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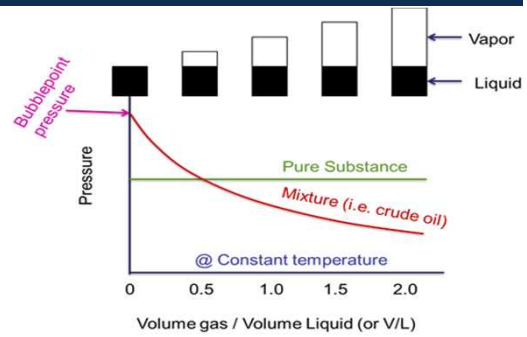

Crude Oil Characterization Research Study Update

Briefing to

Senate Energy Committee Minority Staff Director

Thermal Test Complex
Sandia National Laboratories
Albuquerque, NM USA
October 26, 2016

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Outline

- Problem Statement
- Project Structure & Objectives
- Project Workflow
- Project Governance
- Project Management Contacts

Problem Statement

- Crude transport by rail poses risks recognized by US and Canadian regulators
- 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.

Project Structure

- Outreach and project administration (Task 1)
- **Crude oil sampling and analysis methods evaluation (Task 2)**
- **Crude oil combustion studies (Task 3)**
- Tight versus conventional oil properties (Task 4)

Project Objectives

- Task 2: Sampling & Analysis Methods Evaluation
  - Evaluate crude oil sampling and analysis methods for their ability to capture and retain components that control volatility
  - Evaluate basic physical properties of crude oils (tight vs. conventional production) that are moved within rail transport environment
- Task 3: Combustion Experiments
  - Collect objective measured data on combustion properties of selected crude oils in controlled burn scenarios
  - Compare these results to existing data on other flammable liquids, including methanol, ethanol, jet fuel, hexane
  - Evaluate if selected tight oils exhibit measurably different combustion properties from a conventional crude and the reference fluids tested previously

Overall Project Workflow

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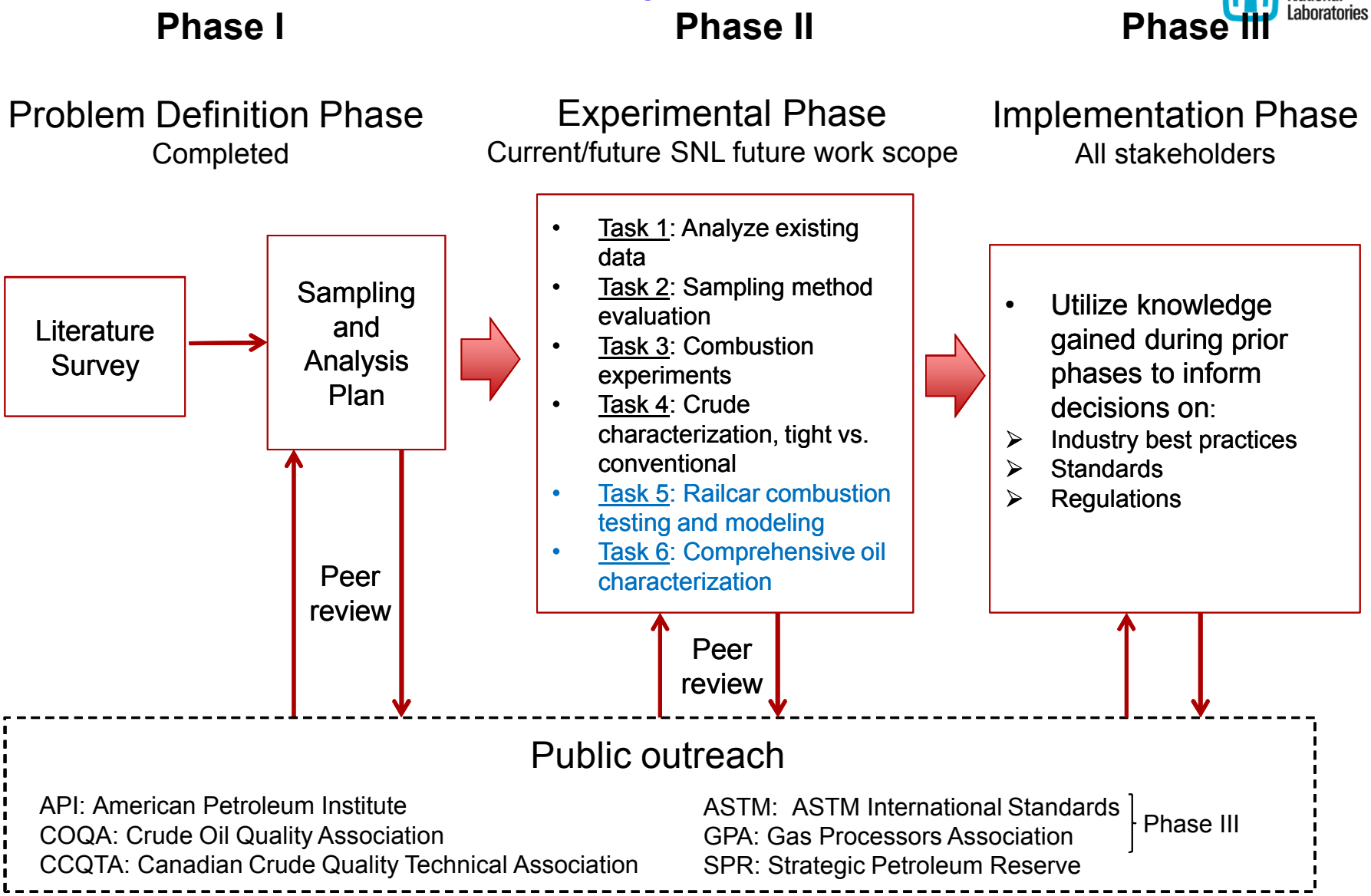
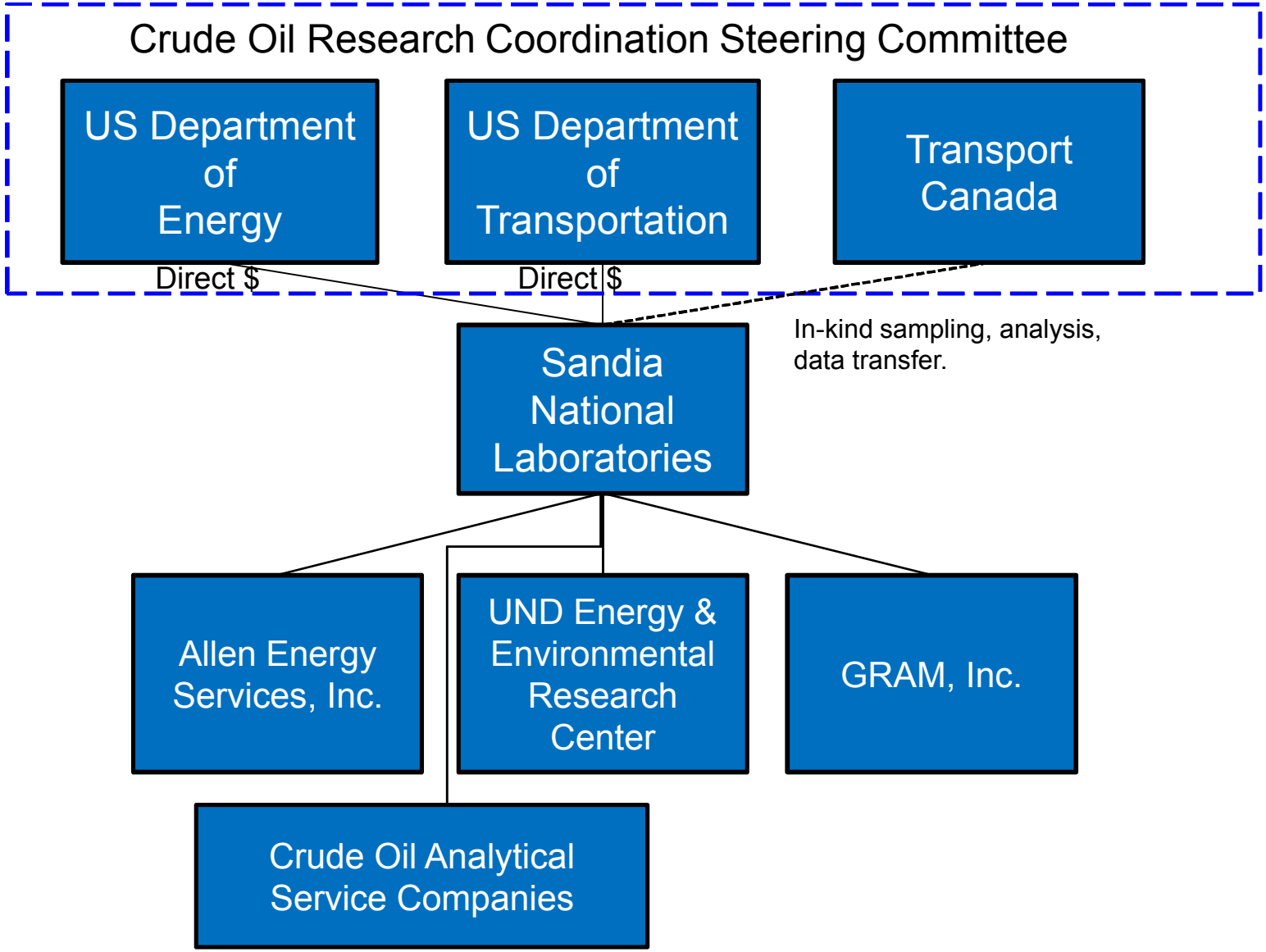


Project Governance



Task 2: Sampling & Method Evaluation

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- Objective
  - Compare sampling & analysis methods for ability to capture and retain components that control volatility
  - Utilize oil samples from two US commercial terminal facilities
- Progress
  - Collected samples from two US terminal facilities, one from a Bakken terminal (September) and another from an Eagle Ford terminal (October)
  - Currently processing data
  - Key findings report on vapor pressure analyses due to DOE/DOT December 12, 2016
  - Second report on full compositional analyses due in draft form to DOE/DOT on March 1, 2017

Task 3: Combustion Experiments

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- Objective
  - Evaluate if selected tight oils exhibit measurably different combustion properties from a conventional crude and other reference fluids (jet fuel, ethanol) tested previously in pool fire and fireball configurations
- Progress
  - All testing equipment has been purchased
  - New and first-of-kind configurations and processes are currently being built, installed and tested
  - Aligned to burn four oils, five burn tests per oil, over course of project
    - SPR stabilized, Eagle Ford, West Texas conventional, and Bakken oil
  - SPR oil burns scheduled to start in December/January
  - Other oils tentatively scheduled to start in Feb/Mar, 2017

Task 3: Combustion Experiments

Task 4: Tight vs. Conventional

- Objective
  - Evaluate properties of multiple types of crudes, to include tight vs. conventional
  - Indicate if/whether properties of potential concern in combustion studies (Task 3) are associated with certain types of crude (tight vs. conventional)
- Progress
  - A sampling and analysis plan has been delivered to sponsorship team and is currently being evaluated
  - Greater-than-anticipated timeline and costs associated with tasks 1-3 have put further effort on task 4 on hold until more resources can be located

Project Management Contacts

- US DOE funding agency point-of-contact
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END OF PREPARED SLIDES