



# Ethanol Roadmap Status Update

PHMSA R&D Forum

June 2009





# Overview

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- **Background**
- **Ethanol Roadmap Meeting Summary**
- **Roadmap Gap Analysis and outcome**
- **Recent research proposal awards**
- **Progress update on short, mid, and long term questions**
- **Outstanding gaps and challenges**



# Background

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- Keen interest in Ethanol Transportation by PRCI members led to creation and funding of several projects (SCC 4-3,4-4, & 4-5)
  
- Project SCC 4-4 included a project task to hold an industry roadmap meeting to identify:
  - ❖ Current state of ethanol transportation
  - ❖ Gaps in current research
  - ❖ Challenges to ethanol transportation by pipeline
  - ❖ Areas for future research
  
- This industry meeting was held on October 25-26 in Columbus OH.



# Roadmap Meeting Summary (October 25-26, 2007)

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- **Key Challenges Facing Ethanol Transportation in Pipelines**
  - ❖ Quantifying and managing risk
  - ❖ Making the business case for new construction or dedicated lines
  - ❖ Achieving operating efficiency with new product mixes
  - ❖ Finding new materials solutions
  - ❖ Learning from Brazilian experiences
  - ❖ Investing under Changing regulations
  - ❖ Understanding potential environmental threats
  - ❖ Improving coordination and communication
- **Four topical breakout sessions**
  - ❖ **Ethanol Sources and Quality Issues**
  - ❖ **Pipeline Integrity Management Issues**
  - ❖ **Pipeline Operations Issues**
  - ❖ **Standards, Guidelines, & Training**





# Gaps in Ethanol Sources and Quality Issues

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- **Lack of a practical method for ethanol testing**
- **Lack of “ASTM-like” specifications for FGE tailored for reliable transportation rather than just for end-use**
- **Challenges in ensuring product quality when products from different producers get commingled**
- **Lack of standardized ethanol source mixtures**
- **Incomplete knowledge of real oxygen concentrations in pipelines nor where stream is picking up oxygen**
- **Lack of understanding of how product composition changes during aging (time, head, length of travel, etc.)**
- **Gaps in knowledge of why different ethanol sources differ in their effect on materials of construction**



# Gaps in Pipeline Integrity Management Issues

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- **Avoiding oxygen contamination**
- **Mixing ethanol from different sources**
- **Understanding how to prevent SCC**
- **Understanding which blends cause SCC**
- **Understanding of consequences of SCC on pipeline, environment, repair, safety**
- **Understanding of how fast SCC develops**
- **Swelling and permeation in seals and gaskets**
- **Understanding the impact of inhibitors on the consumer**
- **Prioritizing locations of greatest integrity concern for inspection and mitigation**



# Gaps in Pipeline Operations Issues

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- Lack of a sustainable business case (policy, regulation, demand distribution, etc.)
- Convincing regulators, media, public that new operation is safe
- Understanding differences between application lab results versus real world operations
- Developing timeline for research results
- Understanding how chemistry limits may define safe operating limits to prevent cracking (e.g., oxygen, water)
- Understanding what needs to be monitored and why, where, and when
- Lack appropriate commercial monitoring technologies



# Gaps in Standards, Guidelines, & Training

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- **Lack of understanding of mechanism of ethanol SCC**
- **Understanding differences between sugar-based and corn-based ethanol**
- **Sharing experience internationally**
- **Turning research into standards**
- **Influencing (proactive) regulations**
- **Coordinating research activities**
- **Cost-benefit analysis**
- **Define threat and susceptibility**





# Gap Analysis by Ray Fessler

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- **Build upon the results of the “Safe and Reliable Transportation of Fuel-Grade Ethanol Workshop” held on October 25-26, 2007, in Dublin, Ohio**
- **Group and condense the list of gaps, indicating which are being addressed by current or planned research, and which require new research projects.**
- **Phase 1 summarizes the results and presents recommendations for new projects that could profitably be started in the near future.**
- **Phase 2 work will be conducted to produce a final report that will contain a roadmap of all of the future projects that have been identified.**





# Suggested Projects for Near Future

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- **Safety of Transporting Blends Containing More than 10 Percent Ethanol**
- **Standardized Tests for SCC in Ethanol**
- **Technical and Economic Feasibility of Preventing SCC Through Control of Oxygen**
- **Feasibility of Preventing SCC by Using Inhibitors**
- **Compatibility of Polymeric Materials and Non-ferrous Metals with Ethanol**
- **Understanding of Ethanol SCC**



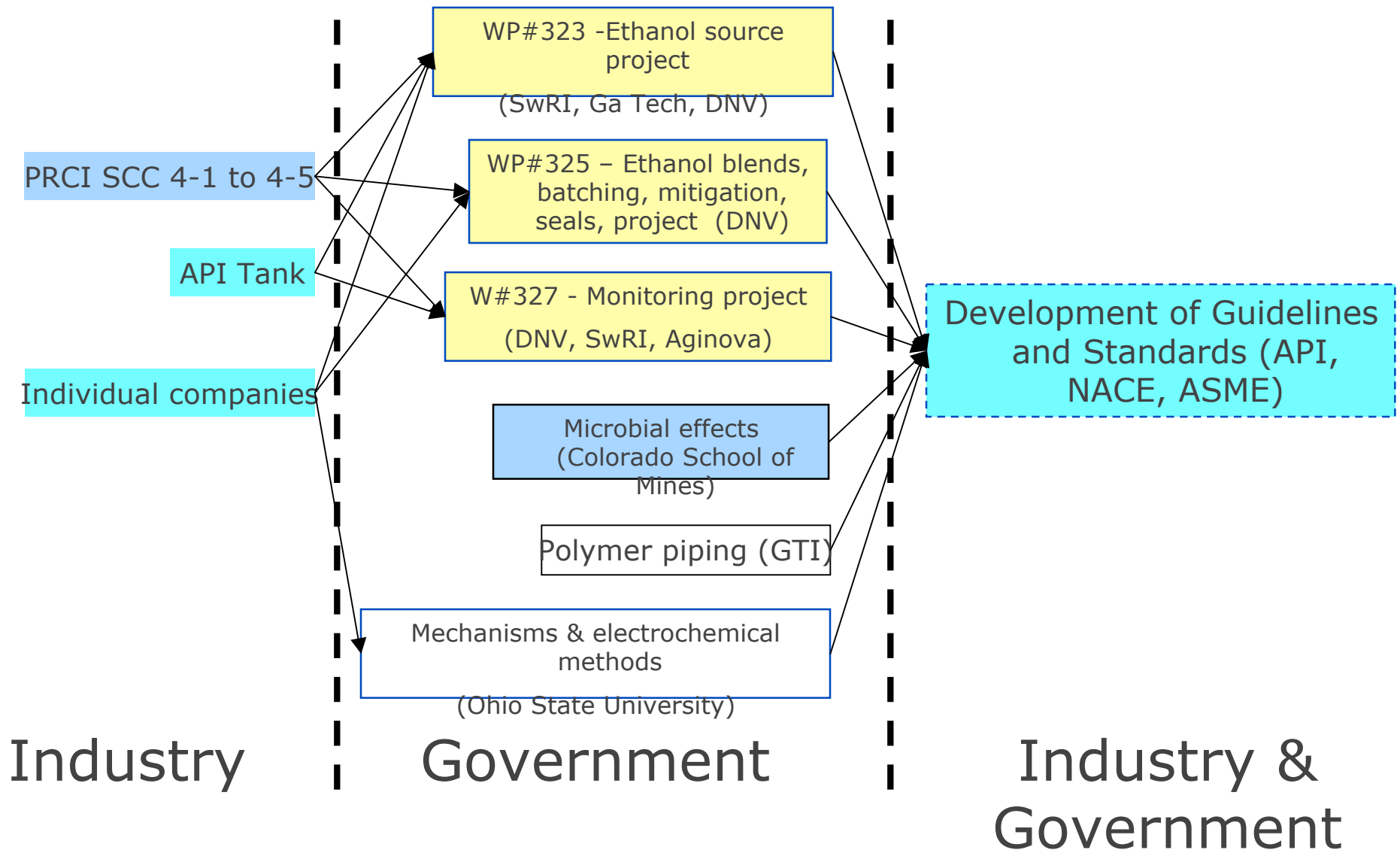
# Other Recommended Actions

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- **Incorporate research results into recommended practices for ethanol transportation and integrity management.**
- **IMP guidelines should address all elements of the program ( risk management, integrity assessment, data integration, etc)**
- **It is recommended that API or some other suitable industry organization establish committees or direct existing committees to prepare those documents. For example, API might develop an overall or umbrella standard, which would refer to other standards to be developed by other organizations, such as NACE for corrosion control and monitoring, ASTM for testing, etc.**



# Overall Ethanol Program Integration





# Short-term questions have been answered.....

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- **Short-term questions: what blends can be transported without changing infrastructure?**
  - ❖ **E-10 can be transported without any modification. E-95 will require operational modifications (inhibitors, deaeration, etc.)**
  - ❖ **No significant effect of metallurgy on SCC**
  - ❖ **Some inhibitors are effective (amine-based)**
  - ❖ **SCC 4-4-1 report submitted in March, 2008**
  - ❖ **Elastomer survey report submitted in May 2008**



## Answers to medium-term questions are being generated.....

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- **What do less-conservative tests reveal about blends and SCC**
  - ❖ **Less conservative cracking tests confirm previous findings - PHMSA Quarterly Reports, December 2008 through March 2009**
  
- **What effect does ethanol have on elastomers?**
  - ❖ **Two elastomers (Viton and low-swell Buna N) that failed in static loading have been identified – dynamic loading tests are continuing**
  
- **Are there effective inhibitors?**
  - ❖ **Some inhibitors have been found effective in mitigating SCC. Crack growth tests will confirm findings**
  - ❖ **Flowing conditions do not affect performance of an inhibitor – may even enhance its effectiveness – PRCI SCC 4-3 Report Submitted January 2009**





## Answers to medium-term questions are being generated.....

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- **Can FGE be transported under batching conditions?**
  - ❖ **Batching tests are continuing – no significant effect of batching on SCC**
  
- **What effect does ethanol source have?**
  - ❖ **Tests on several ethanol chemistries (lots) have been completed – some differences in SCC noted, but no definitive correlation to chemistry**
  
- **Results to these are expected by end of 2009**



## Research to answer to long-term questions are in preparation.....

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- **Monitoring ethanol tanks/piping/pipeline**
  - ❖ **Activities have begun to identify monitoring sites**
  - ❖ **Integration of electronics and wireless has been completed**
  - ❖ **Installation of sensors will await safety assessment**
  
- **Developing ethanol finger prints**
  - ❖ **Significant progress has been made. Tests on different lots of ethanol are continuing.**
  
- **Microbiological effects in ethanol**
  - ❖ **Research at Colorado School of Mines – initial results suggest viability of bacteria**





# Research to answer to long-term questions are in preparation.....

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- **Understanding ethanol SCC – basic research**
  - ❖ **Progress being made at OSU and Georgia Tech. Results not expected until 2010**
  
- **Ethanol transportation guidelines and risk management**
  - ❖ **Activity needed to capture research knowledge generated to date**
  - ❖ **Potential future research topics**





# Outstanding Gaps

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- **Long term questions are beginning to be addressed, but some gaps identified in the original roadmap session remain**
  - ❖ **Monitoring of tanks and piping is crucial to answer some fundamental questions**
  - ❖ **Need to develop industry guidelines and Integrity Management Program approaches**
    - Risk Analysis
    - Threat Identification
    - Integrity Assessment
    - Repair Criteria
    - Preventive & Mitigative Measures
    - Etc





# Outstanding Gaps

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- Long term questions are beginning to be addressed, but some gaps identified in the original roadmap session remain
  - ❖ More effort toward understanding ethanol SCC fundamentals is needed
    - Validate current research
    - Expedite follow-on research
    - Develop ASTM-like specification for shipping
  - ❖ Ethanol “fingerprinting” work hasn’t progressed far enough yet to know if follow-up research will be needed
    - Standardized Ethanol Testing
    - Degradation Products



# Summary

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- **Ethanol program funded by PHMSA and co-funded by industry is robust**
- **Many short-term engineering issues have been addressed**
- **Some medium-term questions have been addressed**
- **Some long-term questions are now in process**
- **Some gaps still linger but, in most cases, can't be addressed yet**
- **Research towards moving ethanol by pipelines is on track**



# Acknowledgements

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