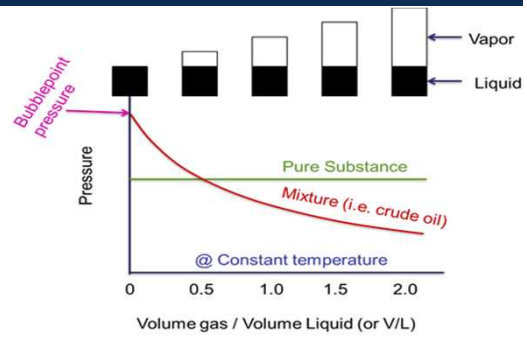
SAND 2016-nnnn C

SAND2016-1311C



Crude Oil Characterization Research Study Update

Presentation to

Crude Oil Quality Association

San Antonio, TX
March 3, 2016

Presented by
David L. Lord, Ph.D.
Geotechnology & Engineering Department
Sandia National Laboratories
Albuquerque, NM 87185

Sandia National Laboratories

Exceptional service in the national interest

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND NO. 2011-XXXXP

Technical Team

- David Lord (Ph.D., Env E.), Project technical lead
  - Geotechnology & Engineering Department, Sandia National Laboratories
- Anay Luketa (Ph.D., Mech E.), Combustion modeling lead
  - Fire Science & Technology Department, Sandia National Laboratories
- Tom Blanchat (Ph.D., Nuclear Engr), Combustion testing lead
  - Fire Science & Technology Department, Sandia National Laboratories
- Chad Wocken (B.S., Chem E.), Hydrocarbon supply chain specialist
  - University of North Dakota Energy & Environmental Research Center
- Ted Aulich (B.S., Chemistry), Hydrocarbon supply chain specialist
  - University of North Dakota Energy & Environmental Research Center
- Ray Allen (B.S. Chem E.), PE (TX), HC sampling and testing specialist
  - President of Allen Energy Services engineering consulting firm
- David Rudeen (B.S., Mathematics), Data analyst and EOS modeler
  - GRAM, Inc. technical consulting

Outline

Sandia National Laboratories

- Problem Statement and Objectives
- Project Governance and Workflow
- Overview of Task 2 – Task 3 Testing
- How COQA can help
- Project Management Contacts
- Project Publications

Technical Objectives

PROBLEM STATEMENT

Problem Statement

- Crude transport by rail poses risks recognized by regulators
  - US DOT Class 3 flammable liquid
  - Transport Canada UN1267
- Hazards have been realized in a number of high-profile train derailments leading to oil spills, environmental contamination, fire, property damage, and fatalities
- Open debate on whether the types of crude (tight oil vs. conventional production) have significant bearing on likelihood and severity of transportation accidents

TSBC (2014). "Runaway and Main-Track Derailment Montreal, Maine & Atlantic Railway Freight Train Lac-Megantic, Quebec 06 July 2013." ***R13D0054***. Transportation Safety Board of Canada, Gatineau QC K1A 1K8. Railway Investigation Report.

DOE/DOT Project Objectives

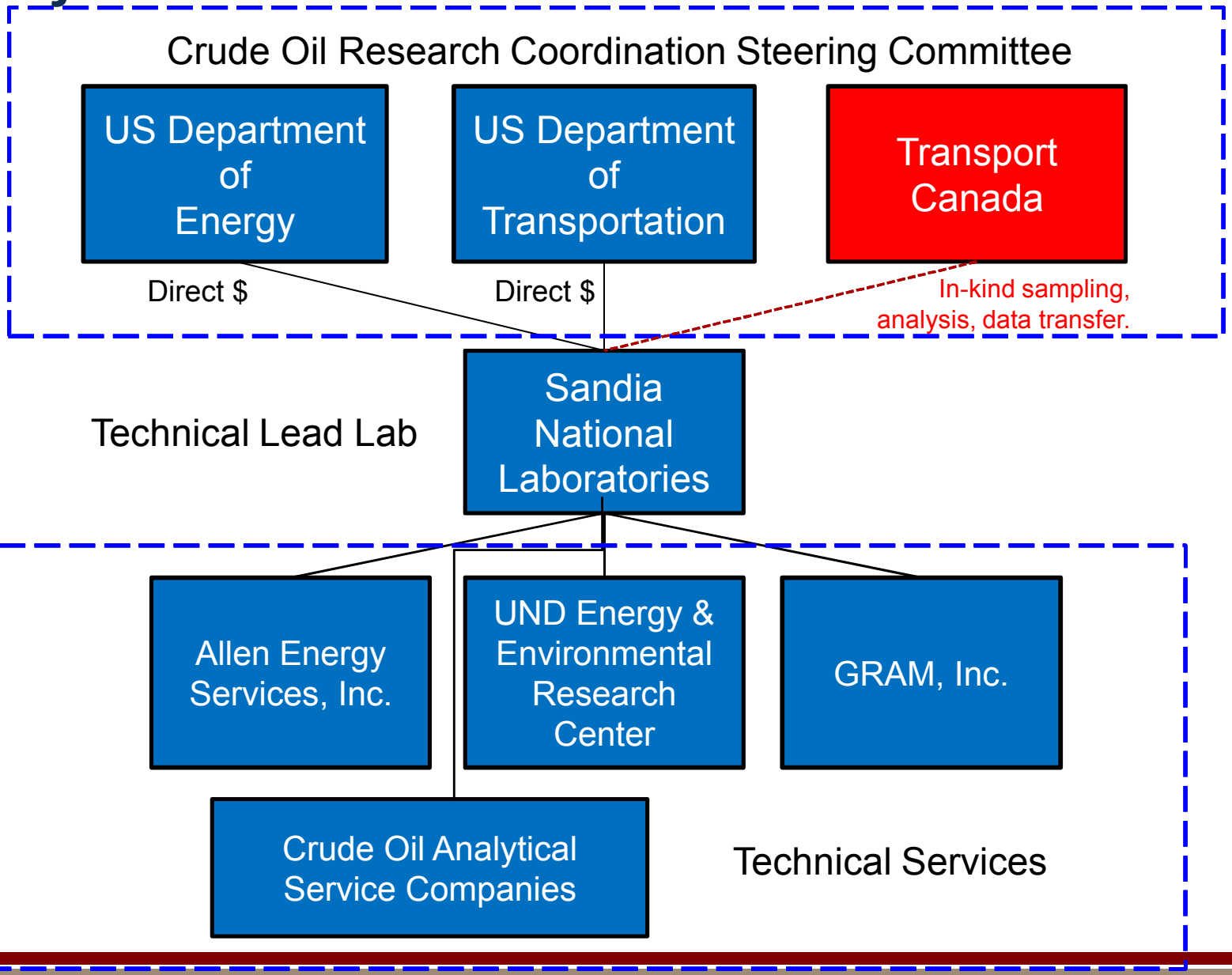
Sandia National Laboratories

- Determine what combinations of sample capture and analysis methods are suitable for characterizing selected physical properties of volatile crudes
- Evaluate selected physical properties of crude oils (tight vs. conventional production) that are moved within rail transport environment that may have some bearing on flammability risks
- Measure combustion properties (flame dimensions, emissive power) of selected crude oils (tight vs. conventional) in controlled burn scenarios that have bearing on hazard determination
- Compare combustion properties to existing published data on other flammable liquids, including methanol, ethanol, jet fuel, hexane
- Evaluate if selected tight oils exhibit measurably different combustion properties from conventional crudes and the reference fluids tested previously

Sandia National Laboratories

PROJECT GOVERNANCE

Project Governance



Overall Project Workflow

Sandia National Laboratories

Phase I | **Phase II** | **Phase III**

Problem Definition Phase
Completed

Literature Survey

Sampling and Analysis Plan

Peer review

Experimental Phase
Current/future SNL future work scope

- Task 1: Analyze existing data
- Task 2: Sampling method evaluation
- Task 3: Combustion experiments and modeling
- Task 4: Crude characterization, tight vs. conventional
- Task 5: Railcar combustion testing and modeling
- Task 6: Comprehensive oil characterization

Peer review

Implementation Phase
All stakeholders

- Utilize knowledge gained during prior phases to inform decisions on:
  - Industry best practices
  - Standards
  - Regulations

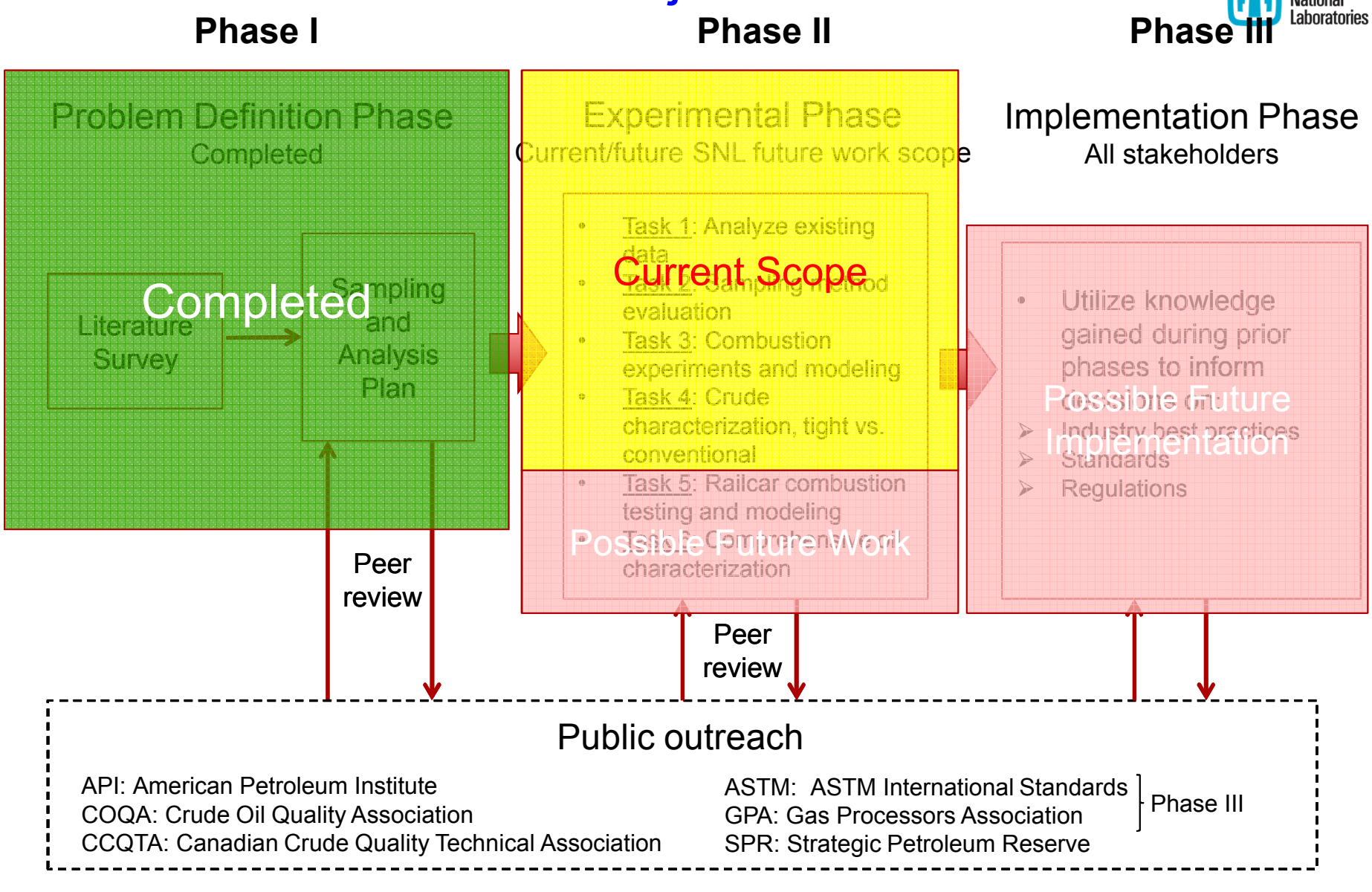
Public outreach

API: American Petroleum Institute
COQA: Crude Oil Quality Association
CCQTA: Canadian Crude Quality Technical Association

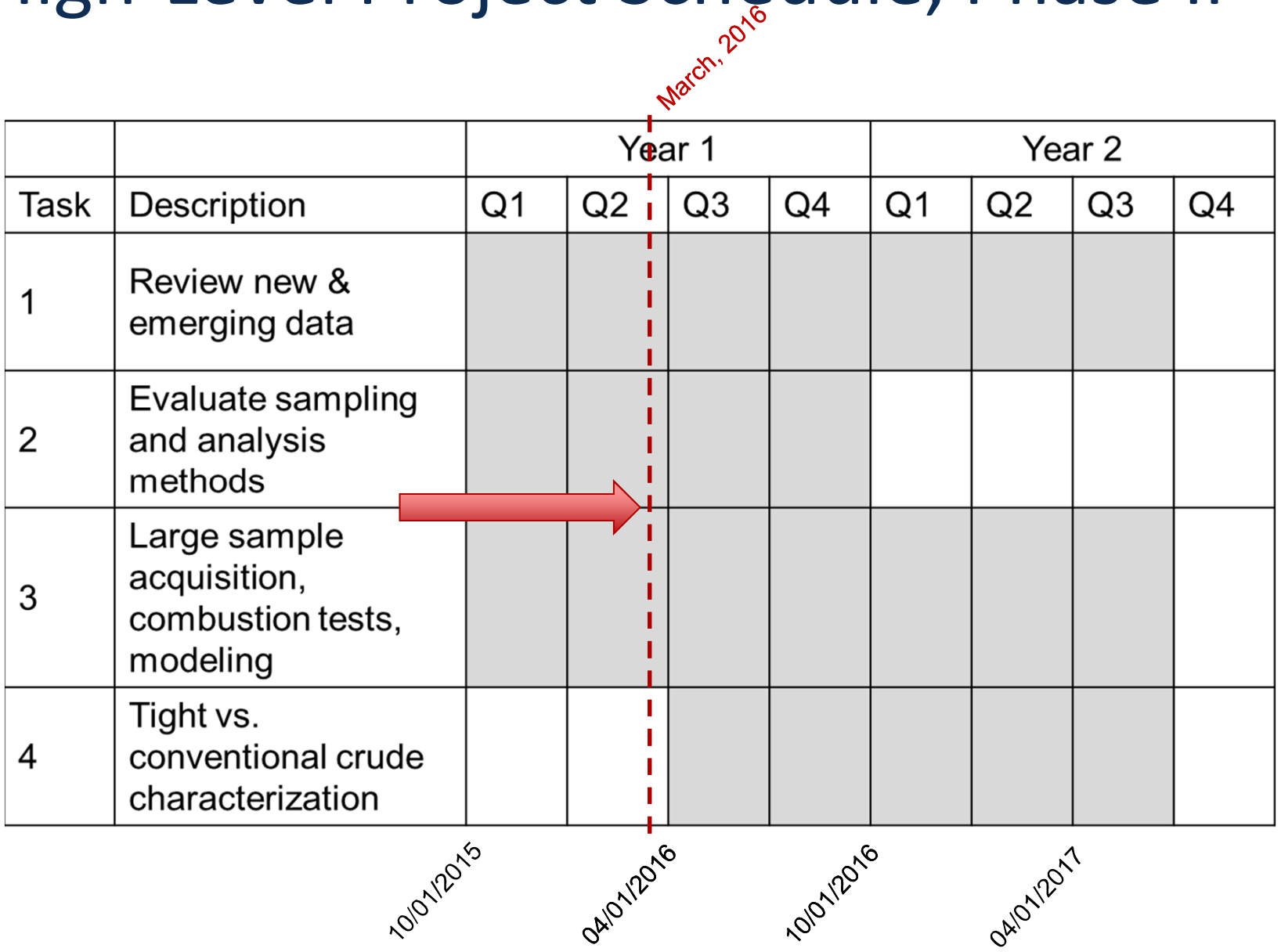
ASTM: ASTM International Standards
GPA: Gas Processors Association
SPR: Strategic Petroleum Reserve

} Phase III

Overall Project Workflow



High-Level Project Schedule, Phase II



Sandia National Laboratories

Crude Oil Property and Combustion Tests

TESTING OVERVIEW

Task 2 Overview

- Compare sample capture and analysis methods for two selected volatile North American crude oils
- Sandia National Laboratories and Transport Canada will administer parallel tests using a variety of sample capture and analysis methods
- Critical review of open vs. closed capture and applicability for use on volatile oils for measuring:
  - True vapor pressure via VPCRx(T)
  - Pressurized GC light ends concentration
  - Unpressurized GC DHA and simulated distillation
  - Unpressurized physical property measurements MW, SG, viscosity
  - IBP based on 0.5 wt% determination

Task 2 Test Matrix

		Property Measurement								
Sample Technique	**Standard**	TVP	Composition 1	Composition 2	Composition 3	Avg MW	Relative Density	Viscosity	Flashpoint	IBP (0.5 wt%)
SPR Tight Line		ASTM D6377 & Separator shut-in	BPP flash gas	GOR flash gas	Separator liquid C30+	frz pt dep	ASTM D5002	N/A	N/A	EOS with flash gas
Floating Piston Cylinder	ASTM D3700-14	ASTM D6377-M	GPA2103 M	GPA2177 + ASTM D7900 + ASTM D7169	ASTM D8003-14 ASTM D7169	frz pt dep	ASTM D5002	ASTM D7042	ASTM D93 or D56	GPA 2103/2177
H_2O displacement	GPA 2174-14	ASTM D6377-M	GPA2103 M	GPA2177 + ASTM D7900 + ASTM D7169	ASTM D8003-14 ASTM D7169	frz pt dep	ASTM D5002	ASTM D7042	ASTM D93 or D56	GPA 2103/2177
Manual Syringe	ASTM D8009-15	ASTM D6377-M	GPA2103 M	GPA2177 + ASTM D7900 + ASTM D7169	ASTM D8003-14 ASTM D7169	frz pt dep	ASTM D5002	ASTM D7042	ASTM D93 or D56	GPA 2103/2177
Boston Round	ASTM D4057-12	ASTM D6377-M	GPA2103 M	GPA2177 + ASTM D7900 + ASTM D7169	ASTM D8003-14 ASTM D7169	frz pt dep	ASTM D5002	ASTM D7042	ASTM D93 or D56	GPA 2103/2177
Manual Syringe	ASTM D7975-14	ASTM D7975-14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Color coding	Test Administrator
White	SNL
Red	TC
Blue	Both

- Test matrix will be run on two North American volatile crudes.
- Objective is to compare multiple methods on a homogeneous sample.
- Oil variability across production regions or supply chain is addressed in Task 4.

Task 3 Overview

- Subject four selected North American crudes to basic property and controlled burn testing
- Span a range from tight oils (Bakken, Eagle Ford) with high visibility to baseline light sweet (WTI, LLS) to specially-stabilized crude from the Strategic Petroleum Reserve
- Compare results against existing hydrocarbon liquid combustion test data

Burn Test Configurations

Sandia National Laboratories

Pool fire

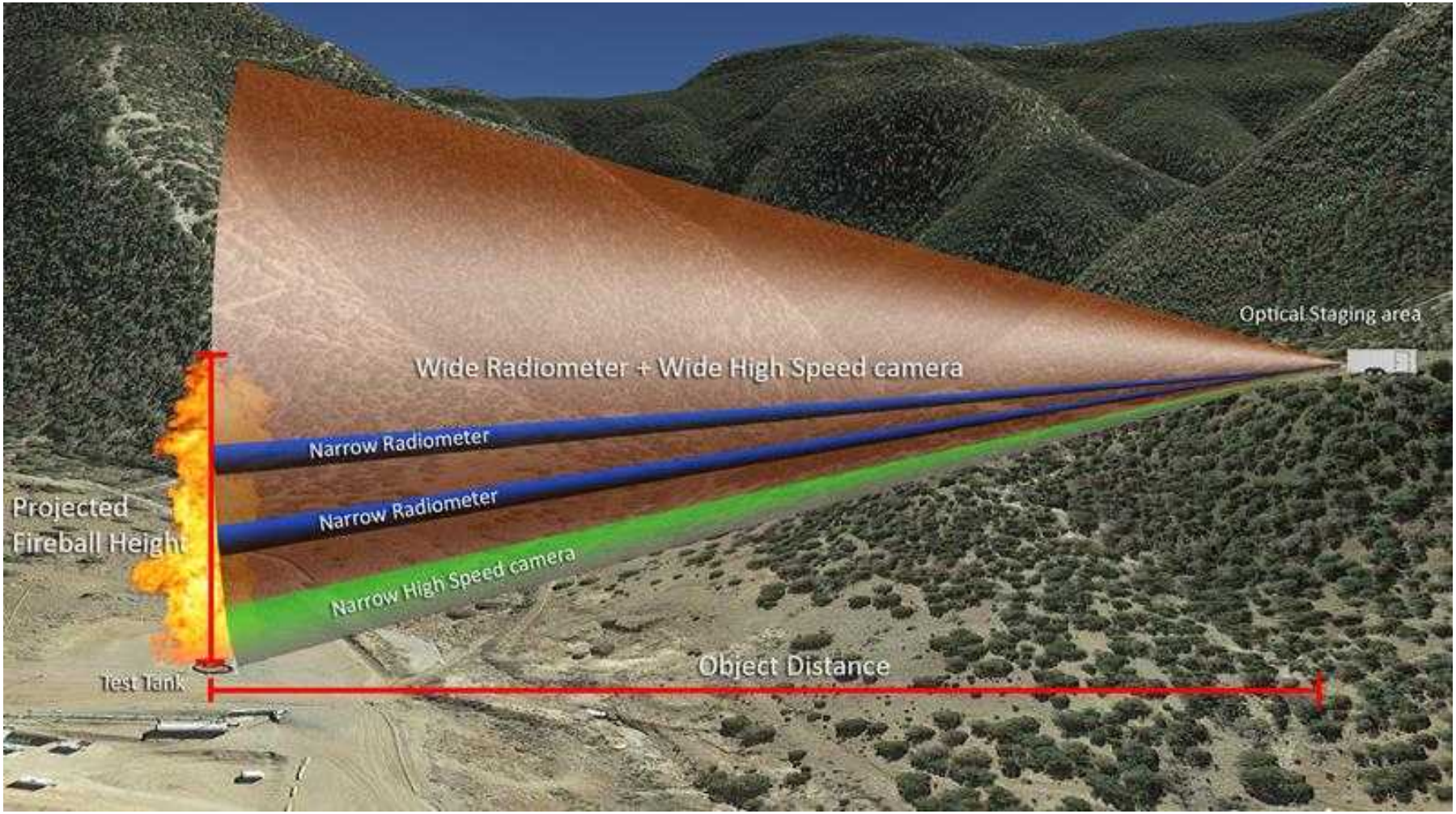
- Surface emissive power (SEP)
- Heat flux to engulfed objects
- Flame height
- Fuel consumption rate

Fireball

- Surface emissive power (SEP)
- Heat flux to nearby objects
- Fireball diameter
- Fireball duration

Fireball Test SEP Instrumentation

Sandia National Laboratories



Task 3 Test Matrix - Highlights

Sandia National Laboratories

Oil	Properties	Pool Fire 2m, 5m	Fireball 40 gal, 400 gal
Bakken	VPCRx(T), Light Ends, SimDis, IBP, MW, SG	SEP, flame height, burn rate	SEP, fireball diameter & duration
Eagle Ford	VPCRx(T), Light Ends, SimDis, IBP, MW, SG	SEP, flame height, burn rate	SEP, fireball diameter & duration
WTI or LLS	VPCRx(T), Light Ends, SimDis, IBP, MW, SG	SEP, flame height, burn rate	SEP, fireball diameter & duration
Stabilized SPR	VPCRx(T), Light Ends, SimDis, IBP, MW, SG	SEP, flame height, burn rate	SEP, fireball diameter & duration

Sandia National Laboratories

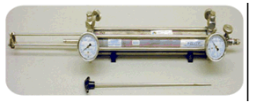
HOW COQA CAN HELP

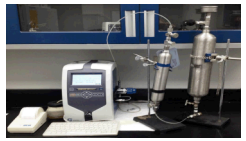
How COQA can help

- Technical peer review of test plans, test reports
  - Working through Dennis Sutton
- Access to sampling points for Tasks 2, 3, and 4
  - Sandia has 7-page sampling proposal (re: Tasks 2 and 3) for distribution to crude oil producers and/or terminal operators who may be interested in helping provide samples
  - Contact David Lord for more information (information at end of presentation)

Access to Crude Oil Samples

Sample Description	Target Timeframe	Preferred Sample	Approx Quantity
Task 2 Parallel Test #1	Mar/Apr 2016	LACT or rail/pipeline terminal in central or southern U.S. that handles tight oil	15 gal (60 L)
Task 2 Parallel Test #2	Apr/May 2016	LACT or rail/pipeline terminal that handles Bakken	15 gal (60 L)
Task 3 Burn Sample #1	July 2016	Bakken	3,000 gal (72 bbl)
Task 3 Burn Sample #2	October 2016	Eagle Ford	3,000 gal (72 bbl)
Task 3 Burn Sample #3	January 2017	SPR stabilized oil	3,000 gal (72 bbl)
Task 3 Burn Sample #4	April 2017	WTI or LLS	3,000 gal (72 bbl)





Images courtesy of Intertek, Bosselman Tank & Trailer, Sandia National Laboratories

Project Management Contacts

- US DOE funding agency point-of-contact
  - Evan Frye
    - U.S. Department of Energy, Office of Fossil Energy, Office of Oil & Natural Gas
    - *evan.frye@hq.doe.gov*
    - *202-586-3827*
- US DOT funding agency point-of-contact
  - Joseph Nicklous
    - U.S. Department of Transportation, Office of Hazardous Materials Safety
    - Pipeline and Hazardous Materials Safety Administration
    - *joseph.nicklous@dot.gov*
    - *202-366-4545*
- Sandia technical lead
  - David Lord, Ph.D.
    - Sandia National Laboratories, Geotechnology & Engineering Department
    - *dllord@sandia.gov*
    - *505-284-2712*
- Sandia geosciences program manager
  - Erik Webb, Senior Manager
    - Sandia National Laboratories, Geoscience Research & Applications
    - *ekwebb@sandia.gov*
    - *505-844-9179*

Project Publications

- Lord, D., A. Luketa, C. Wocken, S. Schlasner, R. Allen and D. Rudeen (2015). "Literature Survey of Crude Properties Relevant to Handling and Fire Safety in Transport." *Unlimited Release* ***SAND2015-1823***. Sandia National Laboratories, Albuquerque, NM 87185.
- SNL (2015). "Crude Oil Characteristics Sampling, Analysis and Experiment (SAE) Plan." Office of Fossil Energy. U.S. Department of Energy, http://energy.gov/fe/articles/crude-oil-characteristics-research. 9-Jul-2015.

Sandia National Laboratories

END OF PREPARED SLIDES