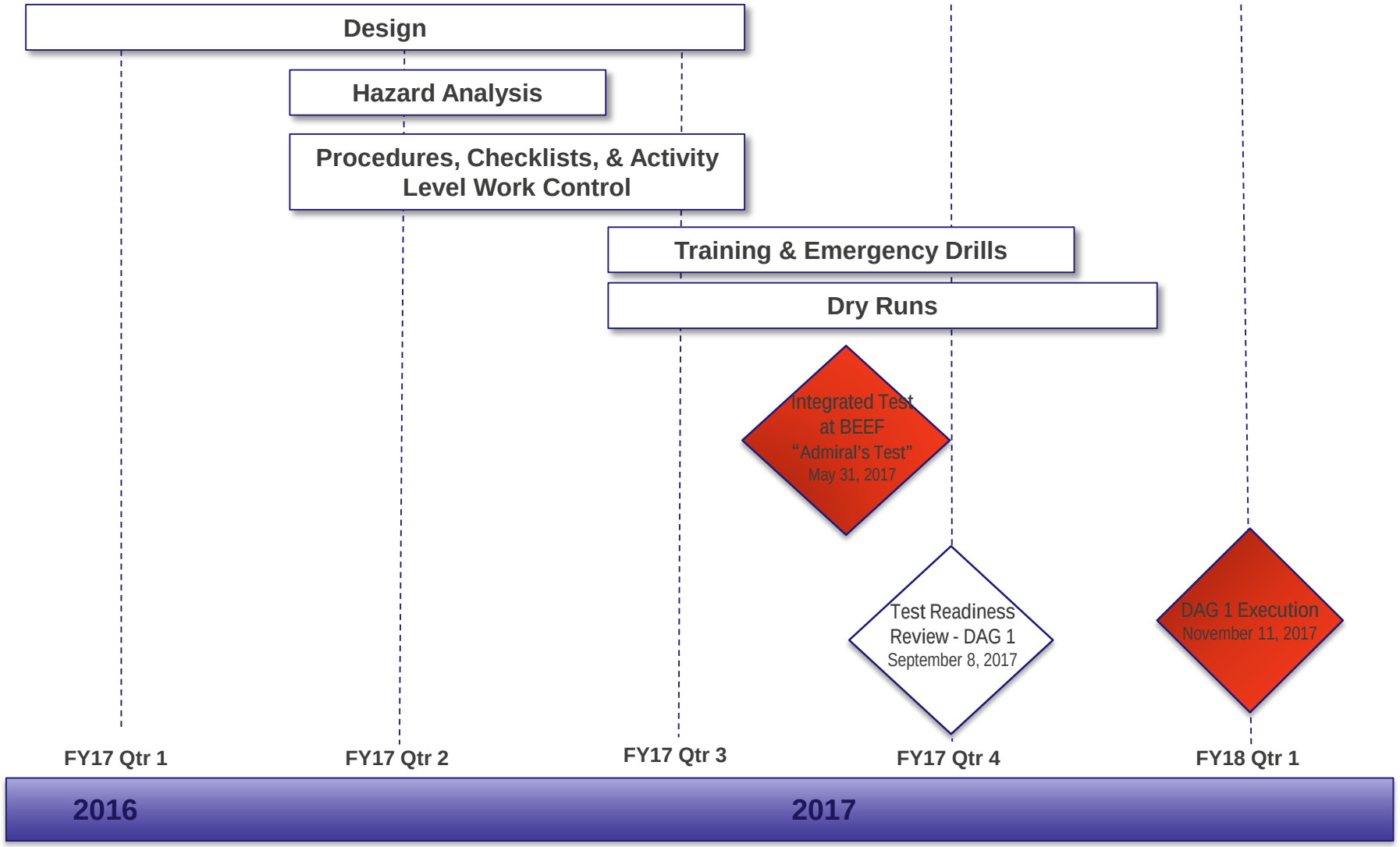
- DAG Shots will be confined by engineered barriers above the explosive source
- Designed by experienced Confinement Scientist
- Hydrodynamic calculations for stress levels at each critical grout plug

Nitromethane Life Cycle

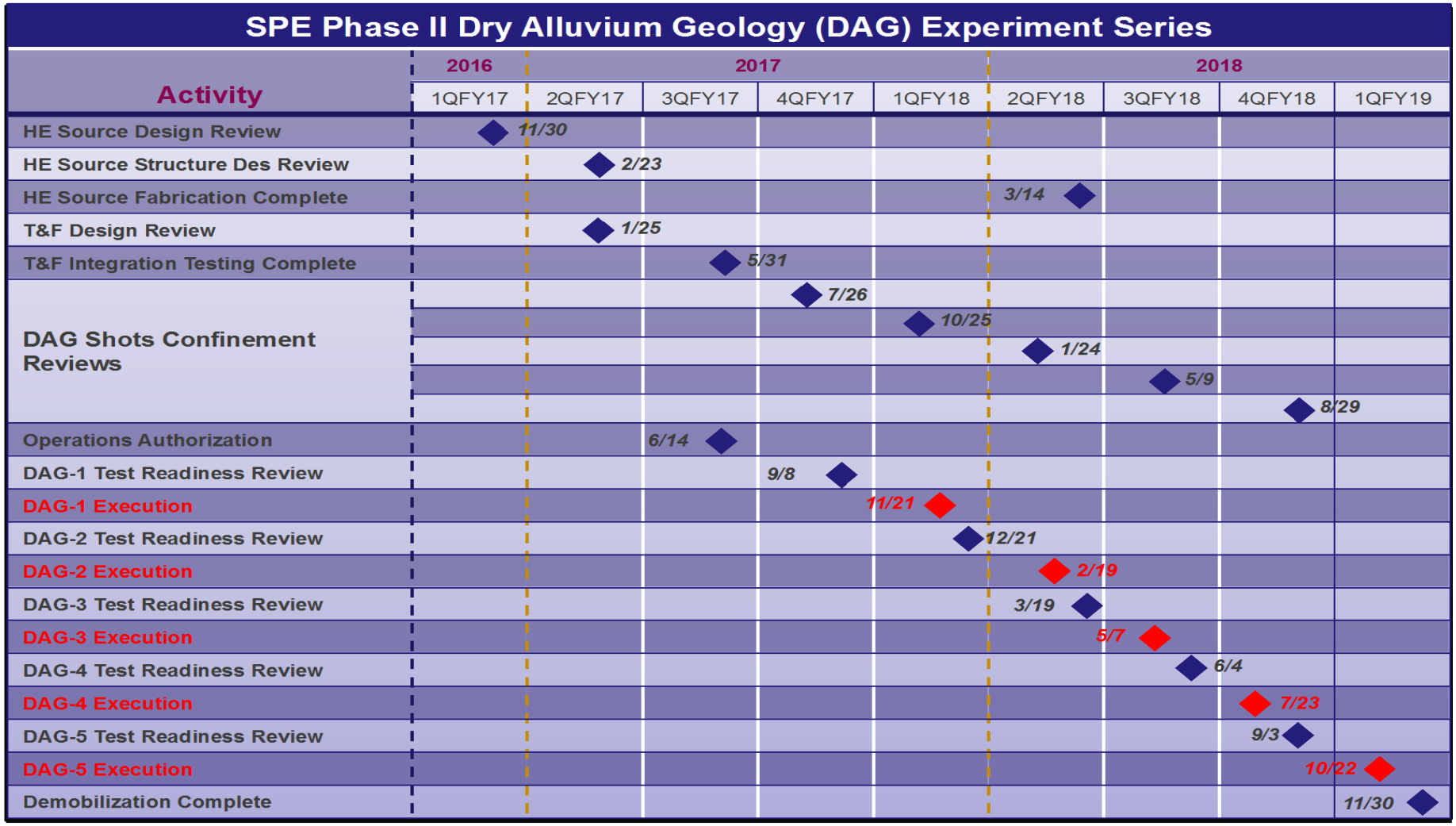


Real Estate Operations Permits




Design
Hazard Analysis
Procedures, Checklists, & Activity Level Work Control
Training & Emergency Drills
Dry Runs
Integrated Test at BEEF "Admiral's Test" May 31, 2017
Test Readiness Review - DAG 1 September 8, 2017
DAG 1 Execution November 11, 2017
FY17 Qtr 1
FY17 Qtr 2
FY17 Qtr 3
FY17 Qtr 4
FY18 Qtr 1
2016
2017

DAG proposed milestones



Applicable Requirements

- **DOE-HDBK-1101-2004,** Process Safety Management for Highly Hazardous Chemicals

- **Explosive Safety**
  - The Department of Energy DOE-STD-1212-2012, *Explosives Safety*, is the controlling document for all explosives operations conducted by Los Alamos National Laboratory.
    - Implemented by LANL P101-8, Explosives Safety

- **Chemical Safety**
  - NSTec CD-M250.001, *Chemical Safety and Lifecycle Management Program*

Applicable Requirements

- **Emergency Management**
  - DOE O 151.1C, *Comprehensive Emergency Management System*
  - NFO-EOC-PLN-101, *Consolidated Emergency Management Plan (CEMP)*

- ***NFPA***
  - NFPA 30, *Flammable and Combustible Liquids Code*
  - NFPA 70, *National Electric Code*
  - NFPA 780, *Standard for the Installation of Lightning Protection Systems*

Applicable Requirements

- 10 Code of Federal Regulation (CFR) 851, *Worker Safety and Health Program*

- SD100, *Integrated Safety Management System Description Document with embedded 10 CFR 851 Worker Safety and Health Program (includes a specific plan for numerous safety programs) Examples are:*
  - Construction Safety
  - Industrial Hygiene
  - Electrical Safety
  - Fall Protection
  - Pause/Stop Work
  - Personal Protective Equipment

Applicable Requirements

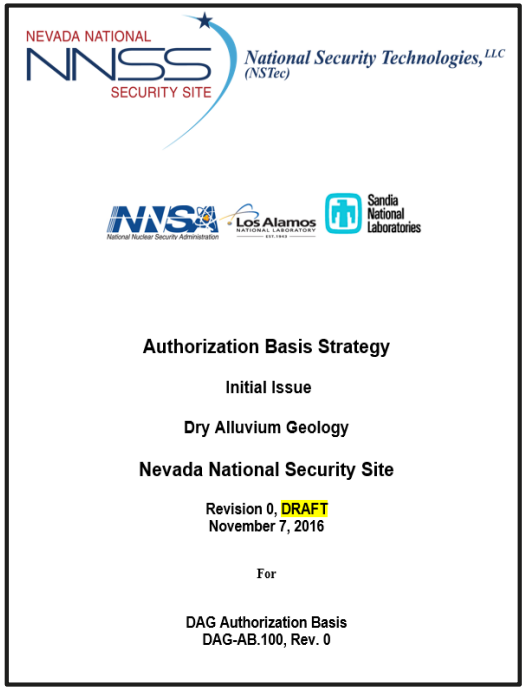
- **Work Control**
  - LANL P300, *Integrated Work Management*
    - Implements 5 core functions of Integrated Safety Management; (1) define the work, (2) identify and analyze hazards, (3) develop and implement controls, (4) perform the work, and (5) provide feedback and continuous improvement.
    - Emphasizes 1) Management and worker accountability; 2) Applying the worker's knowledge, experience, skills, and training; 3) Providing integrated documentation that includes defined work tasks/steps linked to specific hazards and unambiguous controls; 4) Identifying a single Person in Charge (PIC) for each work activity; 5) Providing independent oversight and facility coordination; and 6) Formally validating, releasing, and closing out work activities.

Mission Assurance Framework

- **Establishes a graded approach for application of rigor to program requirements**
- **Defines roles & responsibilities for configuration management, change control, non-conformances, document control & records, and other important activities and processes**
- **Defines necessary phase gates (requirements reviews, design reviews, operational readiness reviews, acceptance reviews) that are required before proceeding to the next step**
  - Defines success criteria, prerequisite criteria, closeout criteria
- **Ensures issues are resolved prior to proceeding to the next step**
- **Defines minimum review panel participants**

Authorization Basis

- **Initial draft of AB Strategy in process**
  - Analogous to nuclear safety basis strategy
  - Defines the methodology to meet PSM and CAPP requirements
  - Can incorporate new Explosive Safety Site Plans
  - Can incorporate DOE-STD-1212 compliant programs
  - Build on existing NPTEC authorization basis, which documented Nevada CAPP applied to Oleum
    - NSTec CD-NENG-031, *Development and Control of Authorization Basis Documents*


NEVADA NATIONAL NNSS SECURITY SITE
National Security Technologies, LLC (NSTec)
NNSA National Nuclear Security Administration
Los Alamos NATIONAL LABORATORY EST. 1943
Sandia National Laboratories

Authorization Basis Strategy

Initial Issue

Dry Alluvium Geology

Nevada National Security Site

Revision 0, DRAFT
November 7, 2016

For

DAG Authorization Basis
DAG-AB.100, Rev. 0

Authorization Basis

- Process Safety Management, 29CFR1910.119
- Required when more than 2500 lbs NM
- Administered through the Nevada Chemical Accident Prevention Program (CAPP)
  - Formal hazards analysis
  - Drawings & equipment specifications
  - Formal operating procedures
  - Formal operating limits
  - Mechanical integrity program
  - Pre-startup safety review
  - Management of change
  - Compliance audits (internal and State of Nevada)
  - Requires a permit to construct and a permit to operate
- Requires a 30 day public notice and comment period

These processes will be in place and meet the of State of Nevada CAPP requirements.

Input for CAPP

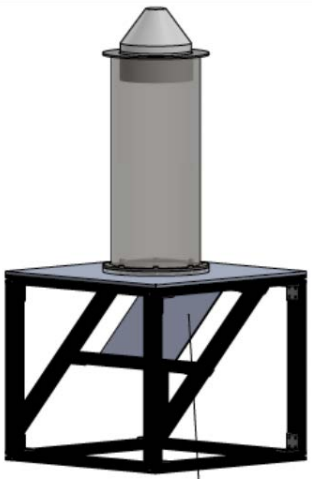
- **Nitromethane will not be mixed with any other chemicals**
- **Nitromethane will be staged in DOT approved containers until needed to support source execution activities**
  - Anticipate approximately three weeks duration for these activities until stemmed (confined)
- **Three of the five detonations will exceed the 2500 lb threshold limit required by the CAPP**
- **Preliminary explosive tests involving nitromethane have already been performed at Los Alamos National Laboratory**
- **A scaled integrated test using small quantities of nitromethane at the NNSS is being planned prior to DAG operations**
  - Will require that the personnel, equipment, and processes are in place to perform the work safely and compliantly to meet CAPP requirements

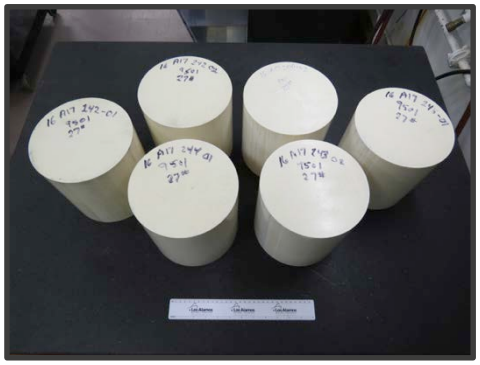
Nitromethane Quantities (approximate)

Shot #	Yield (TONS)	Pounds NM	Gallons NM	Drums NM (55 gallon)
1	1	2,004	211	4
2	50	100,182	10,556	192
3	1	2,004	211	4
4	10	20,036	2,111	38
5	10	20,036	2,111	38
TOTALS		144,262	15,200	276

Successful validation tests have been completed

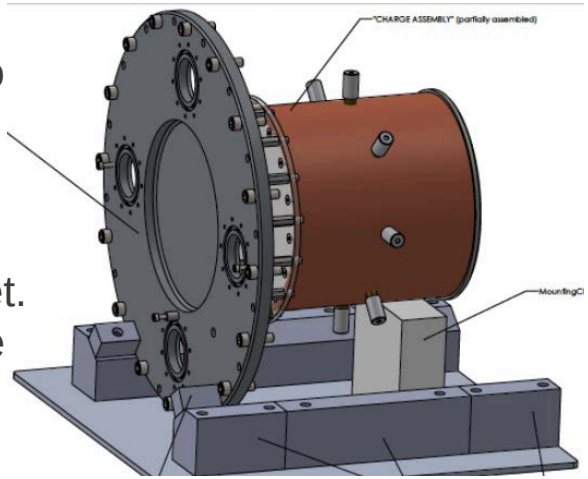
- **4 pseudo-1D configurations to observe initiation margins and detonation front curvature.**
  1. 8-in PWL / 8x2 in PBX9501 / steel flyer
  2. 8x4 in PBX9501 / steel flyer / 8-pt ring light
  3. 4-in PWL/ 4x2 in PBX9501 / steel flyer
  4. 8x4 in PBX9501 / steel flyer / 4-pt ring light

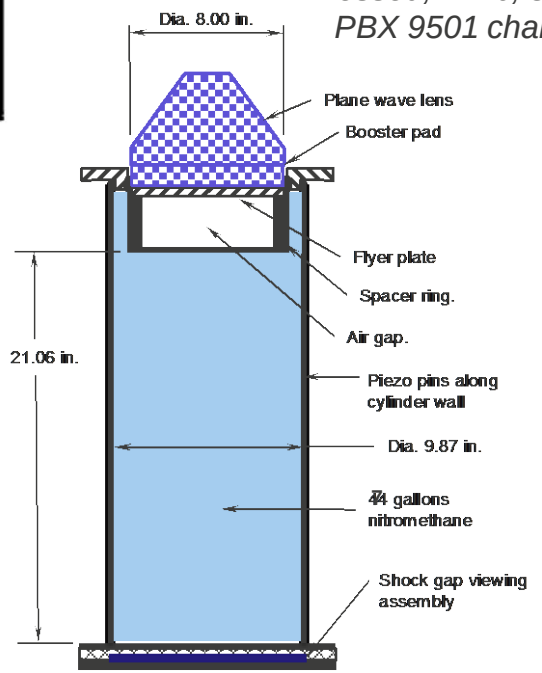




Pressed, 27-lb, 8"x8" PBX 9501 charges

- **2 confirmatory tests**
  1. Full initiation system w/o NM to measure axial & radial flyer velocities and shock profiles
  2. Full initiation system in a large container of NM to measure det. wave arrival at canister surface





Next Steps

- **We are refining our schedules with better detail and resource loading**
  - Including dry-runs (practice evolutions) for many of the activities to assess and refine processes and procedures
- **Will complete remaining proof-of-concept tests at Los Alamos**
- **Initiate hazard analysis in parallel with design to incorporate controls into the design**
- **Plan to perform a scaled integrated above-ground test using nitromethane at the NNSS**
  - Nitromethane will be small quantity under the CAPP limit for this integrated test
  - Will have all procedural elements in place to meet the CAPP requirements to validate compliance and operability
  - Will include design and safety reviews prior to commencing operations

- **Provide updates to the State of Nevada as needed to ensure transparency and compliance with CAPP requirements**

Questions?

Requests?

Thank you for your time and attention

Backup Slides

Properties of nitromethane

Chemical formula	CH_3NO_2
Molecular mass	61.0
Appearance	Colorless oily liquid
Melting point	-29 ˚C
Boiling point	101 ˚C
Density (nominal)	1.13 g cm^{-3}
Viscosity (25 ˚C)	0.61 cP
Vapor pressure	3.2 kPa (20 ˚C), 14 kPa (50 ˚C)
Flash point	35 ˚C
Oxygen balance	-39%
Detonation velocity	6300 m s^{-1}
Shock hugoniot	$U_s = 1.65 + 1.64U_p$
Detonation shock pressure	13 GPa
TNT equivalence	1.13
Failure diameter	44 mm
Shock initiation threshold pressure	~ 8 GPa