Smith, Robert (PHMSA)

Good morning, and welcome to the final day of the PHMSA pipeline transportation hydrogen and emerging fuels R&D public meeting and form. My name is Robert Smith and I'm the senior research program manager for PHMSA's Office of Pipeline Safety. I'm returning to serve as your master of ceremony for today. Nathan Schoenkin, who's also a program manager within our research program, will also be assisting throughout the morning. We thank all of you for your attendance and participation on Day 1 and Day 2.

We would also like those extend a special thanks to our working group leaders and presenters. And your experience of this virtual event is important to them. So let me go through a few housekeeping items.

General attendees will remain on mute. Only presenters and moderators will unmute or will be unmuted for their participation on today's agenda. We intend to adhere to the agenda as strictly as possible. We have a short agenda for you today and will adjourn roughly at 12:30 PM eastern.

As I said on the first day, these proceedings will have a transcript. The transcript and all presentation files will be available on the meeting website as soon as possible after the event. All registered attendees will receive an email notification when all event files are posted.

Something different for today—we have a 30-minute public period comment period planned for roughly 12:00 PM and we welcome you to provide any comments at that time. The moderator will have some further instructions when we get to that point part of the agenda.

So moving on to our first agenda item for today, we're going to talk about the PHMSA R&D Portal and solicitation of gap ideas and topics. I want to welcome back Sentho White, director of the engineering and research division within PHMSA's Office of Pipeline Safety, who will give a brief overview. So let me go ahead and stop the camera here and bring up the presentation.

White, Sentho (PHMSA)

Alright great, thanks Bob. And good morning, everybody.

Smith, Robert (PHMSA

Alright go ahead and proceed.

White, Sentho (PHMSA)

OK great thanks.

And as Bob said, I am Sentho White, director of the engineering and research group at the PHMSA Office of Pipeline Safety. And on the next slide. We've historically...the research gaps are identified and roadmapped at public events similar to the great work that was done by the working groups yesterday afternoon; however, with our forums being held periodically and while hundreds of attendees usually participate, at these events, many stakeholders can't attend for whatever reason and miss that opportunity to provide input.

And so in in March 2019, PHMSA released a special notice for identifying pipeline safety research ideas and the federal business opportunities portal, which is now called the system for award management, and the special notice...provided the opportunity for any interested stakeholder to submit ideas for future research.

And so how does it work? In terms of our research gaps and ideas that we consider, these ideas must be an idea that's jurisdictional (within) PHMSA's statutory mission. And our program staff reviews these gaps to remove any duplication to currently funded PHMSA or research partner portfolios. And these are presented to and approved by the leadership to solicit forward...and research. So solicitations are within our CAAP, our Core, and our SBIR programs. And they are solicited either in SAM or grants.gov...since 2019. We've actually had 37 total submitted gaps and of those, 5 of these have actually been funded roughly about $3.3 million. Funding has been awarded in the areas of leak detection, hydro testing, stress corrosion cracking, and plastic pipe inspection.

And so you know as I mentioned...this portal provides the opportunity for any stakeholder to submit their gap ideas and it's shown here on this slide. The slides will be available after the meeting on our meeting websites. So you can go there for the link and there are also detailed instructions on how to actually populate...the data fields.

And again, you know, we review the submissions...and you know if there are any ideas that you did not see that were part of the report out later on in the agenda, then please feel free to go to this link and submit those ideas there.

And again, thank you and...please feel free to reach out to myself or anyone on the R&D team if you have any questions about our program in general or on the special notice. I'd like to just...thank all the presenters and all the attendees for their participation and input from Day 1 as well as yesterday in in developing the report outs for the 6 working groups. We're eagerly looking forward to hearing about the results so I'll turn it back over to Bob. Thanks.

Smith, Robert (PHMSA)

All right, well, thank you very much. Sentho. Let me close this.

OK, so now it's time for us to learn what resulted from the work completed yesterday within the 6 working groups. Let me also reintroduce Kandi Barakat, who is, once again, one of two operations supervisors for the engineering and research division within PHMSA's Office of Pipeline Safety. Kandi is going to moderate this panel, and we have a Q&A session after that. You'll also moderate so can you go ahead and proceed. ...Start there and I'll bring up the first working group presentation.

Barakat, Kandilarya (PHMSA)

Great thank you, Bob and good morning, everyone again. My name is Kandi Barakat. I'm one of the operations supervisors at the engineering and research division. Before I start, I just want to say kudos to all of the efforts and great work that went into these working groups to generate the gap ideas.

Before we hear from the working groups. I wanted to cover how you can submit questions. Please submit questions to the panel moderator during the planned Q&A period after this panel. Please use the Teams feature entitled Show Conversation and type your questions there. Be sure to specify if the question is for the entire panel or for (a) certain working group by number.

Will the representative and presenter for Working Group 1 on the rehabilitation of aging cast iron pipelines please unmute and introduce yourself. And, please, proceed with your presentation summary.

McLaren, Chris (PHMSA)

Well, good morning. I'm Chris McLaren, presenting for Workgroup 1—the rehabilitation of aging cast irons. The co-lead for this group...Saadat Khan said, "I can't be here today because of other work requirements." We also had great support from Nathan Schoenkin and S&K Consulting. We had a wide variety of stakeholders from very diverse and very appropriate grouping(s) across the spectrum of our stakeholders.

What we were specifically covering was in support of Executive Order 13985, Advancing Racial Equity and Support for Underserved Communities Through the Federal Government. We explored R&D topics that would advance technological solutions to rehabilitate cast iron pipelines, which are prone to leaks and are located in socially vulnerable communities or urban areas. This group developed 3 specific research topics on technology solution and data tools.

To assess (the) potential risk and to rehabilitate aging cast iron pipelines, during our discussions and as could have been expected, the bare steel issue came up also. ...And so a lot of our comments address both those 2 leak prone pipes. (This) presentation effectively showed that we really needed to be addressing both but primarily the cast iron along with the wrought iron in some instances, primarily cast iron but also includes steel bare steel and its issues. We started with a total of 28 ideas that fell into about 7 buckets, while they were combined and put together.

And then we went through the voting, a program that was good, and came up with three identified R&D gaps of highest interest and five additional items. Feedback from the group was that this virtual platform was efficient and effective and one of the best working experiences of this sort they had. So I thought that the feedback was that it was very effectively and efficiently done. Those three initial gaps are same day lining with service reinstatement. In other words, as we are moving forward with cured in-place liners specifically how can we improve that process to make it more efficient and effective, we were able to bucket a few of those ideas into this topic area. And then there's one specifically that's still in the additional gap items.

Gap 2 was a decision tool for replacement and rehabilitation. This would be more of a tool concept. There are decision trees where an operator has to identify the criteria that says that this pipeline is in need of replacement or (needs to) be rehabilitated. Some of those criteria can be set through programs such as (indecipherable) processes or others that were discussed, whereas (indecipherable) has specifically said that these types of line pipe are leak prone and shall be considered as such a moving past that, ...then we have to understand the suitability of the line

pipe and the pipeline system within the environment. It operates on whether it should be rehabilitated or replaced so we saw some work.

There, the third main gap of these three highest is the development of structural liner materials. There are some higher-strength liners that are in use. But still, these are being considered by PHMSA and state commissions during those rate recovery discussions as liners that will prevent...the leakage of the product from the pipeline, and not as a structural line pipe being able to be qualified as a host pipe such as would be submitted on the gas distribution annual report. There is a lot of work in this space.

So let's go through those first three gaps. ...One—same day lining. There's going to be a few items in here, but it's really about trying to get that pipeline back-end service that day to quickly reinstate the services to the individuals or companies main provided with that service, whether...we have worked with steam and ultraviolet curing (or) accelerated curing of these liners to look at that same day in the past. But by and large today, it's utilized a more cured in place at ambient temperature has provided the best results. We want to look at how we could work to accelerate that and get those services cut out and reinstated...effectively and specifically around 12-inch and even less than 16-inch mains. How can we make that happen faster? We talk about these operating environments and some of the other drivers of course.

This is all part of a reducing methane emissions and in most all of the pipe we're talking about, a large percentage of it occurs in urban environments, which may be underprivileged or underserved. There are some specific ASTM standards already in place. But as we look at some of these, they're as we go down the list, that standards development is an important part and PHMSA is involved with standards development and we see that as a key place for industry regulators to be involved in standards development as we move through modifying...these practices and processes.

(The) next gap was this decision tool. It is really a tool and it needs some more vision put around it. We've developed tools in the past for risk modeling...that we researchers and stakeholders have developed. Add ONS to them to address certain things, but when we look holistically at the environment in which a cast iron...vintage material or cast iron or bail spear serial operates, there are environmental factors from outside and also inside the pipe, as well as the condition of the line pipe inherently, and it's joining processes that all need to be taken into account.

Also, a lot of the some of the primary causes of failures are land movements, frost heave, possibly even seismic settlements, which doesn't occur typically in the Midwest or Northeast as much. But we have had earthquakes in Virginia and certainly this and (indecipherable) and other things, and so there are other considerations to look at. That would be add(ing) O&S into this tool. Initially, I talked about that. That decision making of a criteria of, how do I say, that this is a pipeline that needs to be evaluated, and we do find prescription added to that at the state level, but also maybe some discussion of being able for an operator to at least relatively if not, hopefully quantitatively understand what some of those risks are as they enter the process.

I think the next one would be fine trying to keep the pace going.

...A development of structural liners. PHMSA has funded research in this (area); we are presented an excellent report. I highly recommend that all of our 6 presentations that are posted to the website be reviewed. It's probably the case for all of our working groups' fabulous amount of knowledge, but it certainly is the integration with ongoing work and the integration of past and in current knowledge that help us understand what our vision should be for implementing this one.

...Trying to get to a point where PHMSA can look at a structural liner to rehabilitate aging infrastructure that then can be considered structurally sound in and of its own accord within the regulatory environment is the proposal. How do we all work together to understand the material systems that are acceptable such as incorporation by reference of certain standards that may be developed or need to be developed? How do we work through the required testing regime that these products have to pass to meet a standard that could then be acceptable? As such, as we do with the polyimides and polyethylene pipelines. There is other work in other industries also to look for.

But there's also a couple of good projects going on that. Jack Lewnard from DOE ARPA presented on that. We're certainly looking to continue our knowledge and make sure we're abreast of (those projects) and support how we can. We certainly see a space in this for us and coming up with that vision of how it all interacts is, of course, Bob's job and Kandi's and that whole group, so thank you very much.

Let's go to some of the additional associated items.

We're hoping the hydrogen group adequately covers this, but one of the gaps that was identified particularly by a couple of our members, was the fact that the work on hydrogen effects on cast iron or on iron. We're talking about wrought, ductile, and cast, but really primarily cast. What are the effects of hydrogen on it, not only within a blended environment where these mixes and maybe even at times very high concentrations of hydrogen are sent through the network, but also on the aligned environment.

There is anticipated to be some permeation of hydrogen through liners that would need to be studied, and (I) understood...there is ongoing work that we reviewed on that currently. But then if there is a lack of adhesion to the host pipe, there would be an annulus created where hydrogen could stand in of itself within that annulus and possibly react with the iron microstructure.

The effect of hydrogen on steels is very well documented and we don't know what the effect on hydrogen is because either that literature search has not been conducted or that testing has not been conducted. And it was noted that currently the B 3112 on hydrogen pipelines excludes cast iron. (I) don't understand the premise for that, yet, but that is of concern.

The other one was that that came up fairly strong during discussions in terms of getting some votes early on, but then losing traction in our second round of voting was getting some sort of criteria and or understanding of...inline inspection of cast iron pipes. Maybe right now, we have the section 122 of the Pipes Act 2020 work, where we're looking at what would an integrity assessment look like on a distribution pipeline other than direct assessment. So we see that as a

as a space where there may be work being kicked off but also where possibly some out of the box college think tank thinking could help. And so that kind of adds a little credence to the section 122 work.

Excuse me one of the other topics that came up in support of improving liners...and getting them done faster, quicker, cheaper—and the ideas that that have focused around the improvements in that space is the live insertion of cured in place liners to avoid expensive and safety concerning bypasses as well as customer outages. Not sure what the vision for that is, but that was really seen almost more as a specific manufacturer/specific product providers in the program. But that is something that that we talked about.

Along with the...methane emissions of valuation was also the discussion of methane and hydrogen blend emission, understanding that currently the work has shown that once this pipeline is lined it (has) passed a pressure test. It's not leaking.

But how do we quantify that and that sort of gets us down to number 5, which is the discussion of...we have some operational experience on showing these liners. Certainly the Star Line 2000 lasting 20 years and PHMSA funded research (and) other consortiums...have looked at them. And...they show good long term viability and appear to have...very, very minimal leakage rate only through permeation as applicable and not really sure there is any permeation. But the question from industry about the EPA assigned leakage rates to assets comes into question of is that a cast iron or is that now a (indecipherable) leakage rate. Some of those discussions, we really didn't bring up to the forefront...but those were our additional identified gaps. Thank you very much and we look forward to questions we do have (from) other industry personnel stakeholders (and) from the committee with us today. (We) will be available for discussions in the Q&A session. Thank you.

Barakat, Kandilarya (PHMSA)

Thank you, Chris, for the summary and findings for Working Group 1.

Well, the representative and presenter for Working Group 2 on the integrity of underground natural gas hydrogen storage, please unmute introduce yourself and please proceed with your presentation summary. Thank you.

Pfeifle, James (PHMSA)

Hi I'm James Pfeifle. I'm the program manager for underground natural gas and Hilary is going to be assisting me here. Hilary, could you introduce yourself?

Petrizzo, Hilary E

Thanks James. My name is Hilary Petrizzo. I'm a project manager at SoCal Gas working in the hydrogen engineering strategy group.

Pfeifle, James (PHMSA)

Mr. Anders Johnson was not available to be here today. He had a meeting that he could not get out of; he was actually a presenter at it. So it's kind of tough to sneak out of a meeting like that.

(Indistinct sounds) Gordon Loyd...I don't believe he's...online, so again what I'd like to do is thank my co-leaders for their assistance throughout this whole process. Next slide, please.

We identified...we started with 72 gaps and we combined these 72 gaps in 213 groups, of which there were multiple groupings. We had especially...I'm not going to go through the process. Chris did a great job of describing the process of the post it notes. But we went through the gaps and looked at them and grouped them; (we) spent a lot of time doing that.

So these are the 4 gaps that we came up with that we felt there were the most important there. Some of the others just lost out a little bit. I would have rather had maybe seven to do. But we don't have (seven); four was the limit. We felt that we had to (make) do here.

So the four gaps are to identify a test to better characterize microbe interactions, and the basic gist of that is anaerobic and aerobic bacteria will react to the hydrogen as a source of food and increase their production of either sulfur or some other thing which the hydrogen will also react with and we feel that that is the number one gap that there needs (to be) some additional funding on. There is some work being done in studies, but we feel that there needs to be one encompassing group there.

Then, the second gap is the pilot studies. We would like to see a pilot study done to explore the feasibility of injecting gas into either pore stratified media or a cavern or maybe even an aquifer to determine whether or not the hydrogen will stratify or be buoyant and rise up because it is a lighter gas. And we'd like to see just a feasibility study, or maybe even a percentage mix with natural gas something of that nature.

The next one is a site selection suitability for hydrogen and carbon dioxide. Those two seem to be the places where I think the research needs to be going into.

And finally, hydrogen gas last monitoring that that encompasses leakage—possibly through...caprock leakage, through cement leakage, through pipeline. Tubular makeups—what kind of lubricant do you put in between the joints to account for the small nature of the hydrogen?

So next slide, please.

Where the idea for the first gap is to identify then test (is) better characterized by this, the microbiology fallout...interactions. And the idea is to start with the existing work. That's been done out there, and come up with a range from 0 to 100 percent hydrogen in mixtures with natural gas to find out where the breakover point is where the bacteria will do the worst or the best.

...The infrastructure bill for hydrogen is one of the major items in here and I believe California also and some other states are mandating some hydrogen work to be done. This needs to be done prior to (indistinct).

It's (indistinct) of a test so that we know if we're going to mix hydrogen with natural gas, that if there are any bacteria in the formation that we need to determine that in advance. We said that we would need in order to do this a request for proposal. Because depending on how deep the

process needs to go, we would need to know that in advance before we could come up with a cost estimate. Next slide, Hilary.

Petrizzo, Hilary E

Thanks, James.

It's as James mentioned, our second gap is to do an actual pilot field test. So this had a lot of support from the group members, I think in part because many of the things that we laid out—really, everything we laid out—we can absolutely study in a real field environment. So what this really covers for us is...it feasible to store hydrogen underground as James mentioned? There's the tie to the infrastructure bill as well as state requirements on hydrogen injections standards.

And so this would allow us to set up kind of a precursor to those...API recommended practices. I would say what we find to be the biggest barrier right now and pilot testing is that there's an awareness of the expense. There's a need to identify a field a suitable field in which to do the pilot, so the group members like the idea of PHMSA promoting this idea, perhaps giving us consortium together. We are aware that this will be a higher-ticket item. You know, $5 million may cover even just the equipment, so having the backing of PHMSA for all the operators interested to come together (and) do a field test, as James mentioned. It could be an aquifer, could be a depleted oil and gas field, but somewhere that we're actually able to begin that injection of hydrogen and then do a lot of the subsequent gap analysis that we identify. Thank you, James.

Pfeifle, James (PHMSA)

Gap Number 3 is the site selection, finding a location for suitability for storage for use in heating and or processing for the hydrogen and or possibly for CO_2 storage. Again, the infrastructure bill is one of the requirements that are going to come out of that.

What we did read for the major gap (indistinct)? We're going to need an API recommended practice in order to determine how the...gas is stored, very similar to (how) API 1170/71 did for underground natural gas storage. Again, we also said that we would need a req, a request for proposal from the academic community for this. Or a consortium for this.

Last one.

Petrizzo, Hilary E

So our last one in the top that we identified—so all of these were great ideas, but the last one that made it in the top was on hydrogen loss monitoring. So this ties into a few of the things that we've discussed about, for example, that microbial activity could be a way that there's acid dissolution into fluids could be a means for loss. Perhaps some information to the caprock so being able to really understand the types of losses.

Now, for when it comes to underground storage of hydrogen, ...one thing that we see this potentially being contingent on is again that field pilot. So there is modeling work that can be done with reservoir software, ...being able to really measure the leakage rates and things like

that, and the pilot. I think would be a nice pairing of projects so that's why we have again, ...RFP needed. We're not quite sure to the extent that this would be done versus...modeling situation versus actual measurement, but it's something that rated fairly highly amongst our participants. Thank you.

Pfeifle, James (PHMSA)

Next slide. These are the 10 extra ones that the people in there our group. But we had a very lively discussion over what these are and we certainly appreciated the assistance that we got from both our presenters and the attendees. There was a lot of good discussion over and a lot of good questions that came out of that discussion and what we have here is like the suitability of caprocks.

That was one of the discussions that for a hydrogen loss. We thought that we could have grouped that into the hydrogen loss grouping. But we felt that this needed to be separate from it, because otherwise you get into a whole lot of Group A whole lot of issues. We felt that was suitable well inspection and monitoring technology. That is going to be a very, very one in it like say the first, the 1 and 2, the well design. How do you—what materials do you make up for the piping number one for valves and tubing and at wellhead configurations cement blends?

...And the lubrication between the threads and all of that stuff needs to be worked out prior to any pilot project so that there are RPIs out there for that. And that one just barely missed it, we wish we could have included that.

Let's...some of these other ones. Design and composition of wellbore cements for hydrogen service again. There are RPIs out there for cementing but I don't believe that hydrogen is included in those processes.

...We anticipate any questions you have, and Hilary and I will be available and if any of our members would gladly chirp in and help us out, I would appreciate it. Thank you.

Petrizzo, Hilary E

Thank you.

Barakat, Kandilarya (PHMSA)

Thank you, James and Hillary, for the summary findings for Working Group 2. Now will the representative and presenter for Working Group 3 on the utilization of inspection tools on hydrogen pipelines please unmute introduce yourself and please proceed with your presentation summary.

Sellu, Christian (PHMSA)

Kirk.

Wissmar, Kirk (BHE GT&S)

Oh, OK. I'm Kirk Wissmar and I work for BHE as a pipeline integrity engineer. This was the...quite an event and I think we've narrowed down our top five gaps the meeting found during

the review process here. I want to thank Christian and Greg. They did an excellent job throughout this process, getting everything set up. Christian, can you hear me OK?

Sellu, Christian (PHMSA)

Yes, I can hear you.

Wissmar, Kirk (BHE GT&S)

OK, perfect. Right, if you want to go ahead. So these are our top five gaps that we identified for R&D.

Number one is the initial IEP process and ASME 31.8. As the actual threats that determine how you're going to assess your pipelines and what concerns you have. While you're assessing what the changes that are going to be imposed on those threads will be by adding hydrogen (or) introducing hydrogen indoor pipelines. Additionally, concerning is whether or not there will be any other threats introduced that we haven't considered yet. That's a very good one. Some examples of that would be laminations that could be extended or converted into blistering, any additional cracking that could occur, and what is going to happen to existing cracks as far as growth rates. Sizing, that sort of thing. So that was our first gap.

The second gap that up...it was highly voted on although not necessarily directly related to ILI, it could be if you wanted to use leak detection tools that are currently in development and some existing leak detection tools, but just the gap that the introduction of hydrogen into the pipelines is going to prevent our existing leak detection from operating appropriately. So that's basically up updating our equipment or leak detection equipment out in the field within our compressor stations, things like that. Around our meter sets or buildings. Those could possibly need updated and again like, I said, we're not sure that this really belongs in the ILI alone. We think it could also be covered under Workgroup 4 and likely will be.

So from their Gap 3 was research into the damaged mechanisms to determine the intervals for ILI tools. That's specifically related to the cycles—how often we need to run the tools based on changes to the Gap Number 1. The threats and anomalies that we find in the lines, how they're going to affect those intervals. ...Is the standard 7-year reassessment interval actually still going to be acceptable? In all cases or in many cases, or is that going to need to change?

Gap Number 4 was specifically related to distribution mains and the need to develop inline inspection tools that are going to be suitable for the distribution systems after hydrogen is introduced. We, someone, thought that small-diameter cracking tools, for example, be made or still in development and not widespread, especially for low-flow, low-pressure conditions potentially.

So Gap Number 5 is researching the anomalies similar to Gap 1, except for how those relate back to ILI and whether or not the tools can accurately size those...defects and anomalies. A couple examples...current algorithms for tools...are based on existing shapes and sizes and...how is the introduction of hydrogen going to affect...the morphology of, say, internal corrosion. Maybe introducing (indecipherable). It's going to change those shapes, the size, and how they're

growing and interacting. And the algorithms for the tools...may need to change to account for that. To add, it adequately detects in size, those anomalies.

I couldn't go to the next slide.

So from there, we went into associated details with each of these gaps in accordance with the PHMSA layout and tried to apply that to each gap. So the first one again. Where are threats associated with ASME that's going to affect...what our tool selection potentially, or how we handle each of the anomalies' water repair criteria, is our response time required for those anomalies. We may introduce new immediate threats that need repair when we get our data sets.

So again, the main objective is identification of changes to existing threats and possible new threats caused by the presence of hydrogen. The research gap suggests that we would need new knowledge as well as possibly new development and deployment of new technology, for example. And new standards, or updated standards to address these new concerns that are going to be related to the introduction of hydrogen and or pipelines. And...maybe new IEP standards, so...the gap will need to address these consensus standards and best practices. Possible review of ASME 31.8S threat algorithms, tool selection, repair criteria accepted, its limits, etc. Revisions, ASME. So part of the CFR.

And then from there, develop a timeline for where we can go. We think the first step is going to be possibly an 18- to 24-month research project followed by large-scale testing to validate everything, so possibly 5 years or more. Estimated cost...300,000 roughly for a paper study to start off and 2 to 3 million, possibly, for field testing over (a) 5-year period.

Second gap that we identified, was the leak detection, it's pretty (indecipherable). We're not going to go in extremely...with this one because, like we said, it's really not completely ILI related and may need to be covered in another group. But definitely, everyone felt that...there is a gap in the technology for leak detection associated with the introduction of hydrogen in our pipelines that the current equipment that we have for our leak surveys, etc., monitoring our buildings, is not going to work appropriately or there's concern that it won't work appropriately. ...We felt it likely an initial research is going to be required to find out what it takes to get that equipment updated, with estimated funding at ($300,000) to ($)400,000.

The third gap research into the damaged mechanisms for intervals in the tools, this is going to be dependent on the studies found and Gap 1, obviously. (The) main objective will be to determine the level of degradation of an in-service pipeline after the ILI inspection (and) determine the time of failure based on the analysis and characteristics of those features. Not all anomalies discovered during an ILI inspection require/need repair. This study will identify remaining anomalies in the pipeline estimate reinspection intervals. The gap, that's decided was a knowledge based gap. Then, like I said, we think a lot of that will be covered in the research from Gap Number 1.

From there, we go into whether or not ASME 31.8S needs updated as well as...Subpart O and incorporation by reference to Subpart (indecipherable) to change some of those intervals and

assessment cycle intervals. We think that's going to be another paper study, potentially 18 to 24 months timeline. ($300,000) to $400,000.

Number 4 is the development of ILI tools for distribution means intended for hydrogen service. The main objective of this is to develop new tools that will be acceptable for that type of service. Like I mentioned earlier, smaller tools that are suitable for distribution lines, crack detection, and any other anomalies that are going to be associated with, again, introducing hydrogen into our pipelines.

The technology is again going to operate in gas service. The roadblock of this development of this tool is technical and the cost. That's going to be associated with it modifying existing tools to operate in these small sizes. The expenses can be very high and it could take a long time for that development. PHMSA has researched and provided funding for the research of many different types of tools that are, for example, unpickable pipelines. ...The costs could exceed up to $5 million and take up to 5 to 10 years to develop, so this would not be an easy gap to address by any means.

Gap 5 is associated with the tools themselves, the sensors, the technology on board as well as the algorithms that are used to review the data...whether or not they're acceptable to properly detect and size. New anomalies or changes to anomalies within our pipelines that are going to be caused by introducing hydrogen, like I mentioned earlier. The introduction of hydrogen could cause morphologies in the internal corrosion (and) change the way...cracks grow. Potentially split open laminations, mid-wall laminations, and planar anomalies...in the pipe wall. And change the way, the tools, it needs to calculate the size and depth of these anomalies as well as...indicating how critical they are. ...How long do we have to repair them one once we do? Find them even if we can't size them accurately? All of that needs addressed, so this is another knowledge and technology improvement gap.

The roadblock is development of these tools, and technology of these advancements could prove to be expensive and cost prohibitive. (The) timeline for this—we think the research upfront as another 18- to 24-month paper. But it's (going to) have to be followed by a much larger, for example, 5-year validation study with field testing to verify and improve all of the testing, all of the testing results. And make sure that we can accurately size these types of anomalies.

...Any additional testing is also going to cost extra money, but we're thinking 2 to 3 million for that, possibly over 5 years. So, Christian.

Sellu, Christian (PHMSA)

Yeah.

Wissmar, Kirk (BHE GT&S)

Desktop study on past/present/near term R&D data that is available is going to be required. Possible academia studies cost ($)150,000 with a 6- to 12- month time duration.

Another gap is Number 2—anomalies and the ability of ILI technology. I'm assuming these are the main two, Christian, you're kind of rolling these up.

Sellu, Christian (PHMSA)

...I just...additional ones we identified.

Wissmar, Kirk (BHE GT&S)

Right.

Sellu, Christian (PHMSA)

It looks like all our issues are probably all related to hydrogen and the impact it has on defects in the pipeline anomalies, so this was just two additional ones that we could probably roll up into the other ones up there.

Wissmar, Kirk (BHE GT&S)

Very good.

Sellu, Christian (PHMSA)

Yeah, I think. Let me just make some comments.

Our SSFC contractor was very helpful (in) guiding us through the voting sessions. He was very (indecipherable). Whether virtual stakeholders from industry lobby block comments to put on about the topic of conversation... We had 40 ideas to start, with which we began, to 29 and with these 5, 7 gaps.

So one of my issues was if an operator does a conversion, so how do we then have to do (it)? He needs to either do all the assessments. What inspections he has to do? So...PHMSA has already funded research only detection as stress corrosion cracking. We (are) just not sure that those studies...included hydrogen in the pipeline. So I have to see.

Barakat, Kandilarya (PHMSA)

Thank you, Kirk and Christian, for the summary findings from Working Group 3.

Will the representative or presenter from Working Group 4 on hydrogen network components please unmute yourself, introduce yourself, and proceed with your presentation summary? Thank you.

Woo, Kevin

Thank you. Hi everyone, good morning. I'm Kevin Woo from SoCal Gas. I'm part of our hydrogen strategy team. So as Kandi mentioned, we are the Working Group Number 4 for hydrogen network components. So first off, I want to give us some thanks. So thanks to Monica from S&K and Vinnie for really driving our working group and getting us through the day.

Very, very engaged lively conversations with the group, so...Vinnie...did quite a bit of talking so (I'm) happy to give him a little bit of a breather this morning. Also, some thanks to our industry presenters going over all of the different research projects that are going on and that are planned related to this topic. And, of course, thanks to our co-leaders Mirela, Tim, and Danielle. Thank

you for your efforts and, of course, thank you to our participants (that) were (in) this working group. Just so much feedback and great conversation was had throughout the whole day, so thank you so much for your participation. We go to the next slide.

Right before I dive into the gaps, I did want to kind of give a little bit of an overview of how things went throughout the day yesterday.

So, hydrogen network components—this is clearly a topic of high interest for everyone across the industry and that really showed with the brainstorming session. We ended up with 105 initial R&D gap ideas, so as you can imagine that was quite a bit for our workgroup. (We) worked through during lunch to try to consolidate the ideas. Apparently 2 hours was not enough. Probably needed a few more hours to try to get through everything to whittle it down more efficiently. But we ended up with...we went down from 105 to 80 gaps.

By the end of the 2 hours, we did spend a little time with the working group to talk through some of that and we would put it down a little bit more down to 70 for the first round of voting. So as I imagined, even 70 was quite a bit for that first round of voting, so we gave some extra time for the first round of voting. So (I) do want to give some special thanks to those who provided some humor through the day, especially during the voting periods with some hydrogen-related jokes. I'm sure that many of us have already passed those jokes along to our colleagues.

So then with the second round of voting...we spent some extra time going through that. I think the second round of voting had about 20 gap ideas for us to go through, and so the second round of voting resulted in what you see on the screen here.

Just real quick, I know we're (going to) go into the details of these, but Gap Number 1, steel weld qualifications and performance, (and) Gap Number 2, necessary modifications to repurpose existing pipeline infrastructure to carry—it says pure hydrogen. But a lot of the thought behind this is to cover both blended natural gas hydrogen and pure hydrogen.

And Number 3, validating existing or new hydrogen leak detection equipment compatible with hydrogen natural gas blends, and Gap Number 4, instrumentation and equipment compatibility related to various types of equipment, and we'll go through those details (on the) next slide.

So actually before I jump into the details of each of these gaps. I do want to preface by saying that the working group did acknowledge that there may be some overlap with existing or planned research work going across (and) going on within the industry. So, to try to cover all of those different existing projects and use that knowledge to whittle down the gap ideas even more probably would have taken another half day to a day to do that. So, (I) just want to mention that (be)cause as we're going through these gap details, if you recognize something that you know that already has a project going on, you know, we do acknowledge that there is the potential for that.

But things will be going...working through that process as they finalize everything. So with that...Gap Number 1 (is) steel weld qualification (and) performance. So this is a big topic for everyone. You know in this industry...there are steel weld piping systems You know welding occurs every day. You know, within our operations. So there's a major impact and need to

understand how those procedures can be safely done in the presence of hydrogen in our gas. And there's two aspects of this...the development of pipeline—new pipeline assets and pipeline systems. ...Some of those can be addressed with future regulations and standards but there is some concern about the existing assets that we have in the existing standards, so for one of the first things that comes to mind is API 1104. So you know for that to be addressed with hydrogen (was) specifically something that the working group was looking at as a priority.

So, the next slide.

OK, so, so necessary modifications to repurpose existing pipeline infrastructure to carry hydrogen...this is something that you know as an industry and as pipeline operators. This is really how we're looking to leverage our existing infrastructure for decarbonizing. There are systems, but we know that it's not it's just a one to one like transition from...natural gas pipelines to introducing hydrogen—whether that's blended or pure hydrogen. So, understanding what the modifications that are needed, if any at all, which at this point...we know that there are certain things that need to be done to our existing pipeline systems in order to accommodate...specific levels of hydrogen.

So looking to understand those specific modifications needed, and...there's some examples there, how we deal with...certain anomalies or gas around the pipeline and, of course, the different types of materials: metallic and nonmetallic. Distribution transmission, some of those, especially the steel materials, exist across all of our different pipeline infrastructure. And then there was the actually the thought about some of the hazardous liquid pipelines that may potentially be converted for hydrogen service in the future. So just working through those details and granularity, it is important for our industry in order to accommodate hydrogen.

Next slide.

So, validating existing hygiene limit detection equipment compatible with hydrogen natural gas plans. So, this is probably one of the biggest topics that we saw brought up when we had this conversation about hydrogen and hydrogen blending in the natural gas infrastructure. So we do recognize that...there's been some work that's underway to look at leak detection equipment and...how the existing tools and technologies that we have are impacted by the presence of hydrogen. And then are there the tools being developed for the future that we know will be reliable for operations in the future once hydrogen is introduced.

So definitely safety is the is the primary driver for (these tools) we use. These types of devices not only on our pipeline systems but...even with the...downstream of the meter. You know, customer house lines and their equipment, so this does have...far reaching implications and this is something that's important for our industry to be looking at.

Next slide.

So, Gap 4—instrumentation and equipment compatibility. So, there's a little bit of overlap with the previous one. But with this particular idea, we were looking at it in more of a broader range of instrumentation equipment. So...things like our measurement equipment, gas chromatographs, any type of a pressure measurement device—all those types of things, we're there, they're

established for our natural gas systems. But how do they? How did they act within the presence of hydrogen in the gas stream? So it's the accuracy issue. ..Reliability and then the material impacts of those different types of technologies that devices that we're looking to be addressed. So definitely a safety implication with this, but there's also the compliance side of things, too. A lot of these two different types of devices are used for compliance with the various federal and state regulations.

Next slide.

So as I mentioned earlier...we started off with 105 gaps. Only a handful of— sorry—just a very few were out of scope. So really the vast majority of those, 105 initial ideas were really great and they're...very relevant to this topic. So...when we saw the voting you can tell...it was quite split across the board. ...Obviously a lot of them are considered priorities for our industry.

So to only have those top four—obviously it's not (going to) cover everything that that we're looking to have studied so we did provide a—I think there's this slide in the next slide—11 additional gaps. So, I won't go through the all the details (of) every single one of them but if you go back to the previous slide...just to kind of give...more of an overview of the different types of things that that we're looking at. So there's definitely more of the material impact. So it will get number 8, there. I know Chris mentioned that and Group Number 1 about...legacy cast iron pipeline, so that obviously has an impact for...many different utilities and in the country still, so understanding that is obviously a priority.

So, there's other items that you know were brought up that that did receive some votes so like Number 3—study that evaluates Part 192 regulations for hydrogen natural gas and that's...kind of important for our industry because...having the standards and regulations in place to specifically address hydrogen are for us as operators. Having the confidence that...once you are ready to introduce hydrogen share systems that we are meeting the regulations. ...So if that's something that can be addressed through this research effort, (it) would be very helpful.

And...in Number 1 there...what level of blending of hydrogen (is) safe under what circumstances. I think that really is the million-dollar question for all of us, so I don't know if there's a way to put that within a specific scope to help address that...that would be definitely (be) a great research gap for us to fill.

Next slide.

And I would just highlight...Number 11, there are...system studies (of) hydrogen blending so...we know that there's a lot of different pilot and demonstration project(s) going on around the world. Definitely more are being planned here stateside, so as we can start to build that database and knowledge and from the findings of those different projects to have that kind of compiled into a single document or repository somewhere that we can all access (it) would be very helpful for our industry.

It's like...I believe a bunch of our working group is available today for Q&A. So (I) look forward to that discussion. Thank you very much.

Barakat, Kandilarya (PHMSA)

Thank you, Kevin, for the summary and findings from Working Group 4. Will the representative and presenter for Working Group 5 on methane mitigation—construction and operations—please unmute, introduce yourself, and please proceed with your presentation summary. Thank you.

Smith, Robert (PHMSA)

Thanks, Kandi, that's (going to) be me...spokesperson for Workgroup 5, so let me talk a little bit about the work group in general and I'll go off camera and go through the slides. So as a reminder, we were looking at...leak detection and methane emissions reduction opportunities solutions in a wide sense...all pipeline types and trying to understand...what's been done, then learn...where we can go. We also were addressing CO_2 pipelines and so it kind of potentially gave us some challenges about getting through the wealth of material. But let me first start. Steve Nanney was our PHMSA co-leader, and we had Zach representing gas transmission pipelines, Adam representing gas distribution, and Nick from Exxon Mobil was really our representative talking about CO_2 systems and we had a really good debate. The presenters of course, (I) thank all the presenters for the working groups, including PRCI, OTD, and RPE. I think they set the stage very well with the audience.

We had a very good debate; we came up with 67 gap ideas for methane and about 27 for CO_2 and of course, like you've been hearing, you know that we worked to review those, consolidate combine, refine, into the list I will go through here in a minute, so let me go ahead and go off camera.

So we have five gaps listed here for methane, one for CO_2. ...Just like (the) other groups, we could have benefited from a little bit more time to kind of digest that. A great list to work the audience to kind of get those nuances out and to kind of further refine the topic ideas. But the first one—technology to detect, accurately locate, and quantify methane emissions in diverse operating environments. (It's) very important to kind of combine the idea of both detection and quantification. We kind of came up with some themes/areas to look at...gap ideas and we later on decided that...these things can't be done in a vacuum. They need to work together.

In situ repair and rehabilitation technologies for pipes and components. I'll get into that one. And when it comes to some overlap issues. Recompression of compressor station operations and capture and or incinerate fugitive methane emissions. Pipeline industry best practices or recommended practices and prioritization for methane mitigation in transmission, distribution, and gathering once again. We were trying to look at...all pipeline types. How some of these impacts were possibly shown and of course, the one that we did get—CO_2—because we wanted to include at least one roadmap topic looking at really kind of a very comprehensive project in materials, but developing codes and standards, including...significant mineral material testing and qualification. Both looking at new systems (and) new construction.

Byrnes, Corinne D.

It's not something...right it's not a type of (indecipherable).

Smith, Robert (PHMSA)

As well as existing systems when before potential CO_2 service.

...The first gap...this was something that we really want to ensure that there is a range of technologies that can effectively detect locate and measure methane emissions. This is something that's kind of wide open, where we want to look at this from...outside the pipe above underground...and all kind of operating environments—urban, suburban, rural—and really deployed from any type of...platform: handheld drones, mobile, aerial, even satellite. So ultimately this would be something that would be (a) wide open topic. We clearly have to move beyond the current locating capabilities and differentiate, of course. I think we now (have) to differentiate between natural and human source thresholds for quantification. Now I also need to progress beyond the state of the art, so we'll be looking for...people who propose on this to...know where we're at with these states of the arts and then illustrate how and how much quantification beyond that can be done in the research project.

For all of these methane ones, we think...there's lots of relevance and...drivers that will further investigate and (indecipherable) into the topic from our rulemaking, from the NTSB, and of course, the executive order that really spawned the idea for the workgroup. And honestly...getting these things out...we have to have full validation on their real and varying conditions for anything that's developed for really kind of having some momentum for a relative or regulatory acceptance of these validated methods. We see 12 to 18 months for potential technology and...this could be something that ranges up to $2 million. ...Once you get out in the field to do these validations, it really shoots up the cost very quickly.

Second, in situ repair. This is the one that we clearly recognize the relevance to Workgroup 1. ...The RPE repair initiative and really what the goal here of...we want to prevent the blowing down and purging. So...development, validate effective solutions to do this in situ. So you don't have to purge the pipe, blow down the pipe, and therefore not have all those other challenges with the emissions. Once again, we're looking at solutions for either inside or outside the pipe. That's kind of very similar to the last topic in that regard...we want improvement and really that that validation is what we're looking for here is the optimized in situ repair rehabilitation process.

We didn't necessarily find any best practices that were relevant in this case. Same idea here...we had to have full validation on multiple diameter types. The other variant conditions and the operations that need to be factored—12 to 18 months (for) this one. It's not the same, like the first one, up to about $2 million could range.

Recompression and compression station operations. We really wanted to look at developing new solutions that decreased the time to achieve that action. ...It takes a long time with some of the current state of the art to blowdown. These systems capture fugitive methane so we also in this topic want to look at potentially...how that captured methane can be reused back into the system after being captured. We're talking about compressor stations and in general...emergency shutdown, the relief valves, liquid storage tanks, etc., and...we're really looking at producing data here that must have a certain threshold of detection that...could be recognized. So, we need

to be able to measure that benefit from the collection and any new improved technologies that can capture and optimize the capture prevention process and we're, like I said, seeking the ability to quantify and or monitor the amount of missions that we're capturing.

Once again, (it's) still relevant to the same things that we did then that the subpart within EPA. So for any of these research topics...we'd be doing our homework in our own research to investigate. All these drivers and other relevant issues here to build these topics to be very comprehensive—9 to 12 months and up to about $750,000.

So this was our only general knowledge topic for methane. (Now) to look at the pipeline industry best practices or recommended practices for prioritization of methane mitigation activities, and both all pipeline types and really from the idea here from construction commissioning maintenance purging and packing. Activities we identified and AGA recommended practice on purging principles and practice that could be expanded to include the type of guidelines or protocols that could be developed here to minimize submissions and then you know the whole prioritization considerations that that could help avoid emissions in the first place.

To see the timeline listed there and come up to ($)600,000 (indecipherable) to highly engage with the industry operators and of course, the AGA, if we're looking at augmenting that recommended practice.

So our fifth one, though, that was the one that we are addressing for CO_2 pipelines. This would be a significant project to look at: the material assessments in qualification for pipe and welds—including fracture toughness, resting fractures, product quality—we would be also trying to look at odorization for detection, operational integrity, and the idea here of how we can mitigate for blowdowns and bending. So...we tried to combine a lot of suggested gap ideas into this. We didn't have the time to do that.

The major review of the submitted the gaps for CO_2. When it came to how we would combine some/consolidate some...we tried to kind of pull together something that we could first include here. And I'll show you the rest here in a second, but this is something where...we do have some areas of the code and maybe some standards. Well, we...have standards that we want to build upon and fill those gaps, so this would definitely be a study that would have extensive metallurgical destructive testing to try to build a type of data set so (that) we can make those understandings about fracture toughness and propagating fractures in these systems. Twelve to 18 months for a project and...clearly up to $1 million, if not more, based on the series of...destructive metallurgical testing that would need to be done.

The next one that we couldn't get to on the methane side was one that we did note that academia might want to take a look at, and we'll investigate possibly through our CAAP program in the future, but comparisons of compatible practices. So, this is something where it's a great idea to kind of get out there, work with the vendor community, understand (the) pros and cons and capabilities that we have out there, so we thought that was a great opportunity.

Couple more there listed for methane and then on CO_2.

So where we weren't looking at (was) the metallurgical requirements. Here...understanding emissions could (see) the same things...for methane emissions quantification. Then...looking at the construction requirements, kind of bringing these systems online so they can be built safely, of course, and not having the type of leak prone situations that we might see in other systems.

And then once I get back on the technology for detection and quantification. Then we had odorant on that list, but we did kind of bring it up so we don't know if we'll keep odorant in that or make it a separate project, but clearly...we don't have any research now and CO_2 systems that we funded yet to date, and this is clearly an opportunity to kind of build a strong portfolio for CO_2 systems.

That's all we had so I'll go ahead and stop sharing. And bring up the final one.

Barakat, Kandilarya (PHMSA)

Thank you, Bob, for the summary and findings for Working Group 5. Now (we) will move to Working Group 6. Will the representative and presenter on breakout tanks—methods to prevent corrosion of tank bottoms—please unmute yourself and proceed with your presentation summary. Thank you.

Obeidi, Zaid (PHMSA)

Good morning, everyone. I just wanted to let you know this is...the last group, but not the least of which is...Working Group Number 6...breakout tanks—methods to prevent corrosion of tank bottoms. They wanted first to thank everyone on the hard work...that was done yesterday and on all the gaps provided, and specifically the co-leaders with me along with the S&K contractor that helped us, Jenni Roach. So, my name is Zaid Obiedi, general engineer with the Office of Pipeline Safety. ...Chris Aldrich, Integrity Management Programs coordinator, Marathon Pipeline; Justin Samuel, engineer, Integrity Tech Services, Phillips 66; and John Field, corrosion engineer, Energy Transfer Partners. If possible...introduce yourself as well.

Aldrich, Christopher J.

Yeah, I can go ahead and again, my name is Chris Aldrich. I'm the integrity management program coordinator for Marathon Pipeline. And (I would) just like to thank you for your leadership here (and) say you did a great job and...the participants as well really helped to lead us to find the gaps you're going to go through so I'll pass this over to Justin.

Samuel, Justin M

My name is Justin Samuel. I work as...an engineer for Philips 66 and I'm just happy to be a part of Workgroup 6 and just appreciate all those that presented and all those (who) participated.

Field III, John G

My name is John Field, corrosion engineer from Energy Transfer, and (I) just want to thank Zaid for his leadership and a great, great group of people we had in Group 6. A lot of interaction. We went fairly late into the night going, over or our gaps, but I learned a lot and I think it was a very positive experience, so thank you.

Obeidi, Zaid (PHMSA)

Thank you, Chris, Justin, and John and, yes, I will re-emphasize that the working group was smaller, I think, than another working group as far as participants. But there were a lot of good discussions that were very educational for me personally and a lot of expertise and knowledge that were discussed in that group, so I'm thanking specifically all the participants were there (for) the hard work and good work yesterday.

And from the identified gaps, as you might know, that...significant work that has been done on corrosion for the pipeline side but nothing has...happened on the tank bottoms. And in particular, that was a new idea to build a portfolio research for possibly...prevention for corrosion tank bottom gaps. So we came up with about, in the beginning, about like 11 gaps into different aspects and then they...ended up being four gaps as you can see in front of you, which is the main gaps that we got the votes on.

One was the corrosion control tanks, which is basically a new or technology development on the monitoring side, and obviously the breaker tanks. And (the) second one was standardizing the vapor corrosion inhibitors. VCI is also a technology development, and the third one—that's kind of...overlapping the second one, which is the VCI compatibility, but it's kind of more into a detail information of many things. On the VCI is that the chemicals that's been used in (the) United States or all over the world and in different environments for the tank itself—the injection point, the equipment that's been used, and other aspects of this—so that compatibility goes into details of all of that. And then, also we discussed the tank foundation.

And sorry, the pads, and I'll be using there's that what type of pad that's been using there is...concrete asphalt? Is there others, and the design of that thing, which is mainly general knowledge gap.

Next slide, please.

So as you can see...we filled it up with a lot of details. I try to even summarize it less, but the group were so interested in putting more and more information and I'm thankful for that. The corrosion control tags, which is the monitoring as we see, the main objective is conducive to multiple technologies, so that include(s) VCI and include(s) other possible technologies...one (of) which is the cathodic protection (CP) system to monitor the tank bottom corrosion conditions.

...And we answer(ed) the questions by...in what operating environment, mostly technology operate, and it's obviously under the primary tank bottom, which is monitoring, excuse me, will be placed within the electrolyte, which is the sand, concrete, or others to monitor the tank bottom could be also between the bottom or within the electrolyte and under (the) original floor.

...Just like the functionality or performance requirements. It's direct corrosion. Direct corrosion growth rate. Mils will be a good indication for functionality for that, which is the mils per year obtained from the monitoring or indirectly, for example. Here, the CP or VCI concentration levels for the tank...at bottom and then the question is...able to incorporate the CP and how the CP influences corrosion rate in that case?

Does the gap addresses any...regulatory, congressional, or NTSB drivers? Yes, based on (the) current Consolidated Appropriation Act, which is in 2021 and in...future...congressional report(s).

And a gap also addresses related consensus standards or best practices and the answer is also here yes. API Technical Report 655 on the VCI and API RP 2610 on the upcoming AMPP PSP 21474 on the external corrosion control of carbon steel on aboveground storage tank (AST) bottom addresses monitoring in any detail and also mention(s) the cathodic protection documents, which is API Recommended Practice 651, then...SP 0193 on the aboveground steel tanks.

...Technical or regulatory roadblocks or barriers to prevent the technology from deployment, their (technology) is the VCI chemistry as mentioned, proprietary. How do you confirm we have got (inadequate) concentration under the tank when we don't know how long it takes for the VCI application to disperse that...to reach all or part of the tank bottom...through the sand pad or if it's dispersed effectively? So, which is a performance and effectiveness (of) VCI. In that case are we just creating caverns through the sand pad under the tank?

So, these are questions that will be asked (about) regulatory roadblock. We need the regulators to approve (an) alternative to the failing CP systems based on industry verification and validation of the research data. So eventually it will be looked at and incorporated by reference with them or code.

What are the anticipated targets or time frame to complete this research? That's, as all the groups are agreeing on, there should be a short term because it's needed, so it is within the 2 years. The funding level for that is anticipated between $300,000 (and) $500,000 and it's a ballpark for that.

Next slide.

So there, the details for Gap Number 2, which is standardizing vapor corrosion inhibitors, you can see that the answers here are kind of similar to that, but it's like...we're trying to broadly understand how to develop their standardized methods to...qualify VCI for the tank bottom application and receive the industry first, then thumbs up approval of that.

New standards are recommended practice. And same thing, not going to go through the whole thing. It's just...under primary tank bottom between the bottom or within the electrolyte and their original floor. The functionality here could be a little bit different because it's either direct corrosion growth rate, which is what we mentioned earlier, on which is MPI, or per the API 653 on the maintenance of the aboveground storage tanks obtained from monitoring or indirectly. So that's including the cathodic protection CP or VCI as an example, concentration levels.

And again, the same thing...(does) that gap address any regulatory congressional or NTSB drivers? Yes, based on the congressional or the Consolidated Appropriation Act of 2021. The gap addresses related consensus standards or best practices again. It applies here, as similar to the previous gap. The API Technical Paper 655 (or) the API 2610 (or) AMPP, the document on external corrosion.

Technical roadblocks similar to that one. We...need (regulation) to approve (an) alternative to the failing CP system based on industry verification, but run validation or on the research data and experiments and possibly the industry request for the, for a special permit and state waivers for the VCI application with applicable engineer critical assessment and all the conditions that that needed to be approved.

What are the anticipated targets? That's also emphasized that it's short term (and) not a long term so standard (is) needed soon. And that's how I would say it isn't...gathering information, so (it) should be within the ($200,000 to $250,000) anticipated...not really more than that.

And then Gap Number 3, which is as mentioned earlier. It's kind of overlapping on the Gap Number 2, which is the vapor corrosion inhibitors compatibility. (It) involves a lot of things from injection point, to the equipment used, to qualifying operators, or qualifying the people...that perform such tasks and more...evaluating long term.

Main question or objective is evaluate the long term interaction between the VCI and the cathodic protection system and associated components within the tank. And the same thing—it's on...under primary tank bottom between the bottom or within the electrolyte...but for the double bottom supposedly or others, and under original floor. The functionality here is a little bit different because it's the first one, is the same thing, either direct corrosion growth, which is the MPY as mentioned earlier, but there is actually the polarization criteria here because we're talking about the compatibility part and the VCI chemical stability (with) operating CP. As far as the chemistry itself, the anode performance was mentioned. And electrolyte compatibility with VCI and more actually where we're coming on board on this.

And the same thing for C&D. It's the same sequence of yes, it's based on (the) Consolidated Corporation Act of 2021. No, and also the same, does the gap addresses related consensus standards or best practices? That's applied on all the previous gaps and this one as well, technical regulatory roadblocks or barriers mentioned earlier and anticipated targets short term as well between one to 22 years. There isn't an experimental fact here and that might require more funding, so would be (S$300,000 to $500,000) kind of the ballpark of this.

Next, please.

...Gap Number 4, which is there, what we discussed, then we got some votes on it or was actually the one of the ones that got a lot of vote(s) as well, which is the tank foundations (and) (the) pads that's been used on the tank. Which is evaluating various foundation and pad designs for corrosion control. This is what we thought...will be on the bucket of general knowledge. It is already unavailable information, but needed to be collected and used for all entities because the gap addresses any regulatory congressional NTSB drivers. Yes, as mentioned earlier on there on the Consolidated Appropriation Act of 2021 and (the) gap addresses related concerns standards, same thing here.

Adding to that other than API 655 and 2610, adding 651. As the cathodic protection documents and then SP0193 for the on grade ASTs or aboveground storage tanks. And API Recommended Practice 653, which is incorporated by reference.

What technical details or scope items are necessary and recommended? Here is that...specific design(s) for tank(s) sitting on various pad type(s)...could be concrete, asphalt, or different types. Application.../design of leak detection barriers, which is high density polyethylene (HDPE) or claymax, which is a different type of rolling liner. ...Release prevention barriers, which is it—the straight one or is it the berm or the one that basically kind of has an edge...and dike liners. And the concern of the tank sealing is that chime (is) being sealed or that shell or they call it dead shell seal. And cone up/cone down drainage. The leak detection methods (are) also (a) concern here.

The anticipated targets for or time frame to complete this research is also anticipated to be short term because information is available and needed to be gathered and distributed for all entities interested.

Funding level estimated to (be) between ($100,000 to $200,000). We were just reluctant if it's 100 or more so we just gave up this 100 to 200,000.

And additional identified gaps that we thought that it's to provide more information was the corrosion control tank design and that kind of fell into different aspects from...tank designer concrete pads and all facets. So we thought that it's kind of repeated in too many of their previous gaps so we didn't provide much information on it.

...I think that's about it, so thank you all for listening and (I) will (answer) any question(s) later on. Thank you so much.

Barakat, Kandilarya (PHMSA)

Thank you, Zaid, for the summary and findings for Working Group 6. Now let's move to the Q&A session for this panel.

Obeidi, Zaid (PHMSA)

Thank you.

Barakat, Kandilarya (PHMSA)

Nathan, I believe we already have questions and the conversation feature, so I'll turn it to you.

Schoenkin, Nathan (PHMSA)

Yes. Alright, great thank you so much. And this is a reminder if you have any additional questions, please put them in the chat box and I will raise them to the appropriate panel member.

The first question here is, "Have you engaged the Solution Mining Research Institute, whose expertise is constructing and maintaining large deep salt caverns capable of storing high pressure (gases)?" I will (indecipherable) that James or Hilary, feel free to go first.

Pfeifle, James (PHMSA)

I'll start. Since we found that there are currently caverns being used in the Texas/Louisiana area for storage of, I believe, blends of hydrogen/natural gas that will be our first stop and then once

we glean the information from those operators, then we would probably meet with the members of SRMI that are in that area and talk to them.

Schoenkin, Nathan (PHMSA)

Thanks, James. Hilary, did you (want to) add to that or?

Petrizzo, Hilary E

Yeah...just a quick clarification. I think it's more pure hydrogen that's being stored in salt caverns and so that's one thing that came up in the presentation yesterday is salt caverns is unknown. So, it's really how can we advance things like aquifers and depleted reservoirs but (I) agree as far as what kind of materials they use. It came up what kind of...materials do these operators already use. We can absolutely learn from them.

Schoenkin, Nathan (PHMSA)

Alright, thank you. The next question here in relation to what's the next step. For these topics, that will be most likely addressing the third and final closeout remarks for today. So, I'm going to leave that for then.

...One second, there's one more question here. VCI. How much (of) the existing information on VCI research or field work are you incorporating in your proposed research? Zaid. I think this is for your group.

Obeidi, Zaid (PHMSA)

Yeah, so sorry, Nathan. Could you repeat? I was up a little bit.

Schoenkin, Nathan (PHMSA)

Sure. How much of the research information on VCI research or field work are you incorporating in your proposed research?

Obeidi, Zaid (PHMSA)

Well, this is the idea of...having...all the group. We presented and we had also many people that actually provided information on the phases of VCI. Along with that was PRCI findings on all phases of VCI compatibility and performance and so on, and so forth. And along with that, the experimental part that that operators have been providing. So, we will be incorporating all that information within these gaps so and that's that would be my answer, I guess, to their question. Chris or Justin, then if you have any additions, please unmute and add.

Samuel, Justin M

No, Zaid, and I agree with you. On that as far as...we know, what PRC is presently doing with Phase 2 and Phase 1/Phase 2, the efforts there, so we obviously want to dovetail off of that and...if the operators are willing to and can provide some information on...what they're doing as well, that would be helpful. But (the) current plan is to obviously incorporate research that has been already done, or that is ongoing.

Aldrich, Christopher J.

And I would agree, we talked extensively about the work that PRCI has completed in Phase 1 and in Phase 2 and how to work off the work they've already done to expand what we're moving forward on VCI.

Schoenkin, Nathan (PHMSA)

Alright, thank you. We have one more question for the same group, so don't go anywhere. How far is the research willing to go? Are you trying to start with a different monitoring system?

And if you don't know the answer to that that is fine. You can feel free to say it's an unknown.

Obeidi, Zaid (PHMSA)

Yeah, I mean, it's the research as mentioned earlier, this is a new... The technology has been. there for a long time, but now we're trying to get the industry operators and all the associations plus the regulators to find out all these questions. So what I mentioned on the three first gaps will be the answer for that. But I mean, there's no solid answers here on exactly what it is will be within the monitoring gaps that will be solicited eventually, so I guess we'll wait on this.

Schoenkin, Nathan (PHMSA)

OK.

Obeidi, Zaid (PHMSA)

Thanks.

Schoenkin, Nathan (PHMSA)

Alright. I'm pivoting a bit to hydrogen. Question: Hydrogen impacts on welds—did the group consider the topic of impact of hydrogen on vintage girth weld(s) specifically? I know weld(s) was a topic.

Holohan, Vincent (PHMSA)

Hey Nathan, I can take that one. This is Vinnie Holohan. I was working with that working group with Kevin and others. Yes, out of the 105 topics that were submitted, welding came up in at least 5 or 6 of them. Going from vintage to new pipeline design, and so (indecipherable) all of the vintage, essentially, and we decided to kind of umbrella them into one topic. But definitely, vintage is one of the bigger concerns, of course.

Schoenkin, Nathan (PHMSA)

(O)K, thanks...and Brian, if you have a question to ask...please pose it in the in the chat box.

Let's see, (a) hand is up over there. OK. Next question.

And...back to Zaid and his group. VCI, talking of concentrations, are you also considering what timeline would it really take to refill a VCI system?

And Zaid, you're muted.

Obeidi, Zaid (PHMSA)

Sorry. So again, it's almost the same answers as we discussed all of these concepts and ideas of the concentration in the timeline and all that, so we try and within the assets that we have is trying to consider all of that, so the concentration part or the timeline...will be kind of discussed in further details once it is approached into that gap, so that I can provide unless... Chris. Have anything or just...to add?

Aldrich, Christopher J.

No, Zaid, I would agree with you. I think that that's right on point and also I believe there was another question regarding heated tanks or elevated temperatures and that's something we did discuss as well. So, our group went into that in detail and I think that was part of our research...

Schoenkin, Nathan (PHMSA)

Yes.

Aldrich, Christopher J.

...Proposal as well as to look at not only ambient but elevated temperatures as well.

Schoenkin, Nathan (PHMSA)

Alright, thank you.

The next question/comment here from Mr. Paulson. I would recommend you keep that question for the public comment period we have coming up shortly. OK.

Workgroup Number 5, in situ repair and rehabilitation—was the vision for leaking pipes and components or is this for mitigating an integrity threat? Bob.

Smith, Robert (PHMSA)

I'll give an opportunity for the rest of the leaders to step up. Steve, any comment on that?

Nanney, Steve (PHMSA)

How, well it would be for, it would be for both?

Did you hear me?

Schoenkin, Nathan (PHMSA)

Yes, yes, thank you. Anybody else want to comment on that or we can move on. ...OK. Alright.

From George here, as the next question in Working Group 1. It is clear that PHMSA is interested in pursuing lining of cast iron in lieu of point repair due to the issues associated with ground movements and resultant cast iron failures. In the interim, will there be an expected increase in usage of liners as part of the special program designated for socially vulnerable communities?

Chris, would you like to take a...

McLaren, Chris (PHMSA)

Yes, thank you, Nathan. Thanks for the question, George. I think that a couple of things to talk about there. One is in in my presentation and is publicly available in terms of data. We saw the use of liners to recondition cast iron has been increasing, certainly since we started collecting the data in 2015. You can see that upward trend. These are shorter segments, so the line mileage, it does not increase vastly, like you would see in other projects, very quickly, and it's not necessarily a part of our initiative. But we do hope that that those cast iron segments that are larger in diameter and less prone to bending mo(ve)ment in fracture and ground movement areas would be lined and then the course that was part of the determinations that operators make that this is the right place to do that. And this is a main that needs to be retained in service and they typically are in socially vulnerable communities. At this time, I'm not aware of any additional programs we have to specifically fund that through this program. Then, the infrastructure bill. There is the...I have not reviewed the that the act recently but there is the original act that was drafted talked about having money for municipal operators to draw from in a grants program that I know I'll be part of it, too.

...Rehabilitate vintage and leak-prone pipe, specifically that would be cast iron and certainly the bare steel. What was interesting in our group was the discussion that while the GTR gas distribution report has a place to talk about recondition(ed) cast iron, it doesn't have one for reconditioned bare steel or reconditioned steel, is probably what we would call it that is a need going forward because that is a significant area for lining and reconditioning. And then as we move forward, we talked about our structural liners and/or structural pipes and possibly even having to move into a data acquisition or understanding that there are what we might call composite pipes out there that have been inserted and/or put into use.

I hope that answers the question.

Schoenkin, Nathan (PHMSA)

Thanks, Chris, and I will actually turn this...over to Sentho and Massoud if they'd like to make any further comment on exactly what may or may not be part of that past infrastructure bill.

White, Sentho (PHMSA)

I will defer that over to our leadership. Massoud?

Tahamtani, Massoud (PHMSA)

I'm sorry, Nathan, I was multitasking. I apologize.

Schoenkin, Nathan (PHMSA)

No, no worries.

Tahamtani, Massoud (PHMSA)

Uh, could you repeat the question?

Schoenkin, Nathan (PHMSA)

Yeah, go ahead.

Sure, specifically the part that we would be asking you about is, will there be an expected increase in usage of liners as part of PHMSA's special program for socially vulnerable communities? As in, could we actually use that 200–1,000,000 this year for liners or is that for replacement?

Tahamtani, Massoud (PHMSA)

So, the language of the law is pretty clear about pipeline...replacement or repair and purchase of equipment. To basically reduce injury and fatality and reduce any economic loss. Now a lot of attorneys are looking at all that language to figure out exactly what it means. That also provides a number of conditions that the applicants have to comply with before we would grant any of that money. And again, this is at the very beginning of the process. We are to issue a notice of funding opportunity within 180 days. So that act (is) becoming law.

Oh, you were in that period of time, and then within 270 days we are to issue the grants. I hope that answers some of the questions.

Schoenkin, Nathan (PHMSA)

Alright, thanks. (I) appreciate that answer. OK, next question here from Erin Murphy; question for Workgroup 1. So, Chris, you can come back here.

The decision tool for replacement/rehabilitation seems like a valuable idea. Could that tool also consider pipe retirement as an option? This could be implicit in rehabilitation as an option, but it might be preferable to extend the life of an existing pipe instead of undertaking expensive replacement if gas demand is expected to decline. Multiple gas utilities around the country are starting to identify opportunities to retire leak-prone pipe or building electrification, displac(ing) the need for the replacement.

McLaren, Chris (PHMSA)

Thank you, Nathan, for turning that over and thank you, Erin, for asking the question. Certainly, replacement is a an option that is many times preferred by PHMSA for vintage leak-prone pipe. We've supported that option in in our rulemakings, certainly on the transmission side and what was...one part of the...rule and certainly as part of the discussions we had in (our) workgroup. One...the operators talk about we're only going to be talking about rehabilitation of these diameters and greater and/or smaller diameters, depending on specific scenarios with the...but with cast iron, because of its reduced beam strength due to bending or flexure, it (is) typically less than 16/12 inches, and less is looked for replacement and I think that that would be a part of that decision matrix in terms of electric. You go ahead.

Schoenkin, Nathan (PHMSA)

I'm...Chris, the question was also around retirement, not just replacement.

McLaren, Chris (PHMSA)

Well, within retirement...PHMSA still does not recognize idle pipeline as a status as either active or inactive and so, if we're talking about retirement, we talk about abandoned or inactive pipe. There is the new movement to talk about idled pipe. But I don't know that that has much to do with distribution.

Schoenkin, Nathan (PHMSA)

OK, alright. And anybody else from Group 1 or I can move on?

And Brian, did you have a question that we'd like to ask her(e)? Or, if you don't mind, can you put your hand down?

OK, moving on up. Will the CO_2 pipeline research include standard developments for flanges and valves? That would be...

Smith, Robert (PHMSA)

Nathan, I think I'll take—I'll jump into that one. We're going to build this as large...portfolios. We can...this is an area that we have not done any research, and I believe...we would be starting with some of the things that you've seen there and bringing it to that stage and then looking at as much (as) can be encompassed in a particular project. Sometimes when you make a topic too large, it makes it difficult to kind of get through that preaward process and sometimes you have to split things up and look at it.

Schoenkin, Nathan (PHMSA)

Yep.

Smith, Robert (PHMSA)

So, we'll be investigating kind of how we build upon the topics that you saw we noted there in Workgroup 5.

Schoenkin, Nathan (PHMSA)

Alright, thank you, Bob. Alright, now I'm going to open it up again for a short moment. Does anybody else have a question they'd like to ask our workgroup leaders?

OK, I see nothing in the chat. Kandi...

Barakat, Kandilarya (PHMSA)

Great, thank you, Nathan and thanks for all of the questions and answers. And I'd like to thank all the presenters who provided their report-out today from the six working groups as well as those who participated in the sessions to help develop the gaps and provide a road map for PHMSA's upcoming research agenda. Great achievement and accomplishment to everyone on their efforts, so a big thank you to everyone.

Bob, back to you.

Smith, Robert (PHMSA)

Great, well, thanks for that, Kandi. Our next agenda item will be (a) period of public comments, kind of following on from what we've already been...doing in the in the Q&A here. So, I'm going to transition over to Nathan Schoenkin...program manager in our research program but really someone (we) rely on heavily to kind of be lead in our programs with competitive academic research with the universities and our participation in the Department 's Small Business Innovative Research program. So, Nathan, over to you...give us some direction and how we're going to handle this.

Schoenkin, Nathan (PHMSA)

Alright, thank you, Bob. We will now commence the public comment period. Please note this will be a bit different from a Q&A session. We don't have the ability to answer the questions here due to time limitations. The comments should be in scope for this meeting and relate to PHMSA's future R&D agenda.

This will not be an opportunity for you to provide comments that you wish to be considered as part of the record .To ensure an orderly discussion, I request that individuals with a question please write the...comment in the chat box as well as your organization's name.

Please keep your comments, if verbally provided, to under 2 minutes so that we can allow for all attendees an opportunity to provide a comment with the time allotted. So, I will now open up the floor and if somebody would like to provide a public comment, please enter it here.

OK, I'll give it another 30 seconds. If not, well....

And, please note we also have a public docket in case you don't have a question to ask today but you'd like to ask it in the...(propose) the comment in the future.

Björn Paulsson

Yeah, Nathan you suggested that provid(ing) the seismic imaging and monitoring after public comment. Is that the time I should do that?

Schoenkin, Nathan (PHMSA)

Yes, yes, you can.

Björn Paulsson

Thank you.

Schoenkin, Nathan (PHMSA)

And you can raise it here if you'd like?

Björn Paulsson

This is in the comment box, is that right?

Schoenkin, Nathan (PHMSA)

Ah, well, you could speak it verbally here.

Björn Paulsson

OK, so there, I notice that's very little on remote monitoring, which is used extensively in the oil and gas industry. Both from mapping and monitoring examples include seismic imaging and microseismic monitoring and I wonder—where do these technologies fit into this program? Obviously, this relates to underground storage of gas and, in the future, hydrogen?

Schoenkin, Nathan (PHMSA)

Alright, thank you, and we will again take that down and consider in the development (of) our agenda.

I have a question here about how long is the docket opened to file comments. I'm actually not sure about the answer to that, Bob, or do you have a thought of how long that may be?

Smith, Robert (PHMSA)

No, I don't think I have enough knowledge on the longevity. Sentho, Massoud, (do) we know how long these notices (are) open?

White, Sentho (PHMSA)

I do not know the answer to that question.

Tahamtani, Massoud (PHMSA)

We can...we can find out and post an answer today to the target.

Schoenkin, Nathan (PHMSA)

Yes, alright, thanks, Massoud.

OK, and the only other question I see here right now, which I will take as a question—Are these presentations are going to be able to the public? Yes, they will.

So, I don't see any other comments coming back. So, I'll give it a few more seconds. If not, I will thank everybody for their comments here.

Please note comments are critical to PHMSA 's ability to develop a well-rounded research agenda and, if you have a comment, again, that come(s) in...that comes up in the future, please post it to the docket again, assuming that it is available.

And actually, it seems like we have a hand raised. Kevin.

Ritz, Kevin L:(BGE)

Yes. Let me

Schoenkin, Nathan (PHMSA)

Yes. Did you have a comment? You had your hand raised.

Ritz, Kevin L:(BGE)

Yes, I did I just wanted to bring up with respect to the overall R&D forum that it...it was unfortunate that with all the activities that we had around, and it was very successful forum, that there wasn't any LNG sessions. And I...think there's certainly potential for impacts to those facilities with some of the discussions we've had here. So, as a consideration, maybe PHMSA could host a pseudo LNG focused forum that might bring to light...some raising concerns, particularly with the hydrogen enriched natural gas supplies to those facilities?

Schoenkin, Nathan (PHMSA)

Alright. Thank you, Kevin. I appreciate the comment.

Ritz, Kevin L:(BGE)

Thank you.

Schoenkin, Nathan (PHMSA)

And Christina, I see your comment here and we'll maintain that for the docket.

Ritz, Kevin L:(BGE)

And.

Schoenkin, Nathan (PHMSA)

Alright, any other hands raised? Bob, John, tell me if I'm missing something.

No? OK. Alright, well...with that I will turn it back to you, Bob.

Smith, Robert (PHMSA)

Alright. Well, thanks, Nathan, and thanks for those comments from the attendees. ...We'll be looking at that and, like Nathan said, understand how to implement that into the program and, of course, try to answer those questions.

So before...we go to...wrapping this up, I'd like to make a couple points from observations I've seen over last couple days. I'm very pleased...this was the first time we tried to execute one of our R&D forums...that every single one that we've done prior, and we've done about 9 or 10 or 11 of these things...we've done...n person. So, the interaction. It (indecipherable) to work, a little differently when it comes to identifying the gaps. We had a lot of economies of scale that I think...(worked) better in person for that.

And...doing it virtually posed some new and unique challenges that...clearly, we have some learnings to apply so I think having this gave us the ability to understand where to make some tweaks moving forward. Now, we hope that we can move back to an in-person event. I think that is the goal to do that, but clearly...we've been able to understand a few things beyond what we were able to predict to apply forward.

So really, I just want to thank the extraordinary efforts—and really, extraordinary is the word here—given those challenges...by everybody (who) was involved with Day 1/Day 2/Day 3. It was a lot of effort and prep, a lot of your time. I know (a couple of) work groups...met beyond the 6 o'clock, into the 7 o'clock hour. So, we just thank you for your efforts that allowed this to be a successful output that we are going to digest and have some traction. ...With...that, let's go ahead and transition to closing this out.

Let me welcome back Massoud Tahamtani, our deputy administrator for policy and programs so within PHMSA's Office of Pipeline Safety. Massoud, the floor is yours. I'm going to bring up your presentation and let's get at it.

Tahamtani, Massoud (PHMSA)

Well, thank you all very much...on behalf of all of them, (and) particularly our leadership. I, like Bob and others, want to thank everyone very much for your attendance and participation.

This was the first time, as Bob said, we held one of these things virtually and as you all know, we hold these things in person as was mentioned. It was very successful and we hope that the next time we come together it'll be in person. These events are successful, as has been mentioned, due to your involvement and participation. And, like Bob said, I was jumping around with the working groups yesterday and one...working group worked until about 7:00 PM last night.

We want to thank all the presenters, attendees, moderators, working group leaders...organizers, event steering committee, and our contractor support.

Just a few stats. We had over 600 registered and, from time to time, over about 300 people attended. More than 60 presentations were made in the last two and a half days and, based on the workgroup reports this morning, I sort of added up the numbers.

Over 300 or 350 ideas were discussed amongst the working groups. Thirty gaps, about 30 gaps, were recommended to PHMSA for consideration and an additional 36 gaps were given to us. We believe that this event was successful in achieving our goal of identifying gaps to inform our research agenda for the next couple years, and we will consider based on this suggestion that was made earlier, we will consider (having) another one just on LNG, hopefully in the near future.

Just to let you know where this is going—we will soon post everything that's been presented to the event page where you registered. And once posted, I'm sure Bob and others will send out a broadcast to everybody so that they can go and look at what's posted.

We will analyze the wealth of information you provided and the recommendations that were provided by the working groups and from this, as I said before, will inform things in R&D. A program to help us as we work to advance the administration focus on safety, climate solutions, equity, among others. So sometime in the near future, we will be soliciting based on identified gaps and we will do everything we can to push these solutions, proven solutions, into the market to again advance safety and help us with climate solutions and other administration priorities.

So with that, said, once again, thank you all very much. Such a great job to everyone. I particularly want to thank our staff for running a great show. So, please stay safe and I wish everyone a great and safe holiday. At this point we are adjourned. Thank you all very much.

Smith, Robert (PHMSA)

Thank you, Massoud.