2008
Safety and Codes & Standards
Summary of Annual Merit Review Safety and Codes & Standards Subprogram

Summary of Reviewer Comments on Safety and Codes & Standards Subprogram:

In general, the Safety and Codes and Standards subprogram reviewers stated that projects were productive and successful. The Reviewers were impressed by the breadth of activities and the ongoing commitment to safety, codes, standards and information-sharing activities. They stressed that successes in this subprogram touch every other DOE hydrogen-related activity by fostering acceptance, collaboration and communication with critical stakeholders.

Reviewers stressed the importance of continuing efforts in critical areas such as hydrogen materials research, hydrogen codes, standards and permitting coordination efforts, hydrogen quality, and safety incident reporting and best practices. Suggestions for maximizing progress included leveraging the efforts of universities, standards organizations, national labs, complementary government agencies, and industry, as well as other subprograms.

Six safety projects were reviewed. The *Hydrogen Codes and Standards* work was praised for its varied engagement with industry, government, and researchers, particularly national laboratories. This work is seen as essential to fully address the Program barriers. However, reviewers felt that a better explanation of the relationship between computational fluid dynamics (CFD) activities and the codes and standards work was needed.

The *Hydrogen Materials Research and Development* project is focused on materials research to support the development of technically sound codes and standards to ensure the safe design of infrastructure for the storage and transport of high-pressure hydrogen gas. The project was praised for its highly relevant technical accomplishments, careful planning, and close collaboration with industry and Code Development Organizations (CDOs) and Standards Development Organizations (SDOs.) The availability of the pressure vessel for high-pressure testing was deemed a particular asset to this work. It was suggested that expanding the candidate materials for testing, perhaps by polling the Program at large, and adding test conditions reflective of particulate formation in a fueling system would enhance the project.

The *Hydrogen Safety Tools: Software and Hardware* project was considered to be valuable in terms of outreach to relevant groups. The open sharing of lessons learned exhibited in the incidents database was seen as the proper approach to take and a good complement to the rest of the Safety program. In addition, the construction of the hydrogen fuel cell vehicle simulator prop and the collaboration with first responders in the prop's development were seen as beneficial. It was suggested that focusing on incidents with commercial compressed gas storage might be more elucidating than focusing on industrial hydrogen practices. Reviewers also encouraged greater interaction with other transportation communities and NASA.

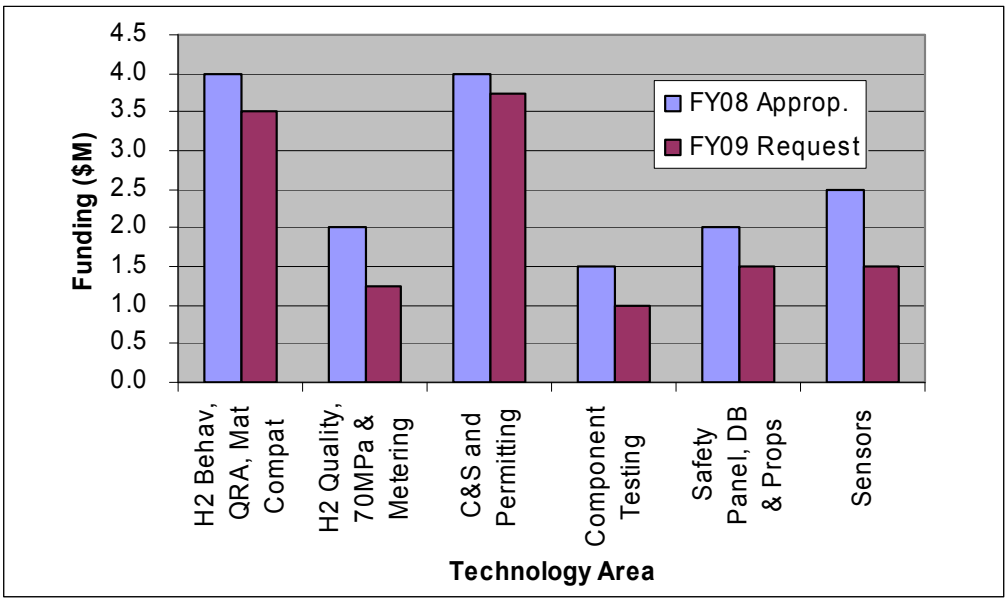
Hydrogen Quality work was praised for its strong underlying approach, emphasizing uniformity in data reporting, round-robin verification of methodology, and overall coordination of testing. Some reviewers noted that the project has not sufficiently taken advantage of the large amount of data in other subprograms. The Hydrogen Safety Panel was regarded as an important activity in which more work is needed. Industry representation was seen as a strength of the Panel, although some reviewers noted that more participation from automakers would be beneficial. The number of safety plans reviewed was

considered realistic given the time involved. However it was noted that there was room for improvement in terms of the number of safety reviews conducted.

Finally, the *Codes and Standards for the Hydrogen Economy* project, which is not a research and development activity, was seen as playing an important, although sometimes difficult, management and support role to codes and standards development organizations dealing with hydrogen technology. It was noted that the project strives to continually improve its business operations. However, it would be beneficial to emphasize the tracking of project deliverables.

Safety and Codes & Standards Funding:

Safety and Codes and Standards funding includes international activities as well as national development and coordination among several agencies. While funding had been a major concern in the past, the subprogram has received full funding for the past two fiscal years. This fiscal year, the subprogram received full funding.



Majority of Reviewer Comments and Recommendations:

Subprogram scores were average to high, with an overall average of 3.7. The planning and analysis for the Materials Compatibility effort was praised. The close collaboration exhibited in the Hydrogen Codes and Standards activity was seen as impressive. The database, best practices manual, and hydrogen fuel cell vehicle simulator prop were viewed as good ways to disseminate hydrogen safety information. The Hydrogen Fuel Quality work, which is seen as key to a successful transition to widespread adoption of hydrogen technology was praised for its coordination. The Hydrogen Safety Panel was viewed as important part of the continuous safety process.

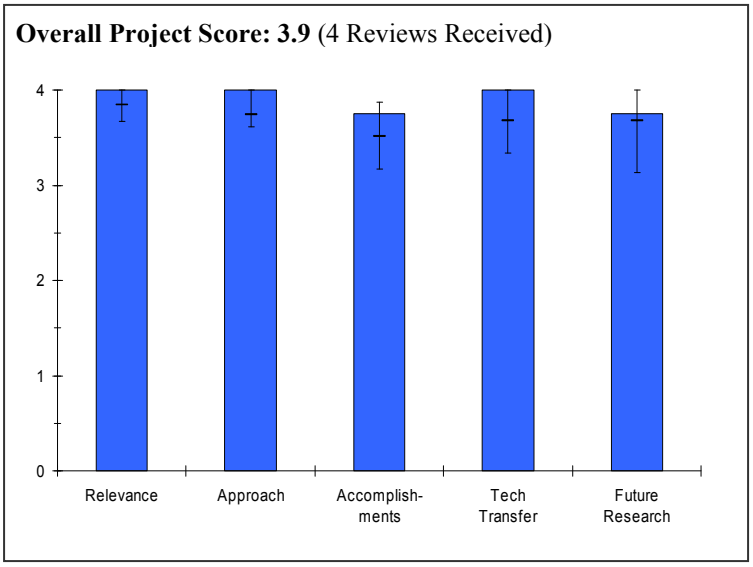
Recommendations included:

- Improve collaboration between international and domestic SDOs under the purview of the Codes and Standards activity.
- Expand materials set to include new materials and "legacy" materials. Effects such as brinelling and other materials degradation should be considered for the Materials Compatibility work.
- Garner content for the incidents database and best practices manual from commercial rather than industrial practices.
- Leverage data from existing projects and open sharing and cataloguing of data among researchers for benefit of the hydrogen fuel quality project.
- The Hydrogen Safety Panel should increase its output of safety reviews and white papers.

Project # SA-01: Hydrogen Codes and Standards
Robert Burgess; NREL

Brief Summary of Project

The objectives of this project are to 1) conduct research and development needed to establish sound technical requirements for hydrogen codes and standards; 2) support code development for the safe use of hydrogen in commercial, residential and transportation applications; 3) advance hydrogen safety, code development and market transformation issues by collaboration with appropriate stakeholders; and 4) facilitate the safe deployment of hydrogen technologies.



Question 1: Relevance to overall DOE objectives

This project earned a score of **4.0** for its relevance to DOE objectives.

- This project addresses a fundamental barrier to the introduction of hydrogen energy technologies.
- It addresses specifically and fully the listed program barriers.
- Developing technical requirements for hydrogen codes and standards is essential to the Department of Energy's Hydrogen Program to ensure that the codes and standards are developed in a manner that promotes the safe and successful commercial launch of hydrogen and fuel cell technologies without inhibiting technical progress. The National Renewable Energy Laboratory's contribution is vital in this way.
- Outstanding: domestic model code, design code, product standard, and material test method work are progressing apace with the evolution of the technology. The work is leveraging the synergy of the domestic standards development organizations (SDOs) to avoid redundancy, isolationism, and territorialism.
- The project addresses and leads to reduction of "barriers to trade" - roadblocks to technology deployment.
- This project is essential for market transformation.

Question 2: Approach to performing the research and development

This project was rated **4.0** on its approach.

- Strength: component and sensor testing; garage issues.
- Question on CFD activities: is there collaboration with the French group at INERIS/CEA concerning their garage experiments?
- Question: how do the CFD activities correlate with the codes and standards work?
- The research and development of the technical background ensures that the proper codes and standards will be developed.
- Additionally, the permitting workshops strongly support infrastructure development by educating AHJs and permit officials so the technical background behind the codes is understood.
- Outstanding. This activity is fully open to all parties and all parties are encouraged to contribute.
- This project has a focused objective to conduct the research and development needed to support sound technical requirements in consensus standards.
- Since codes and standards are by their nature collaborative activities, the approach emphasizing coordination, collaboration, workshops, and publications is exactly correct.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.8** based on accomplishments.

- Strength: excellent knowledge transfer strategy.
- Strength: excellent codes and standards coordination and development support work (e.g., ISO, SAE, NFPA C&D activities).
- Weakness: CFD/validation work concerning the garage/enclosed area problem is currently underway at CEA/INERIS as part of the DRIVE initiative (instrumented garage already available). Some collaboration would be nice for validation purposes.
- The National Renewable Energy Laboratory consistently proves itself to be a laboratory capable of conducting highly technical component testing. This project is no exception.
- Very good. Work is progressing as fast as industry is supporting it, as it should.
- The presentation documented eight diverse accomplishments, all valuable and well done.
- The presentation demonstrated good collaboration with the consensus standards community (e.g., SAE, CSA, ASTM, ISO, etc.)
- The principals demonstrated great leadership in the National Hydrogen and Fuel Cells Codes & Standards Coordinating Committee.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **4.0** for technology transfer and collaboration.

- Strength: there is tight integration and networking with international efforts.
- Strength: significant efforts have been made.
- There is much collaboration between the National Renewable Energy Laboratory and SDOs, key stakeholders, national labs, and industry. This collaboration ensures that the research benefits the industry as a whole.
- Outstanding. Being an open dialogue with all parties has established an open structure where input and information is flowing to where it is needed without presupposing who would need it.
- The principals demonstrated close cooperation with leading standards development organizations, as previously mentioned.
- The principals demonstrated great leadership in the committees on which they served.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.8** for proposed future work.

- Strength: strong and impressive program.
- The specific roles of the National Renewable Energy Laboratory and Sandia should be clarified in the future garage simulations/validations; they seem to have converging objectives
- The future work identified in the presentation is necessary. However, further research, particularly into hydrogen quality, is necessary.
- Outstanding. The future plans are to continue the course to completion.
- The proposed future work continues to be relevant and the approach continues to be good.
- The coordination between internally conducted research and development and external communities of interest continues to be well planned.
- The proposed work on back-up power for telecommunications is relevant to the program and well linked to past standards work (e.g., permitting workshop).

Strengths and weaknesses

Strengths

- This project is very strong in all of its objectives, particularly the codes and standards work.

- The National Renewable Energy Laboratory's research and collaboration with SDOs will help to ensure a safe roll out of the hydrogen industry.
- There is synergy and cooperation among all the contributing domestic parties.
- The codes and standards advanced by this work are essential in enabling technology deployment.
- There is excellent coordination and outreach.
- The external collaborations motivate and inform the internally conducted research.

Weaknesses

- An increase in the collaboration between international and domestic SDOs is necessary.
- There remains an attitude to focus activity and credit to ISO at the expense of the ANSI-recognized SDOs and code development organizations. It is important to note that state and local regulators use ANSI standards not ISO standards.
- Also, I believe that the fuel quality slide is inaccurate. See notes supplied to A. Ruiz for US Fuel Cell Council.

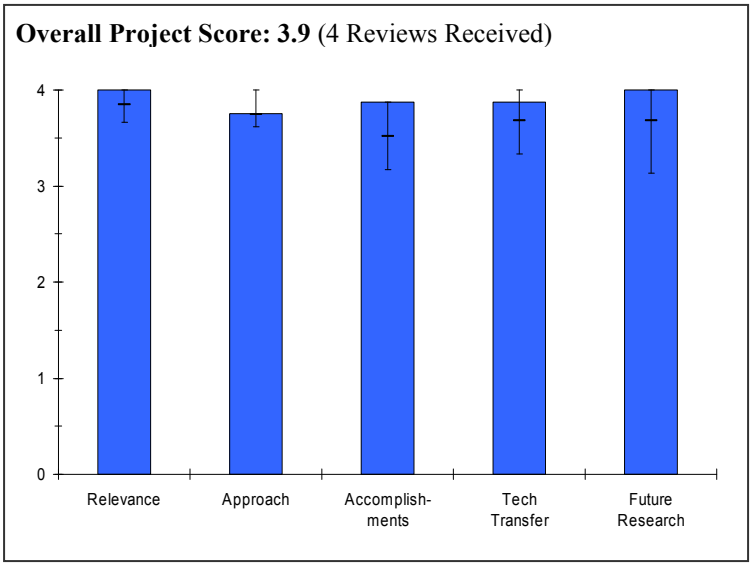
Specific recommendations and additions or deletions to the work scope

- Underground garages and tunnels should certainly be a focus of the simulation group.
- Seek specific input on this project from HySafe.
- Leak rate measurements from components.
- Hydrogen quality research efforts should extend beyond ISO and SAE. Assistance is needed in ASTM D03.14 to develop proper test methodologies.
- A 70 MPa Particulate Sampling Adapter has not been developed. The 70 MPa Hydrogen Quality Sampling Adapter collects gaseous for constituent analysis, but particulate analysis is part of the J2719; thus the ISO and DMS report/guidelines/interim standards.

Project # SA-02: Materials Compatibility
Brian Somerday; SNL

Brief Summary of Project

The objectives of this project are to 1) enable development and implementation of codes and standards for hydrogen containment components; 2) evaluate data on mechanical properties of materials in hydrogen gas; 3) generate new benchmark data on high-priority materials; 4) establish procedures for reliable materials testing; and 5) participate directly in standards development. Sandia completed measurements cracking thresholds for SA 372 Gr. J, DOT 3T, and DOR 3AAX steels in high pressure hydrogen. Also, the effects of fabrication and service variables on hydrogen-assisted fracture in 316 stainless steel were evaluated.



Question 1: Relevance to overall DOE objectives

This project earned a score of **4.0** for its relevance to DOE objectives.

- Objectives are directly relevant to addressing the cited Department of Energy barriers.
- The research into materials compatibility and associated involvement with standards development organizations taking place at Sandia National Laboratories is vital to the DOE Hydrogen Program to ensure a safe and successful industry, specifically by providing a guideline for station or technology developers to follow for assurance of hydrogen compatibility.
- Material properties are essential to safe design of hydrogen systems.
- Safe design of hydrogen systems is essential to a safe hydrogen infrastructure.
- This work supports traditional design methods.
- Hydrogen embrittlement of structural materials is an important safety consideration in technology adoption; this project provides high-quality reference data and standards to enable appropriate engineering.

Question 2: Approach to performing the research and development

This project was rated **3.8** on its approach.

- Impressive experimental facilities.
- The applied research and standard development at Sandia has proven incredibly successful, from the materials reference guide to the direct input into KD-10. Enabling the development of standards has been and will continue to be exceeding expectations if Sandia continues using the current approach.
- Good selection of materials.
- Additional materials could enhance the usability of the project data.
- It is important to also check "legacy" materials where modern data is not available, such as existing pipeline materials and existing valve, pressure vessel, and appurtenance material where data is lacking.
- It is important to test materials that are candidate materials for advanced systems. This should be done by working with advanced tank and system designers in the Hydrogen Program.
- This project provides technical data and best practices to enable rational design of hydrogen storage containers (e.g., tanks and even pipelines).
- It is a solid approach to develop engineering data through research and then to allow the consensus standards community to interpret the data and to draw the conclusions from them.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.9** based on accomplishments.

- Strength: excellent progress on the hydrogen compatibility of materials information materials.
- The technical accomplishments at Sandia are phenomenal: thorough, directly applicable.
- Very impressed with the pressure vessel to evaluate fatigue crack growth.
- Good progress.
- Learning from the results as they go.
- The compilation "Technical Reference on Hydrogen Compatibility of Materials" is particularly noteworthy.
- The pressure vessel for high-pressure testing of hydrogen is an extremely valuable asset.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.9** for technology transfer and collaboration.

- International Energy Agency Task 22/Task 19 issues.
- Sandia's direct involvement, specifically with developing KD-10, is representative of Sandia's vast amount of collaboration with industry stakeholders to ensure proper information is shared.
- The project could be enhanced by polling the entire Hydrogen Program for candidate materials of interest.
- There is direct coordination with relevant standards development organizations, including ASME and CSA, and relevant industry (e.g., Swagelok and Fibatech).
- This work complements work being done under the Production and Delivery program element well.

Question 5: Approach to and relevance of proposed future research

This project was rated **4.0** for proposed future work.

- Sandia's future research work extending beyond normal hydrogen (i.e., compatible materials fatigue testing) will add to the understanding of the mechanics behind hydrogen embrittlement and/or material fatigue associated with hydrogen. This extended understanding will assist in developing standards for safe design.
- Well-planned program.
- The proposed future research is a natural extension of on-going work.
- The work thus far emphasizes static loading. The proposed future work on fatigue crack growth rates and other deleterious effects of in-service vibration and pressure cycling would be very valuable.

Strengths and weaknesses

Strengths

- Technology, thoroughness, and a fantastic presenter.
- Excellent analytics.
- Learning from experience and data obtained.
- Supports traditional design methods, such as ASME.
- The development of fundamental engineering data by an impartial and competent laboratory is an essential part of the Hydrogen Program.

Weaknesses

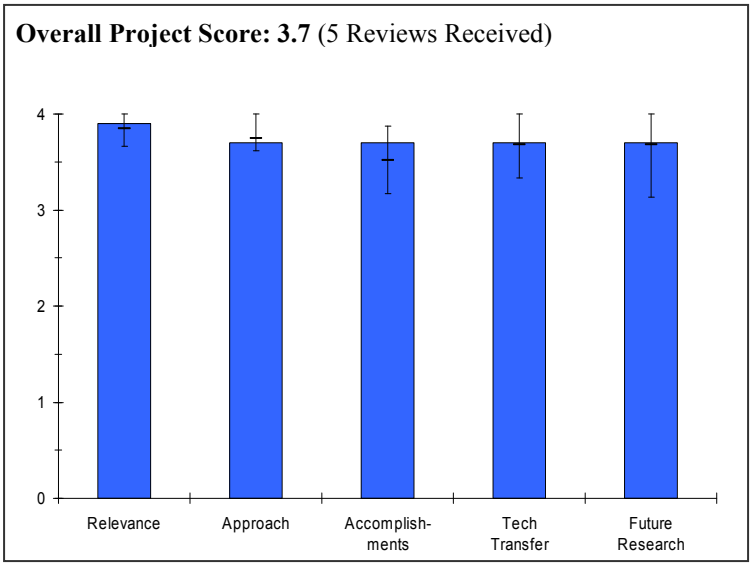
Specific recommendations and additions or deletions to the work scope

- An understanding of particulate formation in a fueling system (such as nozzle brinelling or other material break-down) would assist in the development in hydrogen quality standards.
- Polling the Hydrogen Program, at large, for candidate materials might enhance the project.
- Higher-pressure testing might be an enhancement.

Project # SA-03: Hydrogen Safety Tools: Software and Hardware
Linda Fassbender; PNNL

Brief Summary of Project

The objectives of this project are to 1) capture the vast knowledge base of hydrogen experience and make it publicly available to those working with hydrogen and related systems, including those just starting to work with hydrogen; 2) collect information and share lessons learned from hydrogen incidents and near-misses with the goal of preventing similar incidents from occurring in the future; and 3) support the design, construction, commissioning and training use of a life-size mobile fuel cell vehicle burn prop that is hydrogen-specific.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.9** for its relevance to DOE objectives.

- The project fully addresses all three barriers that it targets and will contribute to increasing the acceptance of hydrogen energy technologies among authorities having jurisdiction.
- Capturing and reporting best practices and incidents is vital to avoiding future incidents.
- Very good. The work is generating useful guidance.
- The subprojects to capture data in a coherent form (Safety Best Practices and Incident Reporting) will lead to better consensus standards and better acceptance of hydrogen technology.
- The relevance as demonstrated by the NRC Phase 2 Report on FreedomCAR is documented on Slide 3.
- The simulator prop is very valuable for training first responders.

Question 2: Approach to performing the research and development

This project was rated **3.7** on its approach.

- The approach addresses all three barriers the project is supposed to address: best practices manual; fuel cell vehicle training (simulator prop); incident reporting (database).
- Web-based tools and hands-on props speak directly to the appropriate audience(s). However, an online submittal form may not provide industry members with sufficient confidence in submitting incident reports.
- Very good. The approach is rational and working.
- Need to reach out more to transportation communities, especially vehicle manufacturers (truck manufacturers associations) and maintenance organizations; for example, USDOT/PHMSA (pipeline safety and HAZMAT transportation); ASE; USDOT/PTA (hydrogen and fuel cell transit).
- The principals are to be commended for developing a well-organized and public website.
- The open sharing of lessons learned is exactly the approach best taken.
- The reporting tool is a good complement to the Safety subprogram.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.7** based on accomplishments.

- Strength: database, prop, and best practice manuals are all important contributions to hydrogen safety.

- Weakness: missing some important NASA input (the NASA Safety Standard and the NASA Glenn Safety Manual chapter 6).
- The websites and prop accomplish the goals of this project.
- Very good. The progress is where one would expect at this point in the project.
- The site is easy to navigate and use. A few "mouse-overs" need to be checked, they are hard to point to.
- Add "vehicle (car/truck/bus)" to choice of "settings" on hydrogen incidents page.
- Impressive accomplishments were made on all three subprojects (see, e.g., Slides 7, 9, 14, 17, and 18).

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.7** for technology transfer and collaboration.

- Strength: very good interaction.
- Weakness: is some NASA input to the database possible?
- It appears that the safety tools have most key stakeholders involved.
- Very good. This activity is being conducted with complete transparency.
- Overall, very strong. Should reach out more to vehicle operations and maintenance communities.
- Particularly impressive aspects of this project are its public face and the depth of data and design reviews conducted.
- The collaboration with firefighters (first responders) on the simulator prop is very good and beneficial to the Hydrogen Program.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.7** for proposed future work.

- The hydrogen fuel cell vehicle simulator prop should be integrated with current first responder training, already developed.
- Continuous updates to the websites will further help to avoid future incidents.
- Very good. This activity should continue the course.
- Need to consider needs of end-user communities with less engineering and technological expertise.
- The additional data proposed for the websites (Slides 10 and 15) are useful and appropriate.

Strengths and weaknesses

Strengths
- Important contributions to facilitate the introduction of hydrogen energy technologies.
- Industry support.
- Highly accessible, comprehensive, "one-stop shop". Excellent progress, strong reporting, and posting of work in progress.
- The extent to which the public is clearly the "customer" of this project and the many steps taken to ensure customer satisfaction.
- The depth of data and design reviews conducted.

Weaknesses
- Focus on hydrogen, which is following industrial practice, and not compressed gas storage, which follows both industrial and commercial practices.

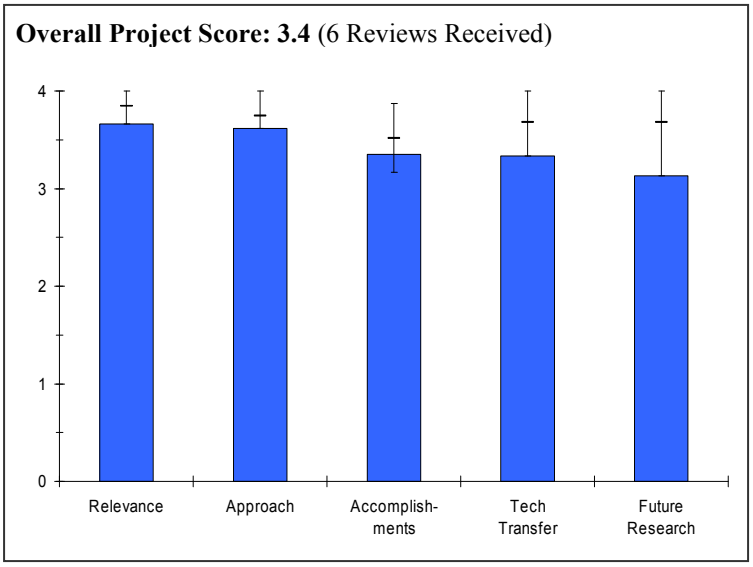
Specific recommendations and additions or deletions to the work scope

- Projects should actually be compelled to contribute incidents.
- A second database on commercial compressed gas vehicle incidents may be more instructive as far as lessons learned than monitoring industrial hydrogen practices.

Project # SA-04: Hydrogen Fuel Quality
Tommy Rockward; LANL

Brief Summary of Project

The objectives of this project are to 1) conduct gauge studies with testing labs and address experimental differences, thus increasing the confidence in the data; 2) create and standardize a Data reporting Format; 3) develop and test new analytical methods for detecting ppb levels of contaminants; and 4) test the critical constituents (NH_3, CO, and H_2S) and provide data sets to fuel cell modelers to establish predictive mechanistic models.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.7** for its relevance to DOE objectives.

- Excellent alignment with key barriers to achieving codes and standards for implementation of fuel cell technologies in the United States and for consistency with emerging international standards.
- The project is highly relevant and addresses important barriers.
- Hydrogen fuel quality has the ability to hinder the industry if inappropriate standards are set. Hydrogen quality research is vital to a successful industry launch.
- Very good. This activity has addressed a lack of coordination in the research in this area. The activity is now coordinated and the researchers are attempting to collaborate.
- The project is well in line with key Department of Energy objectives on hydrogen standardization.
- The smoothing of conflicts is particularly useful in U.S. situations with a variety of actors.
- Addresses an important barrier, the development of harmonized standards for hydrogen quality determination and requirements.

Question 2: Approach to performing the research and development

This project was rated **3.6** on its approach.

- Strong approach that leverages data from multiple sources for reliability and reproducibility.
- Good balance between understanding fundamentals of fuel impurity impacts, developing analytical methods for impurity detection, and developing codes and standards based on what is technically feasible.
- Very strong round-robin testing approach in which same cell tested by multiple participants with initial and final tests at Los Alamos National Laboratory.
- Strength: standardization efforts (reporting format, round robin verification of methodology) are a very worthwhile objective.
- Weakness: the study seems to address only specific contaminants. There is probably an effect from the storage technology used (chemical hydride storage, metal hydrides, adsorbents) on the level and the nature of impurities on the hydrogen released, and it would be important to perform such studies. This could actually help to qualify the usefulness of these storage strategies.
- Understanding the effects of constituents on the fuel cell stack and identifying proper analytical methods is the appropriate approach.
- The round-robin testing with the single cell utilizing the U.S. Fuel Cell Council procedure to calibrate all laboratories involved reduces potential future technical barriers.

- Outstanding. The round-robin activity forced the researchers to work together to generate and execute a detailed test method and resolve testing anomalies. This activity has resulted in data that is repeatable at a number of labs and reproducible among labs. This allows the merging of test data sets from multiple labs with a high degree of confidence.
- The approach is good with clear indication of activities to overcome the addressed barriers.
- The use of round robin requires better description in the way fuel cells systems, used as reference test sample, are chosen.
- The PI is not clear in distinguishing the role of round robin, which is addressed to verify data reproducibility on fuel quality in various test labs, from the research needs to analyze fuel impact, which mostly depend on fuel cell system design and operating conditions.
- Very good combination of determining what the sensitivity of testing is and then identifying the methods for testing for the critical impurities.
- The overall thinking is that technology development and codes and standards development should go in parallel. This project is carrying its own effort in parallel – learning about the impurities effect on fuel cells and identifying how the codes and standards should be developed. This is a good approach.
- There seems to be a great amount of effort in making sure that they "get it right." This is evident in the painstaking method of testing the cells before and after the round robin, and in running the round robin in an exhaustive manner. The amount of data gathering gives one confidence.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.4** based on accomplishments.

- Excellent progress in developing and demonstrating consistent testing protocols and results at a good number (4+LANL) test sites.
- Good progress developing data reporting format. Not sure if this format has been implemented yet or will be tried this coming year.
- Excellent progress assessing impact of H_2S, NH_3, and CO on fuel cell performance and understanding the mechanisms that lead to degraded performance.
- Longer duration contaminant studies will probably be necessary, and evaluation of recovery from higher impurity concentrations should be evaluated.
- Good breakthrough in developing method to assess sulfur ion concentration at very low concentrations.
- Strength: good progress so far on standardizing and validating measurements.
- Weakness: identifying contaminants and tolerance to contaminants (only sulfur was completed?) should probably have been an earlier priority, as this may affect the testing procedures.
- The collection of data thus far appears thorough and accurate.
- Very good. One barrier appears to still remain, the parochialism of the researchers to share unpublished data. This perceived barrier may delay completion of this effort beyond the DOE target dates.
- The results are valuable and interesting in harmonizing fuel quality analytical methods and specific equipment for contaminants determination.
- The round robin is instrumental to create a common basis for hydrogen fuel specifications and measurements.
- The PI does not clearly explain how contaminants analysis is related to fuel cell characteristics and operations, which makes this activity less relevant to harmonize fuel analysis methods to address DOE barriers.
- A large amount of progress appears to have been accomplished by the Los Alamos National Laboratory team.
- The team seems to have successfully moved from calibration and standardization, through Los Alamos National Laboratory and the round robin tests, to conveying with confidence that impurity data are not cell or test-method anomalies.
- The only minor issue here is that the presentation was a bit hard to follow in places. The presenter needed a pointer.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.3** for technology transfer and collaboration.

- Good collaboration among team members.
- Good effort to implement data reporting formation as part of standards community.
- Additional collaboration with ASTM and industry members should be included.
- Very good. The industry and academic cooperation is working well.
- The national testing network is well coordinated with good integration of testing laboratories and expertise.
- The PI describes the international activities well, along with the development of the data reporting format.
- The extensive collaboration with modelers and developers requires better description to identify actors and advantages for each.
- Seems like a good and successful use of the round robin participants.
- A bit unclear as to what the roles of the lab partners (SRNL, NIST, NREL, ANL) were.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.1** for proposed future work.

- Reasonable extension of prior activities.
- Need to address what the recommended impurity standards are going to be in terms of what can be measured and what is actually required for fuel cell performance. Focus seems to be too much on pushing the envelope on what is possible analytically in terms of detection without adequate tie-in to what level of analytical detection is required in terms of practical fuel cells.
- Strength: coherent future research that builds on past progress planned.
- Weakness: the effect of the production/storage/purification chain on contaminant levels should probably be addressed.
- Cannot wait to see the results of all of this hard work!
- Very good. The task is to follow through with the plan.
- The future activities are well-aligned with the DOE barriers and previous results.
- The planning must better focus on basic testing procedures definition with the extension to other laboratories and coordinate with international activities.
- The contaminant-effect analysis requires better specifications with clear identification of reference samples (fuel cell) and stakeholders.
- Their proposed future work appears to be just what is needed.
- The international portion may be difficult.

Strengths and weaknesses

Strengths
- Important project that could affect several aspects of hydrogen energy technologies – production, purification and storage technologies.
- Collaboration with industry and researchers.
- The project has created a large testing network with valuable collaborations to be used for further harmonizing common testing analytical methods.
- The international role is very important with adequate resources and expertise to fully support the action in ISO activities on fuel quality specifications and standards.
- Painstaking care in approach.
- Data look quite convincing.

Weaknesses
- Lack of a database of contaminants and their effect on fuel cell.
- Parochialism of researchers with data.
- The project must be sure to effectively represent in international setting bodies the complete needs and expertise in the United States.
- The planning does not clearly specify the existing collaborations and the technical background to make the contaminant analysis more effective.

- The project is not sufficiently using the large amount of research work and results on testing methods and contaminants analysis coming from specific projects in other subprograms, such as Fuel Cells, Technology Validation, and/or Analysis.
- Some of the presentation was a little hard to follow. (Give the young man a pointer to use next time!)

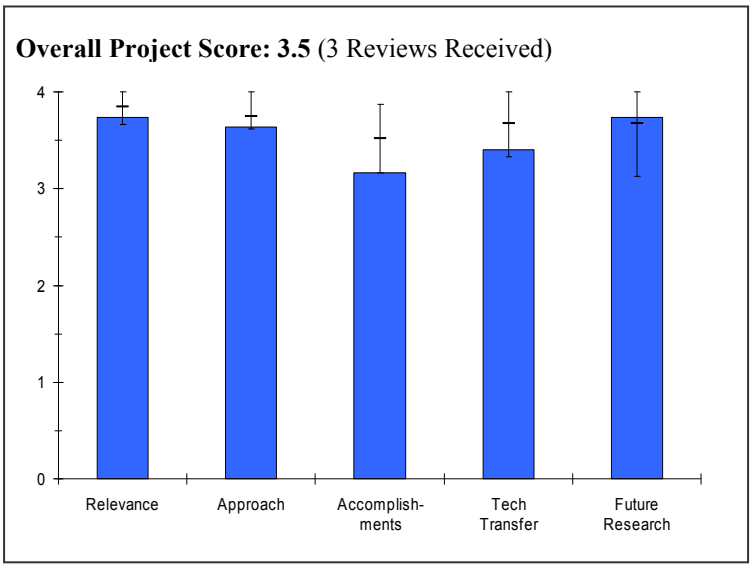
Specific recommendations and additions or deletions to the work scope

- Fuel impurities that would come from unconventional storage units. Coordinate with Storage activities, specifically, metal hydrides, physisorbents (also important in purification), and chemical hydrides.
- Evaluation of commercial and industrial cleansers. The hydrogen-containing components need to be cleaned to prevent contamination. The cleanser should not be a contaminant.
- The project must focus more on analytical methods and the creation of the large testing network for fuel quality analysis.
- The project must use more ongoing projects' results by screening and extending collaborations with other projects in different subprograms.

Project # SA-06: Hydrogen Safety Panel
Steven Weiner; PNNL

Brief Summary of Project

The objectives of this project are to 1) provide expertise and guidance to the Department of Energy (DOE) and assist with identifying safety-related technical data gaps, best practices and lessons learned; and 2) help the DOE integrate safety planning into funded projects to ensure that all projects address and incorporate hydrogen and related safety practices. Pacific Northwest National Laboratory will engage panel members, original equipment manufacturers, energy companies, international partners, first responders and other stakeholders in all aspects of the hydrogen safety program.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.7** for its relevance to DOE objectives.

- Safety should be the top priority of the Department of Energy's Hydrogen Program. The hydrogen safety panel ensures that all safety concerns are thoroughly investigated to reduce risks in the future, thereby ensuring the safety of all involved.
- Very good. The safety review of the DOE projects is an important activity.
- Very relevant. Need more work here.
- Make an effort to engage local agencies in some way – personally, meetings, briefs, etc.

Question 2: Approach to performing the research and development

This project was rated **3.6** on its approach.

- It is important to note that safety is a continuous process. As long as industry members are and will remain active, the approach is sufficient.
- Very good. The process is tried and true.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.2** based on accomplishments.

- It would be beneficial to see more whitepapers come from this group.
- Good. The number of safety plans reviewed (approximately two per month) is realistic. However, the conduction of only five safety reviews (about half a review per month) shows an area for potential improvement.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.4** for technology transfer and collaboration.

- More participation from automakers.
- Very good. This activity is being conducted with complete transparency.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.7** for proposed future work.

- Again, safety is a continuous process. The future work proposed is necessary.
- Very good. This activity should continue the course.

Strengths and weaknesses

Strengths
- The team has strong technical background, good industry input.
- Industry representation.

Weaknesses
- The number of safety reviews. It is not unreasonable to think that one project a month is attainable without overly taxing the volunteer membership. Focus should include the academic labs working with hydrogen and other compressed gases.

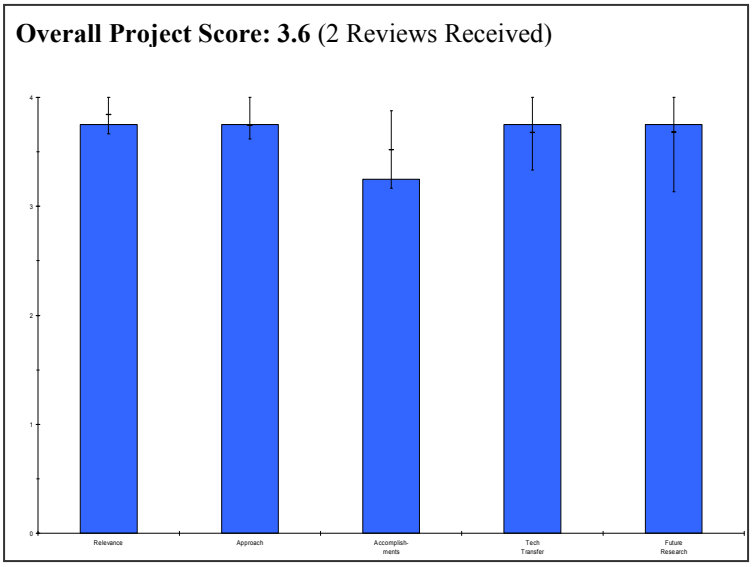
Specific recommendations and additions or deletions to the work scope

- The effects of these safety learnings on liability, insurance, etc. for station developers and/or owners was not shown as addressed in the presentation. There may become a more prominent need for the industry as stations are built if this is not already being investigated.
- Engage local fire and safety officials.
- Publicize panel activities on websites (e.g., EERE, PNNL, etc.).

Project # SAP-01: Codes & Standards for the Hydrogen Economy
Gary Nakarado; Regulatory Logic

Brief Summary of Project

The objectives of this project are to 1) accelerate the availability of appropriate codes and standards to ensure consistency and, if possible, uniformity of requirements and to facilitate deployment; 2) enable certification to applicable standards in order to facilitate approval by local code officials and safety inspectors; and 3) promote uniform standards because manufacturers cannot cost-effectively manufacture multiple products that would be required to meet different and inconsistent standards.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.8** for its relevance to DOE objectives.

- Very good in support of enabling the Department of Energy to support the development of model codes, design codes, and product standards and material test methods.
- Codes and standards are essential for technology deployment and risk management (insurance underwriting).
- Standards development organizations provide fora, but standards do not actually get written without determined and sustained leadership.
- Leaders are often volunteers and the individual financial burden (e.g., meeting travel) is more than they can personally sustain.
- This project provides support to leaders to ensure that codes and standards actually get written.

Question 2: Approach to performing the research and development

This project was rated **3.8** on its approach.

- Good in support of enabling DOE to generate the appropriate test data to support the development of the document types noted above.
- This project is outsourced, back office support for DOE an the National Renewable Energy Laboratory.
- The function of this project is to disperse support payments, using subcontracts, to standards development organizations (most often, non-profit organizations) or otherwise support standards development for the public good.
- This project performs low-overhead business services.
- This project, by its nature, performs no research and development and makes no technical decisions.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.3** based on accomplishments.

- Good in support of enabling DOE to meet its self-imposed scheduled deadline.
- The project is performing its business function well.
- In future reviews, presentation should clarify what the subcontract deliverables are and whether or not they are meeting expectations.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.8** for technology transfer and collaboration.

- Does not apply. The closest comment is that they appear to be properly supporting the DOE-selected standards development organizations.
- The essence of this project is collaboration within voluntary consensus standards organizations.
- The consensus standards process produces documents that describe best technology and practices, for general public benefit.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.8** for proposed future work.

- Does not apply. The closest comment is that they appear to be properly supporting DOE by directing additional research contracts as directed by DOE in direct support of the above discussed types of documents.
- The project strives for continuous improvement in its business operations.

Strengths and weaknesses

Strengths
- Supports DOE with financial administrative support.
- Unloads national laboratory assets.
- Appears to be more cost-effective and responsive than having the national laboratory administer.
- Codes and consensus standards take years of work and must be produced well in advance of technology deployment, which their absence can often frustrate.
- This project addresses the reality that standards are often written by volunteers (such as retired persons), who would otherwise have no source of support than their own personal funds.
- This project allows the sustained effort of volunteers, which they might otherwise be unable to provide.

Weaknesses
- Although this project does not make technical decisions, increased emphasis should be given to tracking the subcontract deliverables.

Specific recommendations and additions or deletions to the work scope

- None.