Safe & Reliable Ethanol Transportation & Storage Technology Roadmapping Workshop

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WORKSHOP SUMMARY RESULTS





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Organized by

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TABLE OF CONTENTS

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PLENARY SESSION: KEY CHALLENGES

- Questions about future policies—are they sustainable?
- Concerns about risk: 1) investment required is significant; 2) technical issues are complex and need to be addressed; 3) integrity in steel systems
- Limited capacity in existing pipelines, should we ship more?
- Rising steel prices and limited resources (metal and expertise; limited crafts people to build infrastructure)
- Locations of consumers and supply create logistical issues
- What will we move (neat, blended, etc.)
- How do we handle interfaces between different parts of transportation, storage, and end-use infrastructure
- Shortage of tanks; limited assets downstream; how will the different fuels affect storage needs
- Efficiency—no one-size-fits-all answer; blends vs. neat may require different solutions
- Dedicated vs. multi-product lines? Demand is not yet significant enough to justify dedicated lines
- Need to clearly define roles of stakeholders and government
- What kind of materials should be investigated? Do you focus on existing or new materials? (depends on the fuel; issues with which ones will be used; start with ethanol and go to next)
- What are the gaps in the current matrix of materials
- Public policy vs. market forces; does the energy balance make sense depending on the source?
- Understanding the threat environment before addressing the technical issues; what is the threat; how do we mitigate;
- What are the short term solutions? Where do we start? Still need work for long term problems
- What are the batching and blend levels needed to stay safe?
- Simple solution such as a coupon to monitor over time
- Need to share more information about incidents; regulations may need to change; concerns about sensitive information
- Capitalize on existing framework for handling integrity risk

- Difficult to quantify risk—how do internal corrosion & SCC compare to external corrosion issues
- Questions about integrity assessments for susceptibility to corrosion (may not be ideal for internal cracks)—hydrotesting, direct, inline inspection, etc.—how will existing methods (3) be adapted?
- How can we optimize new construction based on external SCC knowledge
- Uncertainties on the impact of mitigating quality issues
- Managing change and abnormal operating conditions
- Can a leak with ethanol or biofuels create an environmental problem?
- How do we communicate the risk with transporting ethanol in order to build new pipelines through or near communities?
- Transfer current knowledge of managing risk
- Be careful of Brazilian experience; cost was major driver; must understand decision making process; avoid cut and paste technology
- Consumer acceptance of product will drive demand (fuel economy, cost point, etc.)
- Challenge of coordination of all the ongoing activities; how do we communicate better?
- Making sound investment decisions into building additional capacity is challenging (supply from Midwest or off-shore?)
- How can we learn from batch transport of ethanol to inform dedicated line systems?
- Need to think way down the distribution channel (how will additives work in engines)
- What is the real level of risk SCC poses; how quickly does it develop?
- SCC may become a bigger issue as volumes increase

Can Brazilian experience be used to fast track process?

- More coordination needed to prevent duplication of efforts

SAFE & RELIABLE ETHANOL TRANSPORTATION & STORAGE

ETHANOL SOURCES AND QUALITY ISSUES

WHAT IS HAPPENING TODAY?

GUIDELINES & STANDARDS	APPLYING LESSONS LEARNED AND BEST PRACTICES	ONGOING R&D ACTIVITIES
• ASTM specification • Does the quality of ethanol affect the manufacturer and design of gas engine • Creation of an international specification (IETA) • Tripartite international effort • API 939 I and E tanks perspective survey and SCC and research to identify procedures and mitigation steps	• There is some information on ethanol transport in pipelines (in Brazil and US) • Utilizing and evaluating external SCC test techniques • Batch flushing - some work/tests has been done, but very controlled • API and SWRI have completed work to determine affect of contaminants on SCC • Systems developed to fight against cheating at fuel stations in Brazil and elsewhere	• Development of O_2 sensor to monitor O_2 concentration in ethanol • R&D into ethanol from corn, switch grass, other cellulosics, and sugarcane • Role of composition on redox potential • SCC on “commercial” grade fuel ethanol • Effect of blend ration on SCC ongoing PRCI/CCT • Effect of batching on SCC • Accelerated until compatibility studies being done on refueling station • “Finger printing” protocol development • Pilot/demonstration cellulosic ethanol plants • Effect of infiltration/oxygen scavengers on SCC: PRCI/CCT completed and ongoing efforts • Brazilian fingerprinting study • Basic SCC research: a) pure ethanol, b) effect of additives, c) effect of cont. • Rugged reference electrode development for potential monitoring in ethanol • Subsidy • Definition of actual dissolved O_2 necessary to produce/prevent SCC • Guidelines for new construction - PRCI

WHERE ARE THE GAPS IN CURRENT EFFORTS? WHAT BARRIERS MUST BE OVERCOME?

(● = Highest Priority Challenge/Need)

TOOLS & RESOURCES	SPECIFICATIONS AND REGULATIONS	CO-MINGLING	UNDERSTANDING OF CONTAMINANTS AND COMPOSITION	CROSS-CUTTING GAPS
• No practical method for routine ethanol testing ●●●●●	• Need "API" specifications (transport based) for fuel-grade ethanol ●●●	• Ensuring product quality when products get commingled ●●●●●●	• Do not know real O_2 concentrations in pipelines - no understanding of where stream is picking up O_2 ●●●●●●	• Challenges in international technology transfer - language issues (Brazil, Russia, Japan) ●●
• Defining the environment (finger printing, pH, electrodes, O_2 etc.) is challenging because off-the-shelf probes do not exist ●●	• Fuel regulations vary by state ●●	• Standardization of ethanol while allowing source mixtures ●●●●	• Lack of understanding of how product composition changes during aging (with time, heat, length, etc.) ●●●●	– base technology transfers from Brazil, etc., then gaps become specification issues
• A database that provides the composition of ethanol based on production routine and biomass source currently does not exist ●	• Reluctance to accept higher water content for blends ●	– Enable several producers to co-mingle product with cellulosic	• Understanding how contaminant pick up occurs in mixed-use pipeline ●	• Public and political motivations are out pace development for all biofuels.
• Need confirmation of the viability of new pipeline materials and understanding of how existing materials are affected by ethanol	• Current ASTM specification is based on vehicle performance	• Uncertainty about how to process ethanol (and water) loaded transmix ●●●	• "Aging" of FGE is not well understood ●	– support for ethanol may wax and wane
		• Lack of knowledge of how ethanol transportation affects aviation kerosene filtering ●	• Lack of knowledge of what contaminants cellulosic ethanol will contain ●	– barriers and standards may change if we expand view to all biofuels
		– scheduling and trail back issues	• Lack of knowledge of cost of removing contaminants, to ensure we are cost-effective	
		• Batch sizes vs. quality vs. tank size ●	• Lack of understanding of steel microstructure-contaminant interactions during SCC	
		– Relates to gasoline quality more than ethanol		
		• Effect of ethanol (water) on corrosivity of transmix still in the pipe		

WHAT R&D, TESTING, STUDIES, OR OTHER ACTIVITIES ARE NEEDED TO FILL GAPS AND ADDRESS BARRIERS?

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TECHNOLOGY TRANSFER

- Create body (committee at NACE, ASTM, or other organizations) to manage technical transfer and coordination ●●●●●●
  - technology clearinghouse
- Create annual forum to gather researchers to stimulate technical transfer ●
- Analyze and compare Brazilian vs. US production ●
- Conduct ongoing technical transfer sessions to stimulate technical transfer
- Learn from Brazilian experience in ethanol transportation in pipelines

TOOLS

- Develop "quick field test" for FGE to test for corrosivity in day-to-day operations ●●●
- Create "Ethanol (biofuels) Handbook" with existing and future data ●
- Develop on-line tools and/or sampling methods to quickly and cost-effectively ensure quality ●
- Develop field analysis kits and procedures for ethanol ●

TESTING AND STUDIES

- Confirm key contaminants of concern ●●●●●●
  - understand which contaminants are a threat to safe/efficient operations
- Identify natural inhibitors and new inhibitors that are acceptable to everyone, including automakers ●●●●●●
  - degradation over time is key issue
- Test FGE effect on degradation of polymers and metals ●●●●●●
- Develop new techniques for electrochemical characterization of ethanol ●●●●●
- Test FGE in flowing conditions in pipelines ●●●●
- Conduct sampling and field analysis of ethanol ●●●●
  - Sampling in real world, start to finish
  - O_2 sampling in field
- Conduct mid/long term stability studies (storage) ●●●
- Test reliability of monitoring systems for FGE (long term) ●●
- Understanding sequencing benefits of batch flushing with and without pig ●
- Confirm oxygen effect (control) on SCC ●
- Conduct paper study to identify technical issues for re-processing of transmix
  - water is one possible problem
  - this may be a "nice-to-have" issue
- Study SCC vs. pipe age, composition, etc.

SPECIFICATIONS

- Bring all learning into a transportation specification for FGE ●●●●●
  - specifications allow for commingling of products
- Define the international specification
- Aviation kerosene provides good example of specifications, testing, processes - adapt to ethanol

CROSS-CUTTING

- Built a solid research program (e.g., are we sure O_2 is the villain?) ●
- Find one good ethanol product and blend to that product profile
- Conduct short term targeted research (step wise implementation)

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PIPELINE INTEGRITY ISSUES

WHAT IS HAPPENING TODAY?

R&D ACTIVITIES	GUIDELINES & STANDARDS	LESSONS LEARNED

• Understanding which pipeline steel grades/alloys are susceptible to Stress Corrosion Cracking (SCC)
• Determining the accuracy of inspection tools for identifying problems
• Building off lessons learned on internal SCC to identify causes of external SCC under existing technology applications
• Collaboration among cyclic corrosion test (CCT) researchers by American Petroleum Institute (API) consensus building activities with Department of Transportation (DOT) funding resource
• Evaluating the effects of O_2 concentration on SCC
• Evaluating post weld heat treating to relieve residual stress
• Pipeline Research Council International (PRCI) current R&D
  ○ Determining the safe blend of fuel grade ethanol that can be safely transported today (does not result in integrity threats via SCC)
  ○ Determine mitigation strategies to prevent SCC in pipeline systems
• Understanding the causes of SCC
	• Existing API guidelines for tanks and terminals
	• Early development of National Association of Corrosion Engineers (NACE) recommended practices for biofuel transport
	• Existing guidelines and standards for ethanol transport in Brazil
	• Understanding the contaminants, components, and production processes behind the specifications (fingerprinting of good and bad ethanol related to a particular bath of a production process)
	• Existing API 939-D and 939-E guidelines for mitigation, case histories, and research results
	• Existing American Society for Testing and Materials (ASTM) standards are intended for automotive applications—not relevant to pipeline operations
	• Existing train industry standards for transporting ethanol
	  ○ Currently do not experience problems, yet conditions are harsh and high stress
	  ○ Use special railcar for ethanol
	• Existing guidelines and soon to be released Underwriters Laboratories (UL) on E-85 dispensers
		• Understanding the full scenario of the SCC failures
		• API Renewable Fuels Association (RFA) testing of ethanol and ethanol production method affects on cracking potential
		• Understanding the difference between corn based and sugarcane based ethanol
		• Recovering ethanol from ground is difficult; understanding ground H_2O contamination
		• Monitoring short-term versus long-term prevention
		• Documenting failures in an API paper
		• Experience where failures are not occurring
		• ASI inspections STI (SP001) and API (653)
		• Determining whether a higher water concentration in Brazilian ethanol is a factor
		• Experience shows SCC problems occur with denatured ethanol and not with blends

WHERE ARE THE GAPS IN CURRENT EFFORTS? WHAT BARRIERS MUST BE OVERCOME?

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SOURCE	MONITORING AND PREVENTION	PIPELINE	CONSEQUENCES	BUSINESS AND INVESTMENT
• Limited understanding of the impact of mixing of ethanol from different sources ●●●●●●● • Knowledge gap on what blends cause SCC ●●●●●● • Lack of knowledge about which constituents are driving factors for the characterization of ethanol ●●● • Uncertainties about which ethanol fuels, fuel blends, and other fuels will need to be transported in the future ● • Limited understanding of the capabilities of other fuel to be transported via pipeline without SCC concerns ● • Uncertainties about the long-term demand for ethanol • Lack of understanding the appropriate batch science • Unstable demand, fluctuates according to source (corn, sugar, cellulose)	• Avoiding O_2 contamination ●●●●●●● • How do we prevent SCC ●●●●●● • How do you monitor for SCC ● • Inspection - is it same as current methods ● • Initial pipelines are likely to be smaller, which are more difficult inspect • Difficult to detect leaks, determine rate of propagation, especially the identification of small ones	• Limited understanding of the consequences of SCC of pipeline, environment, repair, safety ●●●●●● • Limited understanding of how fast SCC develops ●●●●● • Swelling and permeation in seals and gaskets ●●●● • Limited understanding of pressure fluctuations—can the accelerate pipeline stress? ●● • Uncertainties about the effects of ethanol on internal coatings (flow improvers, drag reducers) ● • Limited understanding of flow issues—will stagnation be a problem? ● • Difficult to control the environment inside the pipeline/tank • Multiple use lines may have complex interactions	• Impact of ancillary inhibitors on the consumer are unknown ●●●● • Uncertain probability of threats—what will be the frequency of addressing integrity issues	• Unknown economic break-even point • Approach to R&D is too focused on treating the symptom • Lack of separation of key variables from less significant ones; there are too many interesting issues

WHAT R&D, TESTING, STUDIES, OR OTHER ACTIVITIES ARE NEEDED TO FILL GAPS AND ADDRESS BARRIERS?

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CHARACTERIZATION	DETECTION	PREVENTION	RISK
• Develop a decision making tool for specific pipeline systems ● ●●●●●● • Develop a field "fingerprint" test that identifies the particular batch in which the ethanol was produced, including production process, operating variables, and raw materials; this will enable a quick and simple 'good/bad' ethanol test ●●●●●● • Measure swelling and permeation in seals and gaskets ●●●● • Develop an analytical laboratory method for identifying specific components that cause SCC; this will enable a more detailed examination of the ethanol used during SCC ●●● • Develop SCC data for various ethanol sources to determine commonalities/differences between sources that cause SCC and those that do not ●● • Research effects of ethanol manufacturing methods on SCC ● • Determine acceptable threshold of blends that cause SCC, such as the ongoing 4-4 PRCI study ○ Run an experimental matrix with ONLY a variation in ethanol blend and/or source	• Develop integrity assessments methods(IL I, hydro, DA) ●●●● • Early detection of SCC ●● • Develop tools to accurately predict residual stresses, e.g., database, FEA ● • Develop monitor to acceptance criteria ● • How to monitor effective treatment - determine the significance of the contact of the ethanol with the atmosphere by comparing it to tests ran in an inert environment ●	• Construction ○ Use alternative materials or linings or sacrificial coatings that have not experienced SCC ●●●● ○ Develop best practices for new construction (pipe metallurgy, post weld heat treating, etc.) ● ○ Develop welding technology that avoids SCC, e.g. friction stir ● • Operations ○ Establish operational procedures for dealing with batches/interface in a non-dedicated ethanol pipeline ●●● ○ Remove sources of O2 in handling, transport and storage ●● ○ Develop ethanol acceptance guidelines document ●● ○ Develop methods to prevent SCC ●● ○ Determine inhibitor types ● ○ Transport blends where SCC is not an issue, including E100 (except in Kentucky) ● • Maintenance ○ Develop post weld heat treatment guidelines to avoid SCC ●●	• Understand the potential SCC failure scenarios●●●●● • Develop guidelines/practices for assessing threats (SCC, internal corrosion (IC), etc.) ●● • Study consequences of SCC in pipeline (likelihood, mode of failure, clean-up costs) ● • Develop a direct assessment approach specific to ethanol ● • Develop public communications about ethanol pipeline transportation risk; raise public awareness ● • Measure effect of SCC on pipeline integrity

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PIPELINE OPERATIONS ISSUES

WHAT IS HAPPENING TODAY?

GUIDELINES & STANDARDS	APPLYING LESSONS LEARNED AND BEST PRACTICES	ONGOING R&D ACTIVITIES
• API 935E Guidelines: identification, mitigation, re-weld & repair • Other API technical publications: e.g., alcohols and blends handling, #1626, #4161 • Guidelines: PHMSA regulations, API, PRCI projects, individual company • New NACE task group on ethanol pipeline transportation issues • MTI (materials selector series) • ASTM standards • Petrobras Standards/ANP (Brazilian Petroleum Agency) • Federal and State regulations – blending specifications	• Ad hoc experience, sometimes shared • Living with SCC • Tank coatings from API work • Review of seals/elastomers, past Southwest Research Institute work • HPH SCC/MN SCC, assessment methods • Field non-destructive testing • API survey failure experience – form (producers, producers tanks, facilities) • API 939D R&D summaries and published papers • Communications essential • Applying very poorly - misinformation, innuendo, etc.	• Identify corrosion and inhibitors, identify effects of heat and various blends, methods of reduction in existing pipelines, criteria for new pipelines • Moving test batches • Developing relationships: producers, pipeline terminals, etc. • Brainstorming handling options • Trail-back, quality, seals/soft goods, storage, shipment SCC issues • Effect of O_2, H_2O, 1,1-diethoxyethane, butanol • API - crack growth rates and fracture from ethanol SCC (consequences/risk) • API - field monitoring for SCC and corrosion/pitting • Identify batching “safe harbor” • Define products ok to ship • Monitoring (e.g., monthly) vs. standards and batch trials • Inhibition: batch vs. continuous, traditional vs. O_2 scan • Minor constituents: importance, variability • Effective monitoring tools • Batching (CTDUT) Operations with ethanol - state of the art in ethanol pipelines (CTDUT) • API R&D (completed) - sources of ethanol, effect of aeration, potential range, CI, butanol • BaOH (bioalcohol?) SCC (alternatives) • Collaboration with Petrobras • Define allowable limits of O_2

WHERE ARE THE GAPS IN CURRENT EFFORTS? WHAT BARRIERS MUST BE OVERCOME?

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BUSINESS PRACTICES	TECHNOLOGY APPLICATION AND TRANSFER (6)	PRODUCT SPECIFICATIONS (2)	MONITORING AND QUALITY CONTROL (3)	OPERATING PROCEDURES
• Show me the money (i.e., business case sustainability) – for ethanol in pipelines – optimal delivery system – gallons? length? ●●●●●●●● • How do we convince regulators, media, public that new operation is safe ●●●●● • Uncertainty what auto manufacturers will require/do ● • Pipeline siting • End user usage/choice	• Application: lab vs. real world ●●●●●●●●●● • Timeline for research results: is current focus correct? H2 identificatin ●●●●● • Safe stresses: levels for no-SCC • Understanding differences between lab and field SCC • PRCI R&D: safe blends (SCC), compatibility of materials, new pipeline construction standards • Gaps: understanding ethanol SCC, market stability, building infrastructure, compatibility with other products • Problems "bred" by existing scale, weld defects, etc. • Majority of SCC standards, etc. relate to facilities not pipelines	• Define safe operating limits: chemistry to prevent cracking (O_2, water), stress, etc. ●●●●●●● • Threshold level of ethanol in gasoline blend to prevent cracking ● • What is the trace compound specification for ethanol	• What needs to be monitored: why, where and when ●●●●●●●●●● • Lack appropriate commercial monitoring technologies ●●●● • How much contamination will occur and where in pipeline system (including O_2) ●●● • How will ethanol products change over time • How to baseline existing line before ethanol service • How do we know if this batch of ethanol will harm the system	• How would we blend: in pipelines or tanks (i.e., change the current model?) ● • Lack effective, practical, economical mitigation schemes

WHAT R&D, TESTING, STUDIES, OR OTHER ACTIVITIES ARE NEEDED TO FILL GAPS AND ADDRESS BARRIERS?

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TECHNOLOGY APPLICATION AND TRANSFER	OPERATING PROCEDURES	PRODUCT SPECIFICATIONS
• Fundamental understanding of ethanol SCC and driving factors (weld, stress, crack, etc.) ●●●●●●●●● • Research to transition from lab to field , including statistical/probability verification, validation ●●●●●● • Identify steps needed to reach real world applications and R&D deliverables ●●●●● • Conduct analytical survey of ethanol from various sources, including detailed comparison of actual sugar based ethanol vs. corn based ●● • Establishment of lab protocol based on actual pipeline system conditions ● • Field test mitigation strategies for O_2 control ● • Supplemental ethanol (cellulose, etc.) beyond corn-based: analyze impacts	○ Emergency response procedure and public safety awareness standards ● ○ Drag Reducing Agent (DRA) for ethanol	• Product compatibility and mitigation means
KNOWLEDGE MANAGEMENT: COORDINATION AND COMMUNICATION	**MONITORING AND QUALITY CONTROL**	**BUSINESS PRACTICES**
• Coordination and communication among these organizations: RFA and EPI (UNICA Brazil), NACE, SAE, API, AOPL, ASME, PRCI, DOT, ASTM, CRC, DOE, USDA, DOD, EPA, Biodiesel boards, NFPA, other international organizations ●●●●●●● • Share experiences (i.e., from Brazil) ●●●●●●●●●● • Consensus re: timeline for R&D industry (published) ● • Identify all ongoing/completed research, remove duplication, catalogue • Continuing implementation dialogue • Educate public/media/government	• Better commercialization approach for monitoring ●●●●● Develop ruggedized potential measurement system in field ●●● • Analyze ethanol as it moves through the distribution system ●●●● • Conduct joint industry effort to field test and commercialize O_2 monitors • Determine applicability of existing O_2 monitors to ethanol and ethanol/gasoline blends	• Comparison of ethanol SCC risks to other current risks - quantify ●●●●●●●●● • Government/industry policy - position study on ethanol infrastructure • Project an ethanol penetration timeline • Identify requirement to ensure need of ethanol transport via pipeline

SAFE & RELIABLE ETHANOL TRANSPORTATION & STORAGE

STANDARDS, GUIDELINES, AND TRAINING

WHAT IS HAPPENING TODAY?

GUIDELINES AND STANDARDS	LESSONS LEARNED	ONGOING R&D ACTIVITIES
• NACE biofuels pipeline transportation • Collected information about existing standards (API) • UL now accepting applications for dispenser certification for ethanol as of 16 October • ASTM re-examining specification for ethanol • EPA emission standards • API bulletin 939E identification repair - mitigation • PHMSA statement of policy - ethanol/biofuels • Standards developing organizations coordinating committee (SDDCC) • Individual companies writing standards and specifications	• Internal SCC coordination meeting in Atlanta 10/17/07 • Multi-agency working groups, EPA, DOE, USDA, DOT, DOD, etal • Petrobras • Case studies API 939E appendix B • Firefighting standards • API technical bulleting 1626, 4161 • Other: – UA reaching out to industry to formulate formal education program – Pending congressional pipeline studies authorizations, energy bill, farm bill, energy water appropriations	• PRCI SCC roadmap • PRCI SCC 4 just finished • PRCI SCC 4-3 just started • PRCI SCC 4-4 just started • DNVRI reference profile co-sponsoring for ethanol TQ SCC research • Ohio State University • R&D inhibitors/OX. Scavengers • R&D SCC susceptibility on blends • API task group on ethanol SCC (API 939D) • R&D activities, additives that meet automotive requirements • Georgia Tech. biofuels work • SWRI and Honeywell in API program • PHMSA Research, joint industry project, broad agency announcement research

WHERE ARE THE GAPS IN CURRENT EFFORTS? WHAT BARRIERS MUST BE OVERCOME?

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THEORETICAL BASIC RESEARCH	PRACTICAL RESEARCH	TOOLS AND TRAINING STANDARDS	POLICY
• Understand mechanism of ethanol SCC ●●●●●●● • Comparison between sugar and corn ethanol ●●●● • Gaps on understanding non-aqueous electrochemistry	• Sharing of experience internationally ●●●●●●●●● • Does PWHT effectively prevent ethanol SCC? ●● • Elastomer and non-metallic compatibility with ethanol ●● • Batch tests on neat (E95) and blends ●● • SCC and pitting corrosion ● • Any research on other pipeline components, pumps, control valves, etc. ● • Unknown impact of additives on other parts of infrastructure (not just vehicles) • Required coating tests for ethanol service • DRA for gas-ethanol blends (or pure ethanol)	• Turning research into standards - influence (proactive) regulations ●●●● • Monitoring technology, O_2 concentration, ref electrode ●● • Current ASTM standards address quality - need to address SCC potential ● • Technical transfer for training, standards, and guidelines ● • Developing an educated/trained workforce - associations, universities ● • Limited ability to write guidelines and standards because of gaps in understanding • Tools for rapid inspection and detection of SCC	• Coordination of research activities ●●●●●●●●● • Conduct and validate economic impact assessment - direct/indirect costs and benefits ●● • Policymakers making uniformed decisions (congress) ● • PRCI 4-3, 4-4, 4-5 API tanks coordination of research - value in independent replication • R&D focus on ethanol - not so much on biofuels • A central alternative fuel lead in executive branch required • As companies and SDD's (Standards Developing Organizations? SDO's?) develop standards - could be harder to achieve consensus

RESOURCES	OPERATIONAL PROBLEMS	INTEGRITY
• Cost-benefit analysis ●●●●●●● • Scope of research efforts has been relatively small. Need much expanded R&D effort ● • What is realistic limit on quantity of ethanol to be used as fuel?	• Emergency response people - how to deal with ethanol ●●● • Standards for overall management of onshore pipelines do not exist. ●●● • P&M strategies ●● • Maintenance of ethanol storage and transportation facilities and equipment	• Define threat and susceptibility ●●●● • Understanding the impact of failure • What is acceptable risk (failures and consequences)

WHAT R&D, TESTING, STUDIES, OR OTHER ACTIVITIES ARE NEEDED TO FILL GAPS AND ADDRESS BARRIERS?

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OPERATIONAL INTEGRITY STANDARDS	EDUCATION AND COORDINATION EFFORTS	POLICY
• Develop integrity management plan for operation ●●●●●● • Non-destructive testing techniques for ethanol SCC ●●● • Repair maintenance standards ●●● • Develop on-line monitors for O_2 and ref. electrode ●●● • Study to determine all the PI threats (what are we missing) ● • Test inhibitors for SCC - reducing effects ● • Study effect of water content • Study effect of aging ethanol on corrosion properties	• Involve Petrobras and other international groups●●●●● • PS DOCC standards development ●●●● • Gather R&D outputs and systematically organize into materials ● • Fast track standard development with ability to modify as data is available ● • Develop strategy plan (includes roadmap, inch stones/milestones ● • Inform Congress and Executive Branch of the risks before they create more policies and rules ● • Develop education and training programs to support future workforce • Form and cross-functional group to conduct an evaluation of threat and susceptibility of failures • Develop a realistic public relations message	• Identify the R&D roadmap owner and steering group ●●● • Conduct definitive, non-political study on viability of ethanol as a replacement for gasoline (cost/benefits) ●●● • Develop biofuels corrosion R&D board ● • Review/update PHMSA pipeline and hazmat regulations • Name lead executive agency

TESTING	FIREFIGHTING/ SAFETY STANDARDS	STANDARDS TO QUALIFY EXISTING FACILITIES	CONSTRUCTION STANDARDS	PRODUCT QUALITY STANDARDS
• Corrosion testing standards ●●●●● • SCC protocols	• Research/identify best practices in ethanol fire/spill emergency response ●●	• Research and testing on large scale to understand mechanism of SCC ●●●● • Test if some steel grades may be more/less susceptible	• PWHT testing ● • Test for effects of stress - constant, cyclic, magnitude	• Analyze effects of contaminants ●●● • Impact of blending on SCC susceptibility ●● • Test if oxygen scavengers are option for ethanol ●