10. Safety, Codes, and Standards

Introduction

DOE is working to develop and implement practices and procedures that will ensure safety in operating, handling, and using hydrogen and hydrogen systems. In addition, DOE is working with domestic and international organizations to identify the current gaps in the standards development process; facilitate the creation and adoption of model building codes and equipment standards for hydrogen systems in commercial, residential, and transportation applications; and provide technical resources to harmonize the development of international standards.

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Relevance	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Hydrogen Codes and Standards and Permitting	Carl Rivkin, National Renewable Energy Laboratory	10-4	4.00	4.00	3.83	4.00	3.83	3.92
Hydrogen Safety Sensors	Robert Burgess, National Renewable Energy Laboratory	10-8	3.20	3.60	3.40	3.40	3.20	3.38
Materials Compatibility	Brian Somerday, Sandia National Laboratories	10-11	4.00	3.67	3.50	3.50	3.33	3.62
Hydrogen Safety Knowledge Tools	Linda Fassbender, Pacific Northwest National Laboratory	10-14	3.67	3.33	3.50	2.83	3.33	3.42
Hydrogen Fuel Quality-Focus: Analytical Methods Development & Hydrogen Fuel Quality Results	Tommy Rockward, Los Alamos National Laboratory	10-18	3.50	3.67	3.33	3.50	3.17	3.43
Hydrogen Release Behavior	Chris Moen, Sandia National Laboratories	10-20	3.80	4.00	3.60	3.60	3.60	3.72
Hydrogen Safety Panel	Steven Weiner, Pacific Northwest National Laboratory	10-23	3.60	3.80	3.60	3.60	3.40	3.62
Codes & Standards for the Hydrogen Economy	*Gary Nakarado, Regulatory Logic*	*10-25*	*3.67*	*3.67*	*2.33*	*3.33*	*3.00*	*3.03*
Safe Detector System for Hydrogen Leaks	*Robert Lieberman, Intelligent Optical*	*10-27*	*3.50*	*3.75*	*3.50*	*2.75*	*3.75*	*3.50*
OVERALL AVERAGE FOR SAFETY, CODES, & STANDARDS				**3.67**	**3.71**	**3.46**	**3.41**	**3.54**

NOTE: Italics denote poster presentations.

Overview of Safety, Codes, & Standards: Antonio Ruiz, U.S. Department of Energy

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

Most reviewers felt that the sub-program area was adequately covered by the presentation. A reviewer stated that the sub-program area was adequately described with enough depth. Another noted that the subprogram was very well covered, the important issues were identified, and progress was shown. A third reviewer commented that Antonio gave a clear presentation that showed significant progress through the program that comprehensively addressed codes and standards needs. Challenges were clearly identified with the strategies to overcome them. To another, the sub-program area was covered completely, barriers and challenges have been identified, and progress has been made from the previous year. A statement was made that the subprogram was well covered and issues and challenges were identified, but a comparison to the previous year should have been presented.

A reviewer offered that progress was clearly presented and the sub-program was covered for what was able to be funded this year. The most important issue to this reviewer is the request for zero funding from the Secretary of Energy as progress was very clearly presented; the program has made significant progress to date, data were aligned and timed very well with codes and standards development, and coordination with national labs generates very valuable data which is incorporated into national standards. The program demonstrated how well they are working with national and international codes and standards organizations and coordinating them. On-line tools for permitting officials of hydrogen installations and the programs for emergency responders are a very valuable resource for progressing the technology.

A reviewer commented that the presentation did not cover all of the issues or barriers that have been identified by the California Fuel Cell Partnership or those who have tried to get projects built. Due to funding issues in the past, a more comprehensive discussion of accomplishments should have been presented.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

Reviewers generally stated that plans were identified for addressing challenges, but that funding would be an issue for the future. A reviewer said that challenges were identified along with progress and accomplishments. However, issues beyond the control of the sub-program and management negate planning for addressing any issues or challenges. To another, there were plans for addressing issues; however, due to the recent budget cut, the presenter did not cover what will happen over the next several months. This reviewer asked how any of the needed goals would be achieved when the Program is in close-out mode. A reviewer felt that plans were not addressed, as there can be no further plans for addressing challenges per the zero funding request from the secretary; this needs to be reconciled.

Planning for addressing future challenges has been identified, according to a reviewer, who went on to note that whether there will be funding to address all the issues is a big question. This reviewer saw a minimal amount of gaps, but would like to see greater involvement from OEMs and energy producers in future work. How to develop the incentives to get their cooperation is a challenge.

A reviewer said that plans for addressing issues and challenges were adequately covered. There should be some discussion concerning potential issues in market transformation segments (telecommunications backup fuel cells, material handling equipment fuel cells) as these are viewed and the nearest term markets and products are being introduced. Another stated that there is a detailed plan and discussion of challenges. There was not much of a discussion regarding remaining gaps- just remaining work needing to be done. There should be however recognition of prioritization related to safety incidents: e.g., shifting or adding resources to cover immediate development (such as component issues at 70MPa APCI site).

Other comments received included that plans were identified for addressing issues and challenges. For gaps, the codes and standards program is comprehensively addressing most or all of the key codes and standards needs. However, additional work to increase international collaboration and the development of codes and standards that may aid the international installation of new systems could help increase the export of American hydrogen and fuel cell products. DOE's codes and standards program could increase its scope to make sure areas that can help increase these international installations are addressed to increase the use of hydrogen and fuel cell products overseas.

3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

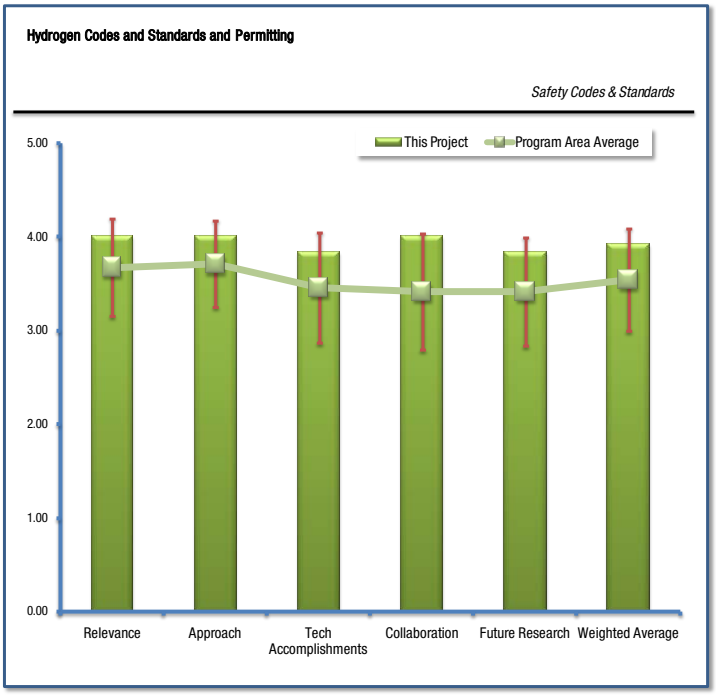
Responses to this prompt were generally positive, with one reviewer offering that overall the subprogram is achieving very good results. Another statement was that the sub-program area is very focused, well managed and effective for the DOE hydrogen program. Further comments were that the sub-program area is focused and has been managed well given the immense barriers and challenges that exist. Managing such diverse areas as the minutiae of fuel quality measurements and getting code officials up to speed on the technology has been well handled. A reviewer stated that the sub-program appears to be well focused and well managed. It addresses the needs of the underlying R&D needed for the development of effective codes and standards. It effectively communicates to a wide cross section of the emerging community of hydrogen users. To another, the sub-program has been very well-managed and focused to date, but this reviewer felt the sub-program cannot continue to address the DOE Hydrogen Program R&D needs if there is no funding made available. The Sub-program was well focused, to another reviewer, but the effectiveness could not be evaluated since many of the projects were just getting restarted.

A reviewer stated that the DOE codes and standards program has done an excellent job of making sure that the most important areas are addressed comprehensively and with significant collaboration. This systematic approach, in coordination with industry, has led to successes that support larger DOE program needs. Without these efforts, new applications would have difficulty entering the marketplace.

4. Other comments:

Other comments received about the sub-program included that this was an important program to leverage also for electric vehicles. A reviewer noted that the program management has done a very good job of managing a complicated set of tasks. This reviewer went on to say that cooperation among the national labs has been good, but necessary course corrections from industry to the projects that will result in usable data have been lacking. This is not the fault of the Sub-program management, but of the individual companies themselves. This reviewer felt that proprietary interests have overridden the need to advance the technology. A reviewer was unclear in general as to how the conclusions supporting the request for zero funding were determined when this well-managed program repeatedly demonstrates progress and meets its goals. The final reviewer asked that depending on the appropriation process, how is the Sub-program going to transition and keep some progress on its actions when it is no longer able to fund any activity? What strategy will managers use to keep information current from the respective demonstrations and studies that are still needed for state funded activities, such as Clean Cities and CA Fuel Cell partnership?

Hydrogen Codes and Standards and Permitting: Carl Rivkin, National Renewable Energy Laboratory



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer said that this program has indeed contributed very valuable information to the development of codes and standards surrounding hydrogen and vehicles and has promoted the progress of the technology, which aligns very well with industry. Another commented that this program is 'mission critical' for the implementation of a hydrogen fuel cell economy. The program is designed to meet the most needed development areas in codes and standards, in another's view.

The work supported by NREL has been critical to implementing the National Template/Roadmap. The test work supported to date has provided necessary data to support the standards development. Going forward, there are existing safety concerns that need to be addressed or investigated to provide validation of the proposed test method and data to support revisions to the standard. A reviewer said the project should move beyond hydrogen codes and standards with R&D for alternative fuels codes and standards.

A reviewer observed that the objectives are correctly identified as critical to the development of vehicle-based components, refueling infrastructure components and preparing the infrastructure for commerce. SDOs have used (and are still using) results of the testing programs outlined as a basis for verification of their performance-based code-writing process. Identification, through a national template, of organizations best suited to develop codes and standards went a long way to getting many disparate SDOs on board.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Positive comments were that the three tiered approach builds and compliments one another. A reviewer noted that again, the testing and data gathering made possible through NREL support is critical to the standards development process. The approach appears to be well vetted by the industry and government. It is an analytical, organized, and easy to understand plan which pulls the expertise of the industry with empirical testing to accomplish tasks. A reviewer said the approach shows a systematic approach to addressing codes and standards barriers, and recognizes the need for consensus and collaboration so that when new ideas get transferred into code changes, they have the highest chance of success. The approach is adequately focussed on technical gaps identified by participants from a variety of disciplines: test houses, OEMs, and Code-writing technical team members, stated another reviewer. Permitting workshops have been instrumental in getting the rank-and-file AHJs introduced to the use of hydrogen in the commercial world. Project work output by the national labs has enabled SDOs to address concerns regarding the technology.

A reviewer noted that going forward, there continue to be issues with the nozzle and PRD's that need to be resolved to provide data to support revisions to the standard and provide reliability information. There are existing safety

concerns that need to be addressed as the industry moves forward. The final comment was that the barriers are significant, but the process to address them has been very well thought out and executed. It is imperative for this work to continue as new and different challenges arise.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer felt that the support for gathering data has been instrumental in obtaining data that facilitated development of performance standards focused on safety. NREL's use of existing businesses that have capabilities or with some investment in capital for the organization would be the preferred path. This makes dual use of the funds by preparing U.S. companies for commercialization of alternative fuel technologies. Another comment was that every technical accomplishment that was highlighted is integral to the safe use of hydrogen as a transportation fuel and source of alternative energy as the technology develops. There are many application areas for hydrogen and fuel cells, specifically, and all areas are in need of this kind of work.

A reviewer stated simply that the work covers a wide vista of issues from component testing to workshops. Another said that excellent progress was made, but a clear definition of areas needing more attention related to infrastructure/ vehicles if any would be beneficial.

Good progress has been made in key areas, according to another reviewer. Online materials are key and those activities should be encouraged to continue to maximize outreach of safety, codes and standards materials. This reviewer said that great progress was made on the fuel quality international standard, residential garage modeling, and support of NHFCCSCC and HIPOC plus participation on other key groups is key.

The final commenter said that 70MPa testing of vehicle storage systems and station components has allowed SDOs to base their work on performance data. This greatly enhances the acceptance of this new technology by the AHJs. Ongoing fuel quality testing at the national labs and academia is allowing NIST to prepare documentation opening the door to use of hydrogen as a vehicle fuel. These types of tests are very expensive and some quite could possibly have been conducted by the private sector. However, conduct by the national labs has achieved greater acceptance by constituents of the SDO technical committees.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

Collaboration comments were generally positive, with one noting the outstanding collaboration with industry, industry groups, SDOs and CDOs. Coordination with and support of groups like NHFCCSCC and HIPOC is key to provide resources to groups which are important but would be challenged to attract outside funding to support their operations. A reviewer highlighted the excellent coordination with the International Standards Organization, which again, is key to the progress of the technology and the move toward commercialization. This type of work brings uniformity to the technology and promotes a very positive leadership/collaborative role for the U.S. A reviewer felt that the national and international collaborations are being handled very well, but suggested that the team should host German/ US/ Japan collaborative meetings (together) to better communicate issues. A reviewer said that the team should continue collaborations nationally and internationally for continuity.

Performers have done a good job of ensuring cooperation between collaborators, commented another reviewer. Development of an international fuel quality standard could not have been achieved without the use of recognized expertise. The level of acceptance of results by SDO has been very good. As above, the permitting workshops, where test data and informational material has been shared, have been very helpful in educating AHJs. It is the acceptance by these AHJs that is going to make or break the new technology, in this reviewer's opinion.

The final reviewer thought NREL does a good job at collaboration with other institutions. This reviewer thought it would be helpful for the program to have NREL to invest more in establishing and building capabilities for other

organizations (as opposed to building new facilities) that will help the transition/commercialization. Specifically, if an organization has the expertise to perform testing/evaluation, etc. using the DOE funds to expand/obtain necessary capital for the initial purpose of obtaining data/validating tests/etc would then transition to a commercial venture once the technology is implemented. This is another aspect of preparing society for the change. This reviewer also believed that priority should be given to U.S. companies.

Question 5: Has the project effectively planned its future work in a logical manner?

The first reviewer commented that the proposed future work programs build on past accomplishments. Another said similarly that future work proposals continue to build on past accomplishments with a new direction to support electric vehicle development. In a similar line, a reviewer said that the future work shows an important continuity with work performed so far. Especially with this subject area, where codes and standards are sometimes slow to develop, that continuity in funding and activity is crucial. Work with vehicles must continue, in this reviewer's opinion. In addition, the work on near-term applications, like sensor placement and any potential standard (if needed) for the storage of hydrogen forklifts during non-use should be addressed.

A reviewer noted that this work was very important to the progress of the technology overall; wide proposed future work has broad application to alternative fueled vehicles in general--presenter has a very good handle on the tasks at hand and understands the issues that need to be addressed. The final comment was that the focus of NREL's activities in supporting work that will address and resolve known barriers is important for providing necessary data to develop appropriate methods for evaluation. The data are necessary resources for codes and standards committees to develop and evaluate appropriate criteria. Research and support for codes and standards activities is key to successful commercialization of new technologies.

What are the project's strengths?

Strengths listed by the reviewers included that the project is broad-based in its collaboration, and that it is well-organized and very effective, with industry/interagency support. A reviewer said that the project provides necessary resources and support for the development of codes and standards that provide a path for transfer of new technology from the laboratory to commercialization. Another strength exists in managing codes and standards development through facilitation and direct participation in organizations responsible for the development of standards. The final reviewer said that great work was done in keeping different codes and standards developments on schedule and moving ahead while avoiding delays that cost much in terms of time. Significant progress was made towards addressing key areas where codes and standards can aid efficient installation of new systems.

What are the project's weaknesses?

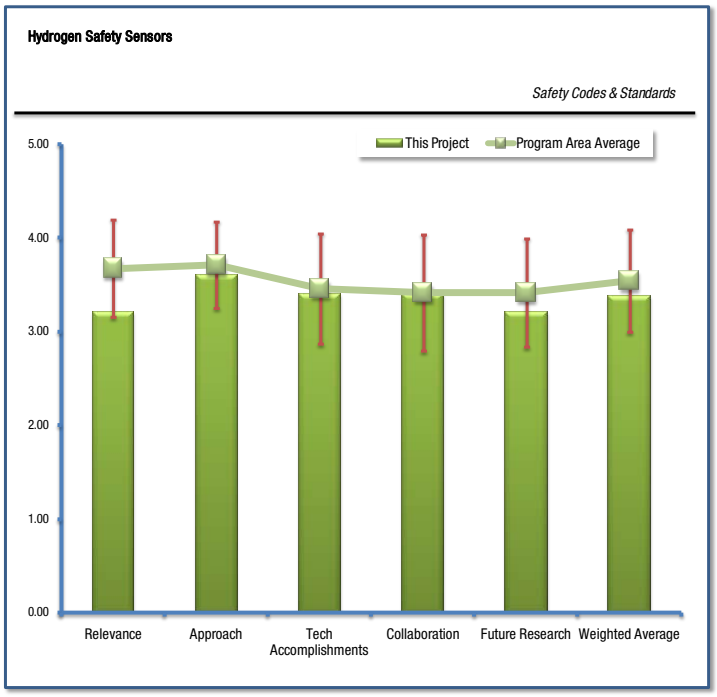
One reviewer did not notice any weaknesses, but others listed issues such as the length of time for processing requests for support for research projects and not utilizing existing business that have capabilities or with some investment in capital for the organization would be the preferred path. This makes dual use of the funds by preparing U.S. companies for commercialization of alternative fuel technologies. A reviewer asserted that the project may be trying to manage too many SDOs. Another listed weaknesses which included the lack of explanation for the hydrogen fueling effort at SAE, there was a need to further harmonize in hydrogen fueling but the GTR harmonization process update was not given, and the need for clarification regarding electric vehicle direction. The last reviewer stated that hydrogen sensor work should focus on refueling station applications, i.e. wide area sensing. This reviewer did not understand the last bullet on slide 15 re: "...special emphasis on electric vehicle standards."

Do you have any recommendations for additions or deletions to the project scope?

A reviewer recommended that DOE maintain and sustain the project. Other suggestions included that sulfur impurities on air side need to be evaluated (Hawaii and in laboratory), and that the team needs to add scope related to hydrogen sensor testing for a field trial once laboratory testing is complete. This reviewer recommended discussing this issue with CaFCP for future prospects. Another suggestion was to conduct additional work to increase

international collaboration and the development of codes and standards that may aid the international installation of new systems can help increase the export of American hydrogen and fuel cell products. DOE's codes and standards program could increase scope to make sure areas that can help increase these international installations are addressed to increase the use of hydrogen and fuel cell products overseas.

Hydrogen Safety Sensors: Robert Burgess, National Renewable Energy Laboratory



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

Positive comments included that development of sensor performance is critical to infrastructure development both for commercial and residential refueling devices. Another comment was that the team has done excellent work with and contributing to the codes and standards development for a specific aspect of hydrogen safety and great work with industry; both are integral to progress. A reviewer highlighted that a need was identified and roadmap was developed for technology transfer to industry.

A reviewer commented that the project listed nearly every barrier in the codes and standards subprogram. At best, the project could help address barrier N: Insufficient Technical Data to Revise Standards. Another asked if the DOE objectives are 0.1 - 10%, why is the evaluation limited to 4%? What is the expertise of NREL to validate new sensor R&D as opposed to NIST? Why should NREL be established by DOE to be the sensor test laboratory? These issues were not discussed in the presentation.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Technical barriers were clearly identified, according to one reviewer who said that collaborating with device developers manufacturers is the right thing to do. Similarly, another commented that barriers were clearly identified with roles and responsibilities highlighted. A reviewer felt that there was a good understanding of technical requirements and constraints for performing hydrogen sensor characterization work. The fact that they balance data reporting for manufacturers while dealing with sensitive, proprietary information promotes understanding and develops competition in the market place, which in turn leads to jobs creation/security.

The interaction between manufacturers and NREL team was not clearly defined, according to the last reviewer. When a manufacturer requests UL certification, they have to pay UL for the tests and final certification. Is this task to replace the UL requirements, provide independent test data for accelerated certification, reduce the cost of certification for the manufacturers, or just provide information to companies who use hydrogen and must install sensors to meet the code? Are the test protocols accepted by NIST and other standards developers or are they still under development?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer offered that the team has a very deep understanding of the various, specific technology required for producing useful data and information for the manufacturers and/or end users. This is another key role in progressing the industry as a whole and very valid work. A reviewer said that there was a clear approach from identifying needs to benchmarking, technology transfer and codes and standards development. Gaps in current technologies were identified. A statement was made that reasonable progress has been made with respect to test apparatus and facilities.

Coordination with sensor standards efforts is good. Better outreach to and communication with sensor manufacturers could be beneficial, this reviewer suggested. Another suggestion was that evaluation of a wide variety of sensor types using a consistent set of criteria should result in the best device for a given application. The final reviewer noted that the lab was running, and asked several questions. How many sensor types have been tested? Do the manufacturers agree with the statistical results? How is the data published? Where is the data from the current round of tests?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer noted that partners and collaborators were identified across academia and industry. Both of the existing and the new collaborations are valuable, according to another commenter. Additionally, the team is also actively seeking new collaborations/sources of data generation and has confirmed results with international testing agencies. This sort of collaboration is invaluable. The comprehensive set of collaborators should ensure agreement on devices, test protocols, and coherent international standards. A reviewer said that there is reasonable collaboration with other institutions and SDOs but increased industry input should be solicited. The final comment was that there was a good group of partners, but more discussion on roles and responsibilities would have been more helpful. Specifically on the testing with JRC, has there been validation testing between the facilities to verify protocols, data collection and analysis?

Question 5: Has the project effectively planned its future work in a logical manner?

A reviewer offered that the plans do build on past work. Another said that there was a clear and focused future work plan, building on prior work and geared to address gaps. A reviewer said that aspects of future work are reasonably defined but the sequencing and dependencies of the elements and decision points need to be better defined. It was noted that the project concentrates on stationary applications, but there may be a need for the same type of evaluation for on-vehicle gas sensors.

A final reviewer asked why the phase II was to be built to handle the wider range if it was not incorporated into the original design. What are the highest priorities for this work, especially if the funding is reduced? What does work towards improved codes mean? more specification? engineering? system testing? These issues were not clear to this reviewer.

What are the project's strengths?

A reviewer highlighted the good team, and a reasonable approach to test different technologies under similar conditions. Another stated that the project has a good handle on what is required to undertake the effort and is making progress. To another, there was a good base of collaborators with a wide variety of potential candidate devices. Finally, a very well rounded and encompassing process was demonstrated for acquiring the equipment to test. They have established good relationships with manufacturers and are able to provide unbiased information for all of the industry, allowing specific companies can acquire data from their own equipment. This program looks very valuable and useful in bringing the industry to the commercial phase.

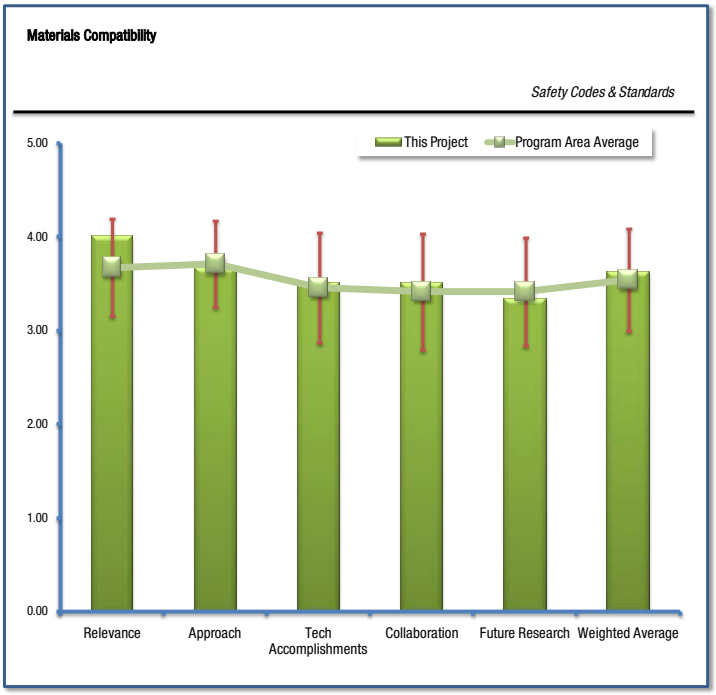
What are the project's weaknesses?

The project seems to address only a single barrier within the codes and standards subprogram though it is conceivable that barriers in other subprograms could be addressed to some degree by improvements in sensor technology. Another comment was that the presentation does not indicate clear winners for specific application (this reviewer was referring to refueling infrastructure uses). Are some performing better than others? The poorer performers should be weeded out and focus shifted to the more promising devices for commercial and residential refueling infrastructure use, according to this reviewer. The final reviewer listed weaknesses as roles and responsibilities, assumptions for the hardware design, and test protocols and validation of same.

Do you have any recommendations for additions or deletions to the project scope?

The only recommendation was that the effort is not examining wide area sensing technologies. It may be that such technologies, used in a number of areas for more generic flammable gas detection, may not be suitable for hydrogen-specific detection. At least an initial assessment is warranted.

Materials Compatibility: Brian Somerday, Sandia National Laboratories



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer stated that the work performed on materials compatibility in a hydrogen environment has been critical to the progress in standards development. The data provided and the information on the web site is the leading reference in this area. Another felt this program had very specific relevance for hydrogen and fuel cell vehicles and was extremely important for overall safety. Commenters said that the project is vital to the commercialization of a hydrogen economy and is very relevant to the hydrogen economy.

The project provides essential data for compatibility of materials used primarily in stationary hydrogen storage applications and is critical for advancing knowledge of the suitability of these materials for such applications and the requirements for engineering design and safety margins needed in codes and standards for these applications. The work is critical for the progress and success of the Hydrogen Program and engages state-of-art science and engineering knowledge and expertise at Sandia National Laboratory.

The final reviewer said the work supports both vehicle component and pipeline material needs. Rather than provide a "catalog" of suitable materials, the project direction correctly pursues testing standards and investigation of hydrogen-assisted crack growth.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer observed that the project appears to be focused on current technical barriers. The web site provides the information obtained and is available for use by anyone. It was this reviewer's understanding that Sandia also adds to the materials list as information is requested from industry. That being the case, the work is focused on providing solutions for technical barriers. Another comment was that the overall approach is sound, but the focus on high pressure containment will lead to gaps in low pressure non-metallic materials. Such materials will be found in the low pressure side of FCV fuel delivery systems. A reviewer characterized the work as having an outstanding approach which leverages industry and government collaboration along with empirical data to accelerate the progress of hydrogen material compatibility.

To another reviewer, the project addresses voids in the existing materials compatibility database, and in-situ testing with high pressure hydrogen gas provides valuable data for both engineering design of high pressure containers and for design requirements in container standards. The work also includes evaluation of test methods and implications for design requirements.

The final commenter stated that the approach to developing test standards as opposed to providing a list of acceptable materials will allow for future development of acceptable materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.
Good progress in meeting DOE goals, stated one reviewer. Another noted that technical accomplishments are being directly applied by industry partner. A commenter said that adding and updating chapters in the Technical Reference is valuable and completion of tests for selected pressure vessel steels show good progress, but some milestones are behind schedule. Updating of technical reference material for aluminum alloys is a positive accomplishment in another's view. Evaluations of cracking thresholds and crack growth measurements for commonly used materials beneficial to component developers. The final comment was that the work performed by Sandia and their involvement in codes and standards activities has provided a much needed resource in the area of materials when exposed to anticipated hydrogen environments. This involvement both on the research side and participation in the standards development is critical to moving standards forward in a manner that will facilitate commercialization of new technologies.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?
One reviewer thought the collaboration is good and effective. Another noted that the broad collaboration (within DOE programs and internationally) was very important. A reviewer highlighted that data were being shared with industry partner, which was also noted by a reviewer who said that feeding material testing results back into ASME and components suppliers will yield long-term benefits. Similarly, providing technical input to and involvement with ASME is crucial and an essential part of the effort. The researcher and his team have been a very valuable asset to the DOE program through its direct involvement with the codes and standards development process. Involvement with the DOE Pipeline Working Group also adds value.

Question 5: Has the project effectively planned its future work in a logical manner?
One statement was that future work plans definitely build on past progress and are adequately focused. In contrast, a reviewer said that the future work seems limited in scope. According to the third reviewer, the project focuses its research efforts where industry indicates a need exists and where there is recognized need for future development to allow improvements in methods and technologies. The final comment was that continued interaction with industry, SDOs, and other labs is essential in addressing future work; more direct involvement with automotive OEMs and with component manufacturers and standard development organizations for components is encouraged.

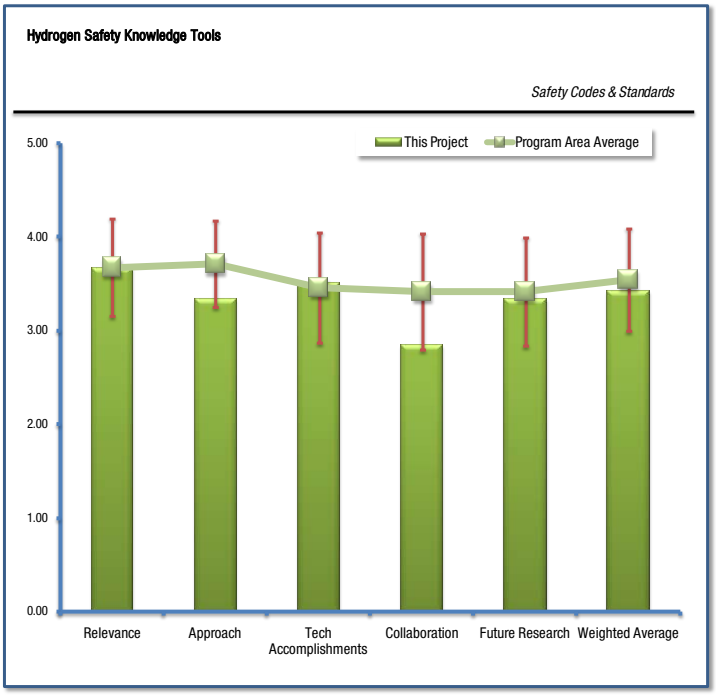
What are the project's strengths?
One strength was that this project has provided a necessary source/reference for materials acceptable for use in hydrogen environments. Without this project, technology would not have progressed to the point it has today. Similarly, work on updating technical references in collaboration with vehicle/station component developers will be a big help. Measurement of fracture response of aluminum alloys may lead to reduction of weight targets for vehicle storage containers. Other general strengths were that the project was comprehensive, thorough, and relevant, and is critical for the expansion of the hydrogen economy. The project was also characterized as having an analytical and thorough plan to address potential materials compatibility concerns. The final reviewer felt this was an excellent application of laboratory expertise and test equipment to address critical needs of the Hydrogen Program, standards development organizations (especially ASME), and industry. The project is an excellent example of how technical expertise and state-of-art equipment at DOE national laboratories can be applied to address essential questions and obtain critical data needed to develop requirements in hydrogen codes and standards.

What are the project's weaknesses?
The project has no major weakness as it is well-designed and addresses critical needs of the Hydrogen Program, according to one reviewer. Another offered that this project needs to be expanded to encompass non-metallic materials at lower pressures. The only other weakness highlighted was the perceived relatively slow progress since 2003.

Do you have any recommendations for additions or deletions to the project scope?

A reviewer suggested that this project needs to be expanded to encompass non-metallic materials at lower pressures. The other recommendation was that if possible, the team should begin to apply materials science expertise to composite materials and expand Technical Reference to include chapters on these materials, particularly if a hydrogen storage tank standard for portable and vehicular use is a barrier and target (slide 2) that the project seeks to address.

Hydrogen Safety Knowledge Tools: Linda Fassbender, Pacific Northwest National Laboratory



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

The first comment was that this project provides an excellent source of materials relating to hydrogen safety, and the hydrogen incidents reporting is an excellent method for a neutral third party to gather and disseminate relevant data to hydrogen incidents. Dissemination of valid data for consumers and industry is critical to advancing the hydrogen technology. Another felt these tools were a helpful resource for those in the industry working with hydrogen: the team has made very good additions/improvements for ease of use, has added additional information, and made more resources available. To another reviewer, both the Best Practices and Incident Reporting databases and the associated activities are important in supporting DOE objectives for hydrogen safety. These tools are an excellent resource for the hydrogen safety community as well as the public. A reviewer said the work was very relevant to document incidents and experiences with hydrogen. Defining best practices for safely working with hydrogen is crucial to widespread acceptance. Incident reporting is also important in moving forward into a hydrogen economy. The final statement was that most activities address barriers. The ones that don't directly address barriers, however, are still relevant and important work.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer said that dissemination of valid data for consumers and industry is critical to advancing the hydrogen technology. Another offered that this was a great approach that could not be done better. Perhaps another example on site would be helpful. To another, the approach to developing the website seems logical and appears to be working well. This reviewer felt the suggestion to focus more on modern incidents instead of the older, potentially less relevant ones seems sound.

A reviewer suggested that vetting information to be posted on the H2 Incidents database with industry experts to ensure that it is useful and valid and meets the goals of the project is good and needed to keep extraneous/less useful information from populating the database. Another reviewer had suggestions on the Best Practices website: a more aggressive pursuit of commercial practices should be conducted. This reviewer understands that companies want to protect what they feel is their proprietary information, but safety should not be proprietary. This reviewer also had observations on the Incident Reporting database: DOE-funded projects should have incident reporting requirements already. Commercial installations should also be required to report incidents, even those that do not result in injuries.

Finally, a reviewer stated that the Best Practices website is well-designed, easy to use, and attractive. The Incidents website is not as attractive and the descriptions of incidents are sometimes sketchy (this reviewer thought this may be due to limits imposed by the facility being reported on). Both websites are well-integrated with other information sources. The Best Practices project is has good interactions with the Safety Panel, national labs, NASA, and IEA. The

interaction with the Safety Panel and NASA for the Incident Reporting is essential. However, just linking the two databases is not be enough and, both projects could be improved by analysis, e.g., how incidents and lessons learned reflect on best practices.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.
The first reviewer said the web site and project seems to be on track with adding materials needed and requested by industry. Another said the incidents alert seems useful, along with individuals sending information. Another positive comment was the statement that the project has been able to create two great websites. On the other hand, a reviewer stated it was hard to judge regarding technical accomplishments, but the document has progressed very well.

A reviewer said that there had been good progress in adding features and additional information to the Best Practices site, but some analysis on how effective the project has been in improving safety practices should be attempted. For the Incident Reporting database, this reviewer stated that just adding more records was not sufficient; more analysis on implications of lessons learned (perhaps for best practices) should be added.

For the Best Practices site, a reviewer said that using the peer review process to update the on-line manual is a big positive. Safety Panel observations resulting in additions to Lab Safety practices enhance the credibility of the on-line manual. Items that were added were useful in identifying/clarifying potential gaps in relevant Codes. This reviewer said that the Incident Reporting Database website is an excellent tool.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?
The project has a good panel of experts that work directly with the project team, in one reviewer's view. Additional collaboration and cooperation with codes and standards developers would enhance the incidents reporting. Providing information on incidents to the appropriate SDO would facilitate prompt review by the appropriate industry technical group and promote revisions to documents in a more timely manner.

Another said there was a good link to Safety Panel, NASA, IEA, and national labs but perhaps the projects can be strengthened with more interaction with code and standards developing organizations and local code officials. More effort and analysis to assess needs for additional safety and codes and standards requirements in addressing causes of incidents would be helpful.

A reviewer suggested that there was a need to collaborate with other efforts at CaFCP & JHFC. Similarly, collaboration is good with the Hydrogen Safety Panel, but could be improved with audiences outside that group, especially non-engineers in groups who are considered to be the target audience, to make sure the sites communicate well to them.

For the Best Practices work, a reviewer would like to see more collaboration with commercial entities. This reviewer understands the proprietary nature of some of the installations, but, for the advancement of the hydrogen economy, more interaction with hydrogen suppliers and industrial process users of hydrogen would be beneficial. This reviewer suggested the team further engage commercial industry for the incident reporting database.

Question 5: Has the project effectively planned its future work in a logical manner?
A reviewer observed that the future work was not well defined, but understood that it is meant to document progress. A reviewer noted that the project has done an excellent job at meeting the need for information on incidents. The project is working to shorten the time between the incident and information being available on the web site, this is critical but it is understood there are many aspects involved that affect the timeline. Another said that the future work is outlined well and should be completed with an emphasis on making the sites more readable and attractive to non-engineers. If all those words are needed, this reviewer would suggest trying to find ways to replace words with

graphics and photos, or links to explain more on another page. A reviewer felt that getting better exposure of the best practices site would be useful: there are currently links to the pages that go back and forth.

A reviewer offered that this was good future work in addressing key issues, e.g., chemical hydrides, nanomaterials. Expansion of work may overlap with other information sources (e.g., hydrogen properties) and care is needed to avoid too much overlap. Also, criteria for selection of best practice issues could be more carefully defined.

A reviewer offered that inclusion of industrial users of hydrogen in the Best Practices site should be included, and vehicle refueling operations should be included to identify best practices. This reviewer also suggested that the team increase vehicle refueling and station operation scrutiny for the Incident Reporting site. If there are not many incidents relative to the number of refuelings, this could be used as evidence of a safe refueling process.

What are the project's strengths?

A reviewer said that this work was an excellent source of information for industry and offered an excellent method of disseminating information both on hydrogen safety and incidents. A reviewer said that both websites provide important information in an accessible and searchable way and are valuable tools in making this information available to the hydrogen community and to the public. Both projects have incorporated the essential structure and information gathering tools and knowledge to become more valuable as the databases grow and are improved in clarity and purpose. Other strengths were the well thought out database that is valuable for those looking for lessons learned, and the fact that the safety panel certainly has the correct expertise to evaluate lab safety procedures/processes.

With the incidents database, the ability to address (or at least attempt to address) all the near-term incidents is impressive, according to the final reviewer. Perhaps more work could be done to explain/emphasize that all recent known recent incidents (or XX%) are covered.

What are the project's weaknesses?

A reviewer proposed that the team needs to have a defined mechanism for communicating incidents to relevant codes and standards area. Another suggested that more commercial inputs were needed. A third reviewer observed that the projects to date have focussed (as necessary) on gathering information. As the projects mature, there should be more effort on analyzing lessons learned from the Incidents database for implications for best practices and for including such analyses in the Best Practices database.

To the last reviewer, the best practices website needs a little more use of graphics. For example, can any graphics be used to replace the sea of text on the main page? This reviewer's comments are also applicable to the Incidents website. NASA's recommendation to make the site more accessible to non-engineers is good, but this reviewer questioned whether NASA is the best kind of advisor for this activity since it's one of the most engineering heavy organizations in the world. How about some communications experts or a group of people who might be considered to represent the target audience?

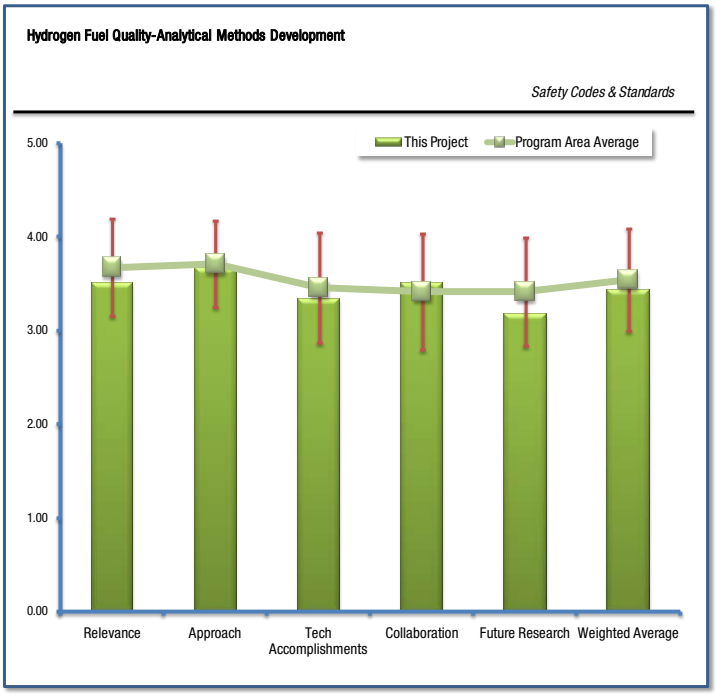
Do you have any recommendations for additions or deletions to the project scope?

Suggestions from the reviewers included adding a method/means to coordinate directly with SDO's on incident information to enable getting the information to the TAGs in a timely, efficient manner. This would promote dissemination of accurate information and implementation of potential codes/standards changes. Another suggestion was to identify which incidents were "taken care of" and which are "ongoing"; knowing this would be helpful.

The projects should proceed as planned by adding more to each database, stated another reviewer. The Safety Panel should do an in-depth evaluation of the databases and extract key lessons learned from the incidents and the degree to which the best practices database reflects state-of-art in industry and laboratory practice.

The final recommendation was that the team should emphasize the future work for best practices outlined in the presentation to include more photos and video (especially video). They need to be short, though, to ensure people watch them.

Hydrogen Fuel Quality-Focus: Analytical Methods Development & Hydrogen Fuel Quality Results: Tommy Rockward, Los Alamos National Laboratory



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

The project is providing necessary data to assist developers and modelers in determining the fuel quality limits that are acceptable, commented the first reviewer. A second said that understanding acceptable contaminant thresholds and fundamental mechanisms are important aspects necessary to form a technical basis for hydrogen quality specifications and standards for PEM fuel cells. Development of a fuel standard is critical to moving hydrogen into the commercial arena, according to the third reviewer. Selection of CO, H_2S, and NH_3 are the right fuel contaminants to check first. My only criticism is that this work has been going on since 2006 and three years later we are just starting to see data relevant to standards (SAE, ISO) contaminant tables. The final comment was that the project is primarily focused on fuel cell impacts related to impurities. Is the breath of the work sufficient if different MEA's, fuel cell type, and materials of construction are selected?

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments on the approach include that it appears technically robust and thorough, and that the project coordinates with industry and provides feedback to modelers to facilitate product development. A reviewer noted that in the case of hydrogen fuel contaminants, developing detection methodologies is key to repeatable experimental data. Testing contaminants in combination more closely represents what will be found in the real world. A reviewer highlighted the sound analytical approach with good repeatability. CO contamination and weight loss of catalyst was an issue with PT and ETEK; however, this work was not discussed in "future" work. This reviewer said the work needs to be broadened for more than PEM. The final suggestion was that more inputs from industry (OEMs) would provide valuable feedback to these efforts.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer observed that generally understanding fuel quality is critical to the progress of technology and bringing product to market, and both infrastructure and product developers require the information. Another noted that detection methods have been successfully developed and effects data generated: this information has been fed forward to modelers working on mechanistic predictive models. A commenter said that sound experimental design was exhibited in accomplishments to date. There are a few results that are still not adequately explained, according to this reviewer. Work involving the interaction of various contaminants seems to be at an early stage and could use better definition of the objectives as well as experimental design.

A reviewer felt there were very good results presented for CO, H_2S, and ammonia. This reviewer had several questions, however. Which data was provided by NIST and which by LANL? Were each data verified independently

to eliminate procedural or equipment differences? What was the accuracy between labs? How does this get incorporated in the respective protocols or procedures? A similar comment from another reviewer observed the very good progress related to hydrogen quality testing with H_2S, CO, and ammonia: this reviewer offered that the team may want to discuss potential 'reversible effects'.

Combination testing of contaminants makes it more relevant to real world fuel applications, according to the last reviewer. Combinations to be tested should be verified by a variety of hydrogen production methods. Are these results being fed to ATSM for inclusion into their testing procedures? Those procedures will be used by NIST and California Division of Measurement Standards to enable a commercially available fuel.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer observed that LANL has worked with a wide selection of government agencies and academia in this effort. On the other hand, a reviewer countered by saying that while a large list of collaborators is presented, it is not clear (aside from round-robin testing) how most of them are participating in the effort. Further on the collaboration front, data exchange and discussion among the participants has been good. Has collaboration with the modelers been satisfactory?

A reviewer suggested that a roles and responsibilities table would have been nice. How do data collection and analysis differences between labs get resolved? What is the method for developing new approaches between labs, such as the sulfur permeation rates? The final suggestion was that a short slide on overall collaboration with other modeling effort would be beneficial to show connection to overall hydrogen quality test plan.

Question 5: Has the project effectively planned its future work in a logical manner?

The team has a good understanding of what is required to modify the experimental configurations to improve test results, according to one commenter. Other comments included that the presentation needs to be better laid out: the explanations of analytical methods run into actual contaminant testing, and the presentation was very hard to follow. A reviewer asked how the revised DOE budgets for hydrogen activities will affect future progress.

Since the work is only 45% complete, what is the expected outcome? A uniform set of fuel specifications for PEM MEA's, analytical methods to be incorporated in ASTM? A protocol for FC PEM manufacturers to follow for materials development? A broader objective and plan should have been presented, according to this last reviewer.

What are the project's strengths?

Strengths include the mixed contaminant testing, the rigorous methodology in use, the team members, the solid analytical presentation, and the analytical results to date. A reviewer said that the project is providing needed resources to advance industry. The project shows an excellent understanding of the technical requirements for executing the effort and delivering clean, sound results.

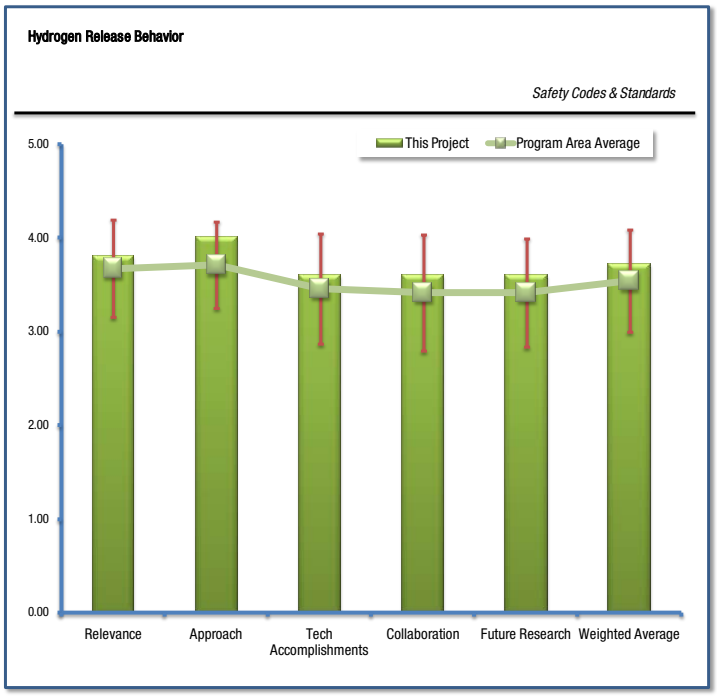
What are the project's weaknesses?

Weakness comments included that more clarity is needed regarding the scope of collaborators participation, and that the team needs to show repeatability in slides. A reviewer asked how the results will be incorporated into engineering, materials development or fuel specifications. The final reviewer observed that it takes a long time for results of testing to be peer-reviewed and published. Only after that can the data be used to update existing developing fuel standards. There must be a quicker way to get the data to the SDOs. Feedback from FC developers is critical. Developers can provide needed course corrections to ongoing research. OEMs should be pressed to provide timely feedback on testing and results.

Do you have any recommendations for additions or deletions to the project scope?

The only recommendation was that sulfur impurities on the air side need to be evaluated.

Hydrogen Release Behavior: Chris Moen, Sandia National Laboratories



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

Hamilton, Jennifer (Primary):

A general comment was that this project is adequate in support of the development of codes and standards for hydrogen and fuel cell technologies. Interactions/involvement with many SDO's were very good, and included collaboration with other National Labs. A reviewer felt the work was very relevant for setback distances. A reviewer commented that the work is critical and essential to meeting DOE RD&D objectives. The RD&D on hydrogen behavior and quantitative risk assessment and the transfer of knowledge gained from this work to the codes and standards development process provide a model of how scientific knowledge and expertise at national laboratories can be applied to enable and strengthen the development of codes and standards based on technical data, modeling, and analysis. The final observation was that hydrogen codes and standards development and harmonization require a sound technical basis for separation requirements and this project is directly and positively affecting code development.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Several commented that the overall approach is technically sound, with one adding that it was thorough as well. One reviewer felt the approach was sound but that laser ignition is not a realistic ignition point.

A reviewer observed that studies on warehouses and parking structures are not mature--this area is very important and needs new and updated reports/data as the vehicles roll out and are used in "every day life" by the consumer. This project made very good use of resources and avoids reproducing data unnecessarily.

The approach is based on providing critical data, modeling, and analysis needed by standards developing organizations to establish a scientific and technical foundation for requirements incorporated in codes and standards. The development of a risk-informed decision process for codes and standards development is a major step forward and one that has been needed for many years. The incorporation of hydrogen behavior RD&D and quantitative risk assessment methodology in the development of separation distances for bulk hydrogen storage is the best example to date of how scientific information and analysis can be applied to the codes and standards development process.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

The first reviewer simply said the accomplishments were good. Another suggested that tunnel studies are very important in the immediate time frame. The work to help reduce prohibitive standards is very good (separation distances)-this is important to infrastructure and minimizing the footprint of hydrogen installations, potentially saving costs on land acquisition, site prep, etc. Auto-ignition work very important to C&S development as well. This reviewer

suggested that the team might perhaps put together report(s) for issuance to AHJs as a resource when permitting stationary installations.

The experimental work on lean ignition limits is an outstanding accomplishment and should be made available to the larger technical community The work on barrier walls is also a valuable contribution to the scientific foundation of hydrogen codes and standards. SNL has presented its work in key scientific conferences and has helped establish international recognition for DOE's hydrogen safety RD&D program.

The results from the overpressure work using various wall configurations are very helpful. Jet ignition boundary work could be influential but the nature of the ignition source (energy, duration) could change the results of this study while providing increased usefulness. Autoignition work from relief devices and vent lines could lead to improvements in relief system design and code requirements. Support of risk informed separation distance code changes in NFPA and ISO documents has been excellent.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer said it was nice to see the expansion of collaboration at the international level, as this is very much needed and critical to uniformity in codes and standards development. Another observed that collaboration with codes and standards development organizations, such as NFPA and ISO, is outstanding, and SNL's involvement has noticeably raised the scientific awareness and technical competence of these organizations. It is also playing a key role in important international projects on hydrogen safety, such as those sponsored by IEA and in European Commission projects such as HySafe and HyPER. Similarly, a reviewer said that coordination with BAM is good, but Hysafe and Japanese efforts were good as well. A reviewer spoke of the excellent outreach and dissemination of results to the codes and standards community. Additional clarity concerning the direct involvement of working team members could be provided.

Question 5: Has the project effectively planned its future work in a logical manner?

A reviewer said the project is very focused but needs the funding for FY 10 to finish and deliver data, information, and reports; the project is imperative for the advancement of the industry as a whole. The proposed work will continue to focus on critical RD&D needs for codes and standards development. Planned work on partially confined spaces is particularly important, according to the review commenter. The project has appropriate future work items but more information regarding timing, task dependencies, and decision points should be provided.

A reviewer suggested that the team needs to evaluate 'realistic flame'/ ignition point as per SAE J2578 (lit cheesecloth) for a realistic evaluation of LFL for standards. This reviewer also said that high ignition points are interesting, but not realistic.

What are the project's strengths?

A strength identified by one reviewer was that all of these studies are pertinent and important, especially in the current status of the industry--all of the issues addressed have high priority for the advancement of the industry and progress toward commercialization.

The most important strength of the project to another reviewer is the combination of expertise in experimental design and engineering modeling to increase understanding of critical parameters of hydrogen behavior under plausible release scenarios. This strength enables DOE to provide key data and analysis for codes and standards development, and the collaboration of SNL with standards and development organizations is exemplary. A reviewer further stated that the project is directly and positively affecting code development through excellent outreach and dissemination of results to the codes and standards community. The final strength was that the work gives initial relative data for generation setback distances with regards to multiple wall surfaces.

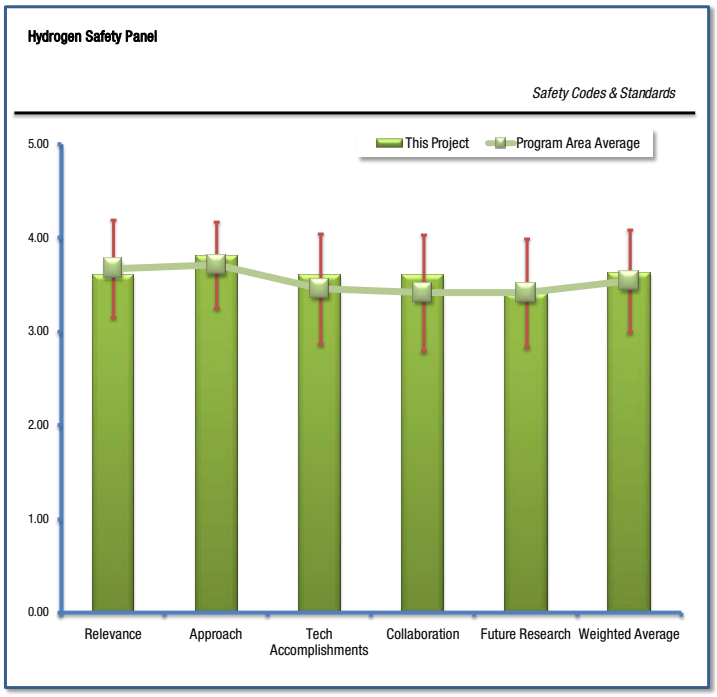
What are the project's weaknesses?

To one commenter, the project staff may be overextended as it is addressing a number of issues and participating in many important efforts with standards development organizations and other RD&D projects. It may be useful to step back and refocus priorities for applying limited resources of expertise and funding. Another weakness was that different types of ignition sources need to be incorporated into the jet ignition boundary effort. The third weakness identified was that the team needs to have realistic ignition point and clearly state a realistic real world lower flammability limit (<8%).

Do you have any recommendations for additions or deletions to the project scope?

Two recommendations were made. The first was that the experimental work on lean ignition limits in turbulent gas flow significantly improves current knowledge of a key parameter of hydrogen behavior and is an outstanding example of the value of RD&D. This work should be made more accessible to the general technical community, which still may not fully understand this important characteristic of hydrogen behavior. The second was that the team needs to state all four ignition sources of studies on one slide (welding arc/spark plug/laser/lit cheesecloth).

Hydrogen Safety Panel: Steven Weiner, Pacific Northwest National Laboratory



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer stated that the panel members represent a broad and balanced perspective on safety and technology and give valuable input and guidance to the program. To another, the project is essential to meeting DOE objectives and provides a valuable forum to identify and address safety issues. The Safety Panel is a key component of DOE's safety, codes and standards work. A reviewer said that this is one of the best projects within the hydrogen program portfolio. Due to perceived safety issues, incorporating sound practices into every project is critical to its outcome. Similarly, the panel's mission is important to mitigate the risk of hydrogen incidents, which could hinder the installation and commercialization of technologies. The final comment was that this was a very relevant topic.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Review comments were that there were excellent results and accomplishments, and that the team has covered a lot of information and had many accomplishments--especially for the low frequency of meetings. The analytical approach and the ability of the PI and his team to stay on top of safety issues were also highlighted. A reviewer stated that PNNL has assembled an excellent mix of experts with a broad range of relevant experience. The interaction of the Panel with practitioners in the field is outstanding, and the level of engagement of the Panel members with the practical issues of hydrogen safety is exemplary.

A reviewer did say that the approach seems a little bureaucratic in general, but the reviewer could not offer a logical alternative to improve that. The approach therefore seems logical to accomplish the intended results. Opportunity for feedback by the applicant is an important part of the approach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

The amount of reviews and safety recommendations are impressive to one reviewer, and demonstrate the clear need for this kind of resource as the technology is advancing, which is very valuable. Another spoke of the excellent progress towards safety evaluation and integration and the positive feedback from industry participants about the process and accomplishments. A reviewer commented on the very proactive approach which addresses concerns in a timely manner. The panel has accomplished an impressive list of safety reviews, recommendations and the like. There was good engagement with Shell/APCI on the public White Plains incident.

The Panel has established a good record of safety plan reviews and planned follow up. The Panel and PNNL should state more explicitly criteria for selecting facilities for safety plan review and a more formal method to integrate lessons learned from the plan reviews into an overall guidance document of principles for safety in hydrogen projects.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer observed that where the collaboration is outstanding as it is, there are sure to be more valuable relationships established with the continuation of this panel. Other comments discussed the excellent team, the well-coordinated and clear objectives, the good collaboration with EU and the Japanese, and the fact that the nature of the panel incorporates a high degree of collaboration which is good. A reviewer suggested that the team could coordinate better with CaFCP/ JHFC.

The active involvement of Panel members in site visits and evaluation of safety plans of DOE projects is good, in the opinion of the final reviewer. The interaction with industry, such as involvement in evaluating the fire at the Shell fueling station, is also good and adds to the value of the Panel. The involvement of the Panel in reviewing the Fuel Cell Vehicle safety prop and the safety course is a good example of interaction of the Panel with other parts of the DOE safety program.

Question 5: Has the project effectively planned its future work in a logical manner?

Future work plan comments were generally positive: there was an excellent plan for future work, and the panel looks like it has a healthy list appropriate work to address for the next year. A reviewer said that the future work is focused on completing FY09 activities, but FY10 work remains largely undefined. It seems likely that the Panel will continue to conduct important work on a case-by-case basis. A more strategic approach that focuses the expertise of the Panel on critical issues and needs may add more value to the work of the Panel. The final comment was that the follow-up on recommendations from the safety reviews should be the priority to validate the work by the panel.

What are the project's strengths?

Among the strengths were the excellent team and accomplishments, the technical experts with wide background who are highly professional and responsive, the high degree of participation in events and reviews, and the good list of experts on the Panel and body of work accomplished so far. A further strength is the excellent mix of expertise and experience on the Panel and strong engagement of the Panel with practitioners in the field. The Panel addresses important issues as they come up.

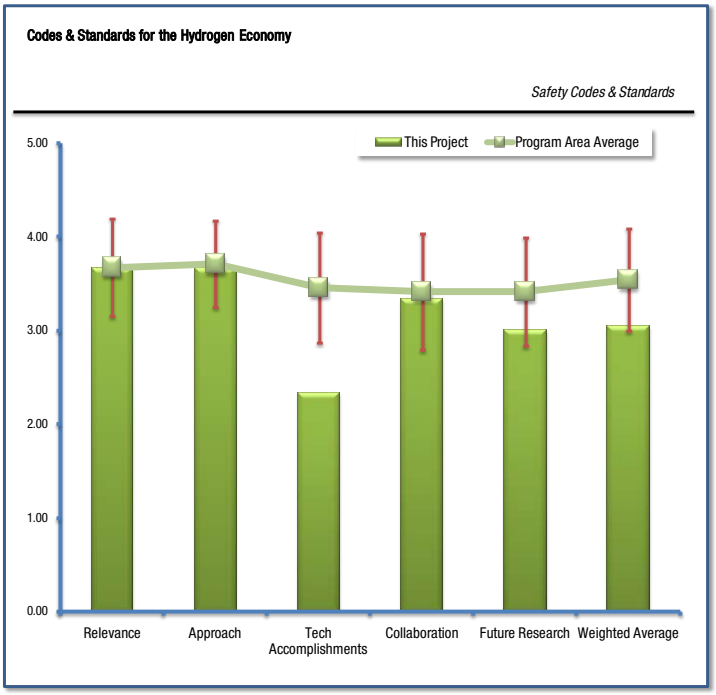
What are the project's weaknesses?

The weaknesses identified by reviewers were that the team is perhaps too ad hoc and has a reactive approach to selecting activities to focus its expertise, and that the project has a limited budget and reduced scope. A reviewer spoke of the outreach of results from the safety panel to share its accomplishments so industry knows what's being done to insure safety, show lessons learned and validate safety systems already in place if the Panel has evidence where they worked as designed.

Do you have any recommendations for additions or deletions to the project scope?

The Panel has the potential to serve as DOE's primary resource for hydrogen safety assessment and strategic planning. This reviewer thought the team should focus more on programmatic issues rather than individual projects to add more value and make better use of the depth and scope of expertise embodied in the Panel. Exploration of a more formal role for the Panel in gathering information and applying its expertise to accident investigation (for the Hydrogen Safety, Codes and Standards program) should be considered. Another recommendation was to conduct outreach of results from the safety panel to share its accomplishments so industry knows what's being done to insure safety, show lessons learned and validate safety systems already in place if the Panel has evidence where they worked as designed. A third reviewer said this was one of the most essential programs on the hydrogen side, and the budget should not be cut, but rather DOE should increase support if possible in critical areas as defined by team (especially hydrogen station components).

Codes & Standards for the Hydrogen Economy: Gary Nakarado, Regulatory Logic – POSTER



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer stated that DOE codes and standards are critical to enabling hydrogen development and programs. Another comment was that development of a coherent set of codes and standards is critical to both vehicle-related standards and infrastructure development and deployment. Awarding of subcontracts is crucial to allowing the subcontractor projects to address the DOE barriers

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer highlighted the logical approach designed to award the subcontracts. Another noted that conflicts between national and international standards are being addressed but there is more work to be done. Training of code officials has been very helpful in addressing AHJ concerns through education and outreach. Finally, a reviewer said that the approach in slide 12 appears to be focused on the process of implementing the codes and standards contracts rather than specific items associated with the goal of accelerating the development of codes and standards.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer said that this is a big project, but funds have been no faster to move to the subcontractors using Reg Logic than they were when the funds came directly from DOE. However, there is more work involved for subcontractors as a result. So overall, from this reviewer's perspective, this project has not yet reached the additional efficiency it was designed to accomplish. Another observed that the code pollution process is inherently slow: domestic SDOs and code writing organizations work on a three to five year revision process, and International Standards take years to develop. The final comment was that the accomplishments in task overview slides are focused on project management rather than the progress of codes and standards development. Further information on progress toward overcoming the barriers would be useful. Additional information on the acceleration and progress of other standards would be useful (similar to the CSA slides (for other standards). The Hydrogen/Fuel Cell Codes & Standards website is good but the "future status" or "next steps" of the standards would add value to the website(such as standard committee is active in revising the standard for future release in the third quarter 2009 or standard is complete and currently not being revised by the committee).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer said that communication with subcontractors has been good, but perhaps more action is needed to respond to their frustrations. Another comment was that SAE and CSA have been out in front of the hydrogen codes and standards development. Incorporation of DOE-funded research results has been instrumental in modifying NFPA and I Codes.

Question 5: Has the project effectively planned its future work in a logical manner?

A reviewer thought that the proposed future work is appropriate but the team needs to reduce subawardee time and streamline the process. Another said that the future work addresses overcoming some of the identified barriers. It shall be seen what the impact of the latest DOE funding has on future progress. Funding of diverse SDOs may be replaced with funding of targeted individuals who have specific expertise to influence the C&S process. The final comment was that the future work slide included only project management tasks: additional comments regarding plans to address barriers would be useful.

What are the project's strengths?

The strengths identified were that the project has the potential to be a more efficient way to award subcontracts and that streamlining the award process will enable the application of more targeted experts to the code-making process.

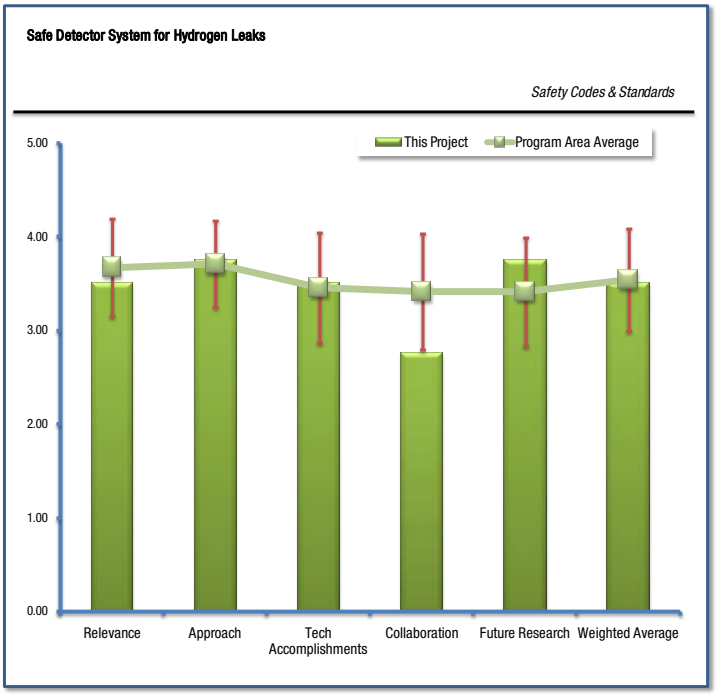
What are the project's weaknesses?

In the first reviewer's opinion, this project has not yet achieved the higher efficiency designed by utilizing them. The efficiency is the same. However, since it takes more work to respond as a subcontractor for the subcontractor, the end result is reduced efficiency. Aggressive addressing of the bullets in future work could improve this. A second reviewer did not identify weaknesses, but suggested the team could perhaps engage more individual expertise as opposed to organizations.

Do you have any recommendations for additions or deletions to the project scope?

It is not clear how a reviewer should approach this project, said the first commenter. Regulatory Logic's effort is largely an administrative one, attempting to streamline contracting and payment processes with a number of codes and standards organizations and expert consultants. In this regard, it seems that Regulatory Logic has performed acceptably (the reviewer would rate all categories Good). If the intent is for the reviewer to assess how well the subcontractors are addressing barriers related to codes and standards, there is hardly sufficient information in the supplied material to make that assessment and the reviewer would not expect Regulatory Logic to be able to provide sufficient information either. The reviewer would suggest that administrative contracts, such as this, not be reviewed as they do not fit the structure of the merit review process. If the intent was to assess the efforts of the subcontractors, please have them present their efforts individually.

Safe Detector System for Hydrogen Leaks: Robert Lieberman, Intelligent Optical – POSTER



Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?
A reviewer said that the project aligns with program goals and objectives but it was unclear based on presentation how this aligns with the NREL/UL task on sensors. Another said that data regarding reliable accurate sensors is needed by industry. The final comment was that this was a very relevant sensor for a vehicle or garage.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
The analytical approach shows much promise for one reviewer, while another highlighted the logical approach to hydrogen sensors. A reviewer offered that there are discrepancies in industry with regard to the usefulness of sensors that are currently required in many applications. Additional data is needed to validate the sensors will perform as indicated/required. The final reviewer had several questions. Why are the specification targets more challenging than the DOE targets from the 2007 workshop? What are the results of the marketing study and application? How does this study get implemented into the research task?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.
The first comment was that the project has been progressing on schedule and achieving admirable results. A reviewer said that this sensor should be tested by the NREL protocol and test system to verify the data supports the work published. The final reviewer had three observations: the sensor has no cross-sensitivity with helium or argon; the sensitivity to humidity is compensated within unit; and the unit appears to have potential to be a cost effective, accurate sensor.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?
To one reviewer, this project had a good team, but a more detailed roles and responsibilities list would have been more effective. Another commented that the presentation was not very well defined regarding collaboration (internal IP). The final commenter said that collaboration shows a mix of industry and research-focused individuals which is good.

Question 5: Has the project effectively planned its future work in a logical manner?
A reviewer felt there was a very good plan regarding future work: another noted that there is much work to be done next year, if the project is funded. The final commenter said that the future work was reasonable based on their results to date. Before integration into a system, the data should be independently verified by the NREL system.

What are the project's strengths?

Strengths noted included the good technical accomplishments and approach, the high potential to utilize if claims are realized, and the low cost, high accuracy potential with no cross-sensitivity. A reviewer said that the team is addressing key areas that need additional work to improve hydrogen sensors. The final comment was that there are discrepancies in industry with regard to the usefulness of sensors that are currently required in many applications. Additional data is needed to validate whether the sensors will perform as indicated/required.

What are the project's weaknesses?

The first reviewer was not clear if this has an application and was not clear what the cost target will be for the system and if this should be a go/no go decision point. The other review comment was that the team could use better collaboration with other sensor experts and companies that would use them.

Do you have any recommendations for additions or deletions to the project scope?

After successfully completing laboratory tests at NREL, it is recommended to do a field trial within a controlled workbay where the other sensors are calibrated (e.g. CGD). A site for a potential contact would be the CaFCP workbay, where CGD have been proven problematic and false alarms are not infrequent.