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

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

Reviewers for the Safety and Codes & Standards Subprogram commented that these projects were very relevant to other DOE activities such as the Tech Validation subprograms, and necessary to furthering the development of national and international codes and standards for the hydrogen economy. Additional focused efforts in critical areas such as hydrogen fuel quality, set-back distances, research and demonstration on the gaps in hydrogen codes and standards, understanding risks, and materials research needs to continue in order to make progress in this area. Leveraging efforts and coordination among universities, standards organizations, national labs and industry was seen as valuable and effective to get a consensus on codes and standards.

Safety projects for this period included the HAMMER emergency response training activities. Comments on the project indicated that there is a need for safety training and that training for first responders is very important to the President's Hydrogen Fuel Initiative. The Safety Panel is continuing its activities this year and has become an important part of DOE activities to ensure the projects funded are operating with safety as a priority and that uniform safety protocols are being utilized. Comments received by some reviewers indicated that the Panel will experience a significantly increased workload in the near future and the Program should accommodate this need.

Evaluating hydrogen demonstration/refueling systems on a world-wide basis is a project that received relatively high scores. A database is being developed to document the International Energy Agency activities and will model and assess these stations.

Continuing concern was expressed over the low or reduced level of funding for the Safety and Codes and Standards subprograms, due to Congressionally-directed projects, and how the low funding could jeopardize maintaining overall DOE objectives.

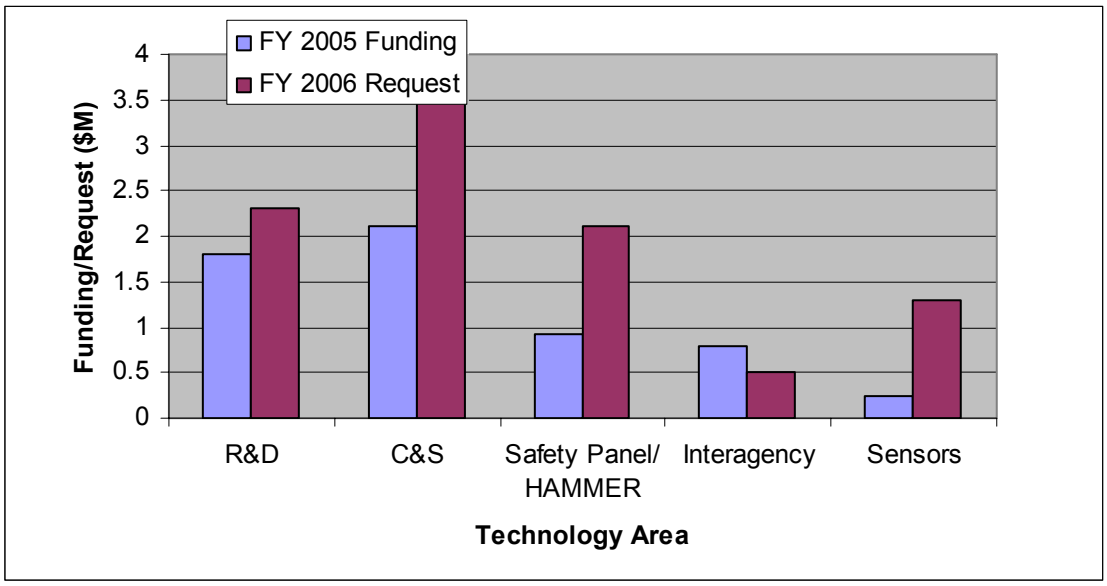
Recommendations by the reviewers included:
- More R&D is needed to fill in the gaps in hydrogen codes and standards – more focus should be made on following the roadmaps presented by the Codes and Standards Technology Team.
- Safety needs to be highlighted and tracked during the DOE demo program. Recommend DOE consider ways of focusing safety as an absolute.

Safety and Codes & Standards Funding:

The 2005 funding budget for Safety and Codes & Standards includes international activities as well as national development and coordination among several agencies. A large number of reviewers expressed concern over funding gaps and were concerned that the low level of funding could inhibit the level of activity that can take place.

The National Academies' report recently issued recommends additional funding for safety, codes & standards, for DOE to broaden its team of safety experts, and to increase public awareness of hydrogen safety issues to facilitate the transition of hydrogen vehicles into the marketplace.

Safety, Codes and Standards Budget:



Majority of Reviewer Comments and Recommendations:

Reviewer scores for the Safety and Codes & Standards Subprograms were average to high (average score for the projects was 3.18). The lower scores were related to the activities with Los Alamos National Laboratory technical support to the EPA/DOT/DOE development of global technical regulations (GTR) and to the International Partnership for the Hydrogen Economy (IPHE) on its efforts on regulations, codes and standards. Comments received pertained to the lack of technical R&D accomplishments, and additional coordination to be made with DOT/NHTSA. Recommendations to DOE are listed below. DOE will act on these reviewer recommendations as appropriate for the scope, focus and coordination of the safety and codes & standards effort.

- **Codes and Standards Development and International Coordination:** Focus on hydrogen fuel quality, and accelerate efforts on specifications. IEA projects should be coordinated with IPHE activities.

- **Safety Training:** Training over one million first responders requires some innovative planning. As part of this HAMMER effort, consider "training the trainer" at the facility and then develop a web-based training module for the masses with local practice. Need to capture "lessons learned."

- **Safety R&D**: Regarding the Panel activities: the checklist of items that the Panel uses to review projects should be described and include suggestion of alternatives to mitigate risks that may occur. More information should be provided on how projects will be selected for site visits.

Project # SA-01: Safety, Codes and Standards
Davis, Patrick; U.S. Department of Energy

Brief Summary of Sub-Program

The purpose of this Safety, Codes & Standards Sub-program Overview and introduction is to describe sub-program goals/objectives, budgets, barriers/targets, approach to R&D, technical accomplishments, interactions and collaborations, solicitations and awards, and future directions. As such, it sets the stage and puts into context the R&D and analysis projects, which will be presented in this sub-program area during the Annual Merit Review.

Degree to which the Sub-Program area was adequately covered and/or summarized

- Summary was adequate. The Team Lead was effective in articulating the scope and program requirements.
- Team Lead did an excellent job of describing the sub-program and all aspects of the research going on.
- Excellent sub-program coverage.
- Very comprehensive and concise presentation of the program. Key issues and priority issues were discussed appropriately.
- Team Lead did an excellent job of fully covering the sub-program in a twenty minute session.

Were important problem/issue areas and challenges identified/discussed, including plans for addressing these items in the future?

- Problems and issues were identified to some extent. Improvement may be possible if greater attention is given to specific problems and issues, which would lead to a more focused program and result in better project solutions and a smaller number or issues.
- Several barriers for domestic codes & standards development as well as GTR were identified and several projects are underway to address them. However, the low level of funding for this sub-program inhibits how much activity can take place.
- Problems were identified; however, more work is needed on resolving setbacks.
- Yes, good overview of program barriers and plans for resolving within each area. Accomplishments and future work are progressive and logical.
- Team Lead focused his talk on the top issues and milestones and highlighted areas that were not proceeding as rapidly as desired.

Does the Sub-Program area appear to be focused, managed well, and effective in addressing the Hydrogen Program R&D needs?

- Given the limited resources, the program should consider focusing (and directing funding) on topic areas that are not addressed or under the purview of other entities. For example, the GTR is better handled by DOT, and safety training by state and local fire departments.
- Performance-based standards are appropriate and preferred in some areas. In other areas, particularly fixed infrastructure, prescriptive standards may be more appropriate. These should not be excluded, and the Federal government should not dictate to the development organizations and local and state AHJs that may use them.
- The program is managed well. The program is effective in many areas; the areas for continued improvement are noted above.
- Management of this sub-program has improved in the last year and the team is becoming more focused. In order to be more effective, additional funding will be needed for these efforts.
- Sub-program adequately covers R&D needs.
- Program requires the management of many, many stakeholders and the sub-program has secured dedicated and expert managers. Communication and the ability to find compromise is a key need in this area and the sub-program managers have been very effective in this as evidenced by the evolution of program priorities.
- Funding status is unfortunate. The program requires full funding in 2006 or will jeopardize progress due to inter-related nature of this sub-program.
- Team Lead is doing his usual good management of the sub-program and making appropriate priority decisions.

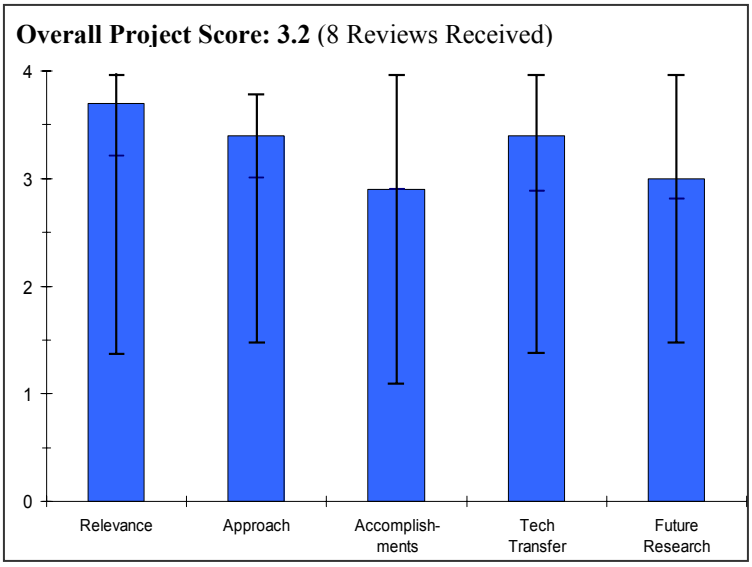
Other comments:

- Consideration should be made for the Hydrogen Safety Panel activities, as it appears to be a significant increase in workload in the near future.
- Team Lead has been very effective in managing the various industry stakeholders interests and recognizes when to compromise and when to pursue change. Current program is very well managed and structured. Funding for 2005 is disappointing and 2006 budget needs to be funded to provide best chance of meeting 2015 DOE targets…under-funding in 2006 will jeopardize maintaining DOE overall objectives.

Project # SA-02: Hydrogen Codes and Standards
Ohi, Jim; National Renewable Energy Laboratory

Brief Summary of Project

In this project, the National Renewable Energy Laboratory (NREL) works on hydrogen codes and standards to expedite hydrogen infrastructure development, coordinate such development activities for the Hydrogen Program, and incorporate hydrogen safety considerations into existing and proposed national and international codes and standards. This is accomplished by bringing together experts to address key issues, coordinating collaborative national and international efforts between government and industry, and by serving as the central point of contact for up-to-date information on codes and standards activities.



Question 1: Relevance to overall DOE objectives

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

- 50% complete. Very relevant to all Technology Validation and other DOE projects. Good cooperation.
- Development of uniform and rational codes and standards are key enablers to the achievement of a hydrogen economy.
- National consensus on codes and standards and a path to timely regulation is critical to commercialization of the hydrogen economy.
- The project embraces all the necessary aspects to support the development of codes and standards for the hydrogen economy.
- The relevance of the subject is in line with what industry and government needs are regarding objectives.
- Coordination by DOE to ensure U.S. codes and standards development is completed effectively and completely is critical to meeting the 2015 goals. The efforts to date have brought a varied and diverse group of stakeholders together to work on a common effort with a common goal. Without this instrumental role from DOE, today's progress in U.S. codes and standards in hydrogen would not have been realized. Continued effort by DOE is needed and is valued by industry.

Question 2: Approach to performing the research and development

This project was rated **3.4** on its approach.

- Good – several slides on approach.
- The project and PI did a solid job of assessing the pathways and outlining a path forward. The project may benefit from a narrower focus. International standards and regulations should not be under this program.
- Reasonable approach for unified national agenda and National template.
- Transportation is receiving more attention than residential and commercial applications, which are not previewed in the objectives.
- Roadmap is an excellent document — consensus gained in response to entire industry.
- The approach by DOE has been appropriate and well planned. The effort in this arena cannot be accomplished over night and required a long-term view to ensure a successful working result. The National template has been extremely effective in moving development forward as has DOE's assistance to certain SDO/CDOs where

specific efforts are underway to resolve codes and standards issues ranging from setbacks to tank material usage.

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

This project was rated **2.9** based on accomplishments.

- Good slide on time frame. Good progress from last year. Good progress in fuel quality.
- The pathways and roadmaps were detailed, but the presentation lacked information on specific accomplishments over the past year.
- To date most accomplishments appear to have been administrative.
- The presentation states that the project is 50% complete and ends in September 2005. There is little real world data to support codes and standards development in many areas, particularly performance based requirements. Continued support may be required for redrafting in those areas.
- Hydrogen fuel quality plan looks good.
- Progress was not shown very well during the presentation.
- DOE has maintained a broad scope yet implemented prioritized focus in specific critical areas such as; hydrogen quality, storage vessel materials, set-back distances, and material compatibility. DOE considers industry and other stakeholder inputs effectively to ensure priorities are tested.

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

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

- Good leverage with other organizations.
- Work with some of the universities (Hawaii, Sandia, etc.) is valuable and it is clear how this transfers over and benefits a number of users. The project could benefit if the direction utilized greater input and direction from the code and standards organizations to meet their needs vs. the codes and standards organizations being led by DOE needs.
- Multiple interfaces with SDOs, international committees, etc. seem valuable. Key will be to see if interfaces prove able to make concrete progress.
- Good coordination.
- Getting better every day!
- Everyone involved in codes and standards should be talking to each other.
- Technology transfer/collaborations appear to be good between U.S. and international organizations.
- Outstanding integration and leverage across industry, academia, labs, and organizations has been achieved in this effort. DOE has been effective in keeping order and providing progress while working with numerous entities.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.0** for proposed future work.

- Good future work plan to test and validate.
- Future research for fuel quality is fine. Other areas, such as ISO TC 197 lack clarity. Work efforts need to be more than just coordination. They should focus on providing data vs. trying to control the process.
- Reasonable future plans for fuel quality and other enabling R&D are more in line with research-orientation of DOE program, but recognize that interfaces with code setting organizations are necessary.
- Future work covers most of the possibilities.
- Hydrogen fuel quality work well-planned. Execute the plan.
- Consider the next area in the roadmap and define the R&D effort.
- Develop an infrastructure R&D project.
- Future plans for research need to be made clearer.

- DOE's MYPP and internalization of the FreedomCAR CSTT Roadmap reflects DOE's future outlook and planning. Timeline planning with significant accomplishment targets are clearly defined and appropriate.
- Future efforts reflect past accomplishments, yet DOE continues to push itself to achieve further success as evidenced by its forward planning objectives.

Strengths and weaknesses

Strengths

- Able to link up NHA with DOE and USFCC to coordinate activities. Project draws on talent from many other good organizations - good mix of industry and university input.
- The interaction among participants seems to be strong.
- Hydrogen fuel quality plan has come together in a short amount of time.
- Leverage of earmark funds into useful work should be a model for the rest of the DOE hydrogen budget as a way of dealing with earmarks.
- Roadmap appears to be an excellent plan.
- Program Manager (Pat Davis) and Codes and Standards Lead (Jim Ohi) are "the" keys to the progress realized to date. Pat has been extremely effective in managing industry issues and ensuring production is achieved. Jim's ability to keep a herd of cats moving forward while being patient at the same time has allowed the National template to become reality and has also enabled the successful combination of the Codes and Standards Coordination Committee with the USFCC codes and standards work and the NHA codes and standards work; a feat that would have been unheard of only a few years ago. Strong focus by all involved and dedication to see results keeps this effort strong and purpose-driven on a daily basis.

Weaknesses

- Question whether there has been adequate progress considering the high budget of the program. The presentation was not clear regarding how the $1 to 2 million annual budget is being spent.
- Cooperation with other countries beyond Japan and EU can enlarge the results and can help to overcome barriers for the adoption of international codes and standards.
- R&D and template budget activities supposedly are separate subtasks now, but we didn't see any detail on that.
- Need detail on amount going to R&D.
- The progress and collaborations need to be detailed better.
- Funding. Codes and standards management requires the funding to ensure this critical bridge to commercialization is built. Without codes and standards, the entire technical R&D will not matter. Codes and standards funding, while small in relation to other R&D efforts, needs to be fully funded each year to avoid jeopardizing having new technologies unavailable to consumers.

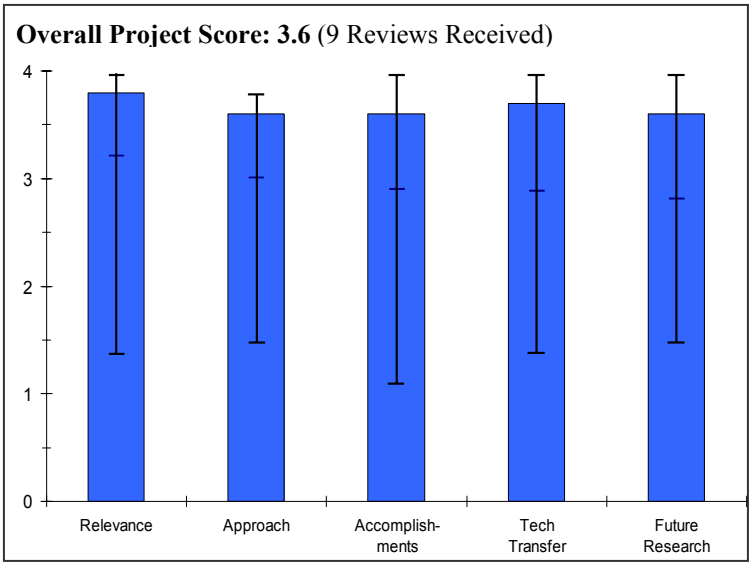
Specific recommendations and additions or deletions to the work scope

- Focus on fuel quality, data collection and underlying research. Eliminate GTR.
- More attention to residential and commercial systems is desirable.
- Move more budgets toward codes and standards R&D and decrease general contributions to trade associations.
- Accelerate efforts on hydrogen quality specifications.
- Correlate fuel cell vehicle performance in demonstration/validation program with respect to analyzed fuel quality provided by infrastructure partners. Would involve Keith Wipke/NREL as well. In the absence of budget detail between R&D and subcontracts to SDO's etc, here's my input based on guesses where the money is going: delete contract with CSA on HGV4, since this should be handled by CSA constituents, delete contract with NFPA, since NFPA 52 and 50A/B are being dealt with by industry, delete NHA support since they are not an SDO. Let other NHA members support it, unless there is a compelling reason for giving money to NHA that isn't obvious.
- Other subcontracts are vital to the program.
- More concentration research activities related to codes and standards and actual progress.
- Full annual funding.

- Consider how to include assisting NETL efforts for new products as this is an important step to placing hardware and systems into the marketplace. Once standards are established, the products typically require third-party testing. Not all manufacturers can fully fund these efforts during "validation" phase projects.

Project # SA-03: Research and Development for Hydrogen Safety, Codes and Standards
Keller, Jay; Sandia National Laboratories

Brief Summary of Project



This project contains two major elements that address 1) risk assessment and consequence analysis of unintended hydrogen releases, and 2) compatibility of hydrogen with engineering materials. The purpose of the hydrogen safety scenario element is to develop a scientific basis for evaluating credible safety scenarios, providing technical data to codes and standards developers. Safety scenarios are used to map unknowns in the codes and standards decision-making process into R&D on hydrogen behavior in engineered systems. Sandia National Laboratories (SNL) will develop benchmark experiments and a defensible analysis strategy for risk assessment of hydrogen systems, including experimentation and modeling to understand the fluid mechanics and dispersion of hydrogen for different leak rate regimes. It includes investigation of hydrogen ignition and combustion processes and subsequent heat transfer from hydrogen flames. Technical information is contained in simple engineering models that are used for rapid assessment of different scenarios and risk analysis. The purpose of the materials compatibility element is to create a Technical Reference to guide material selection and methods of construction in codes and standards development for the hydrogen economy infrastructure. SNL will compile existing data on hydrogen compatibility of materials from reports and journal publications. Material testing is being conducted to fill information gaps identified during the literature search. The focus is on materials data for applications that involve the storage, distribution, and consumption of high-pressure hydrogen gas. Material systems include pressure vessel steels (stationary storage and transportation of hydrogen gas), pipeline steels (hydrogen gas transportation), stainless steels (ancillary components in the storage, distribution, and consumption of hydrogen gas such as piping, pressure relief devices, and valves), aluminum alloys (hydrogen gas storage vessels on vehicles), copper alloys (high-pressure hydrogen seals), and composite systems.

Question 1: Relevance to overall DOE objectives

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

- Materials testing proposed is very critical to HFI. Hydrogen gas jet behavior understanding is very important to HFI.
- The program is addressing many fundamental knowledge needs necessary to facilitate codes, standards, and general technology advancement.
- Hydrogen safety, codes and standards are key enablers for a successful hydrogen economy.
- Key codes and standards gaps have been identified and data is being generated to close gaps.
- The relevance of the subject is in line with what industry and government needs are regarding objectives.

Question 2: Approach to performing the research and development

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

- The program is well thought out and organized.
- Approach seems reasonable.

- The speaker should not be so negative toward "old" data. Despite their age they have served a very large industry quite well for many decades.
- National labs, universities and knowledgeable contractors are being used to close key gaps in a collaborative way.
- Consider describing the setback work in different terms; the word setback has negative connotations.
- Why not hydrogen refueling station design optimization or something like that?
- The use of setback just entrenches in people's minds that hydrogen is different and dangerous.
- It is dangerous but so are other things that we manage all the time.
- Approach appears logical.

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

This project was rated **3.6** based on accomplishments.

- The PI's clearly understand the barriers and challenges and have a clear plan to achieve their goals.
- Good progress so far on materials.
- Doing interesting and potentially valuable work in hydrogen embrittlement.
- Flame jet research is very valuable and should be shared widely with SDOs.
- More important to do materials research than participation in codes and standards activities.
- Setback distances are still unresolved and need more work. Models developed to date are robust and uncertainty has been quantified.
- Materials compatibility very useful.
- Good work in materials compatibility.

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

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

- Partnership is very comprehensive and each role clearly understood.
- PI enumerated several industries, SDO, and other entities that are benefiting from the results and contributing key input and materials. This needs to be maintained.
- Good collaboration with Miami, JPL, SRI, others on flame jet work.
- Unable to assess value of collaborations with other industry partners as PI declined to name them. Might have scored higher otherwise.
- The role of partnership alliances is very important to this effort.
- Leading universities and national labs have been used to generate data needed to close gaps.
- Continue interactions with other groups.
- Technology transfer regarding materials compatibility with hydrogen is excellent. However, Collaborations is lacking with other entities in the U.S. and internationally doing similar work.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.6** for proposed future work.

- The proposed future work should provide valuable results in materials and hydrogen gas behavior understanding.
- Future research on materials compatibility and flame release is on target. There are other areas of needs but the program appears focused within its financial constraints.
- Future plans look good. Continue emphasis on materials properties; testing of low alloy and stainless steels.
- Future work compliment and build on work already completed.
- Move toward work on solutions to problems SNL has identified.
- Future Plans for research are not very clear other than future activities.

Strengths and weaknesses

Strengths
- Project well thought out.
- Investigators and the SNL provide a wide variety of capabilities related to hydrogen safety for fuel cell vehicles. The metallurgical aspects of the work are most valuable.
- Key codes and standards gaps have been identified and data is being generated to close gaps by leading universities and national labs. Future work compliment and build on work already completed.
- Good focus and organization.
- Some of the best capabilities and understanding of hydrogen behavior in the world.
- Analytical approach to assisting with codes and standards.

Weaknesses
- The flame behavior work should endeavor to tie in to "real-world" scenarios, which add considerable complexity to the behavior of a leak, hydrogen dispersion, and flames/deflagrations/detonations.
- Quite correctly the investigators are less focused on flame properties for establishing the separation distances utilized in natural gas and hydrogen fueling stations. They should continue to downplay connections between separation distances and fueling station dimensions.
- Set back distances are still unresolved and need more work.
- There are no weaknesses to be pointed out.
- Not clear who is doing the risk assessment work, NREL or SNL, or both. Most companies will do their own risk assessment.
- Unclear regarding future efforts in tank testing what the scope and makeup will be.

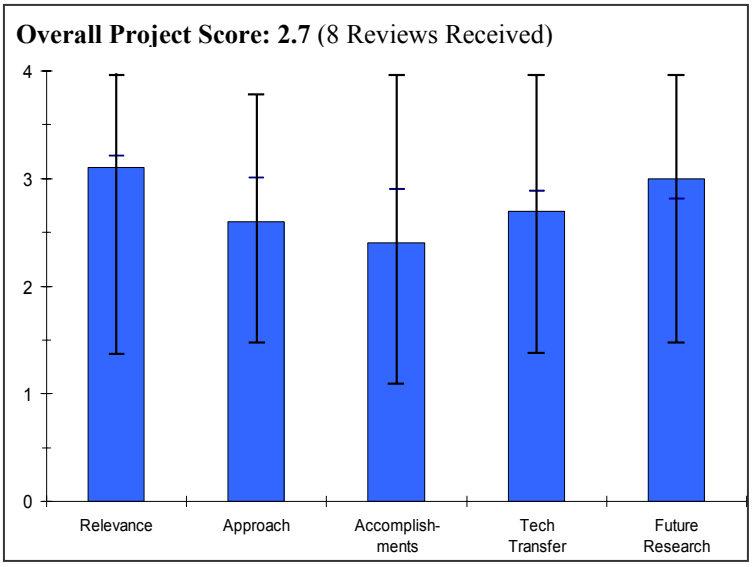
Specific recommendations and additions or deletions to the work scope

- Risk assessment should be narrowed or dropped. The project did not appear to fully incorporate many well established procedures already in use by government regulatory bodies.
- High-strength alloys will also need to be tested. This should be done in conjunction or in response to partner and collaborator requests and input.
- The flame studies are more of an academic interest than a practical interest. Interesting to know but what does one do with the results? The work on frequencies of releases is relevant and should be expanded.
- Financial and people resources to complete FY06 are tight, cut backs in these areas would have impact on delivery of hydrogen program objectives.
- On the setback work, we may not have the required 75 +/- feet, so add work to identify and validate an alternative solution to setbacks. Design optimization.
- Identify how to safely store hydrogen above ground with materials development to block heat from failures.
- More R&D is needed to fill the gaps in hydrogen codes and standards - more focus should be made to follow the roadmaps presented by Codes and Standards Technology Team.

Project # SA-04: International Standards and Regulations
Padro, Cathy; Los Alamos National Laboratory

Brief Summary of Project

This Los Alamos National Laboratory (LANL) project provides technical support for the EPA/DOT/DOE joint effort in the development of global technical regulations for hydrogen and fuel cell vehicles. Working collaboratively with DOT/NHTSA (principally), LANL participates in the global effort to develop performance-based standards and regulations for hydrogen vehicles. This project also provides technical support to the International Partnership for the Hydrogen Economy and its efforts related to regulations, codes and standards.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.1** for its relevance to DOE objectives.

- Although international collaboration is not critical to the U.S. goal of reducing U.S. reliance on foreign oil, these kinds of programs are important for international collaboration and vehicle homologation.
- Supports DOE objectives for GTR.
- The development of international standards and regulations is a key point to the Hydrogen Fuel Initiative.
- There is a relevance of the subject to the RD&D plan objectives. The execution of this, however, has not assisted to the overall DOE objectives.
- International coordination by DOE to ensure U.S. codes and standards development is not only effective but consistent across international boundaries. It is a significantly important effort in a global economy. Ensuring international consideration is also helpful in leveraging limited resources and accelerating learning and development in this area.
- Providing the U.S. auto/fuel cell/energy industries with visibility into the morass of the EU regulatory process is a good thing. However, other than an information sharing exercise, this project provides little value to the charter of the Codes and Standards Tech Team, which is to identify and initiate research into the science that will enable a good basis for emerging hydrogen codes and standards.

Question 2: Approach to performing the research and development

This project was rated **2.6** on its approach.

- Seems to be working with the right international bodies.
- Consider how DOE or the U.S. can better influence the GTR process to accommodate our needs without jeopardizing other participant needs.
- The approach has not only failed to add to the progress of international codes and standards, but has in fact added to the compounding divide between U.S. and worldwide GTR progress.
- The international approach is being modeled, to some degree, off the U.S. National Codes and Standards Template, which has proven effective domestically. An International Codes and Standards Template has been put forth which can have the same aligning effect as it had in the U.S. Together with the U.S. TAG, IPHE, and integration with domestic codes and standards efforts, the approach was well rounded and comprehensive. The approach also recognizes the challenge ahead and provides for flexibility to ensure success.

- NHTSA, not DOE, sets vehicle regulations for the US and is the representative to those international forums that discuss global regulatory issues related to vehicles. LANL could perform a monitoring function at the request of DOT (NHTSA).

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

This project was rated **2.4** based on accomplishments.

- There are no technical or R&D accomplishments in this project; more of a status report on international collaborations.
- Collaborations have been slow, laborious and challenging.
- GTR roadmap development with strong input from DOE/U.S. is important work.
- Not clear if IPHE accomplishments are result of these project activities.
- This category tends to be N/A as the projects goals are not necessarily technical in nature.
- The progress is adequate in view of the difficulties related to the international character of the activities under way.
- A primary early test bed for leveraging international collaboration is being explored with the issue of hydrogen quality. In this area there has been good early work and progress that has brought the global stakeholders to the table. Other areas will include providing commercial opportunities for U.S. industry to have business internationally and effectively being managed via the U.S. TAG and the UN processes.
- LANL participation has increased the awareness of the Codes and Standards Tech Team into the progress (or lack thereof) of the regulatory process of the hydrogen economy within the EU.
- I do not necessarily see a limited DOE role in regulatory issues as a problem.
- How is LANL (DOE) seeking to increase U.S. industry support within this international framework? Has there been an increase in that support?

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

This project was rated **2.7** for technology transfer and collaboration.

- Seems to be working with the correct international bodies; many collaborations.
- Good collaboration with DOT, ISO, U.S. TAGs and others with respect to GTRs
- Coordination with other institutions clearly exists.
- It is difficult to evaluate how deep the cooperation among the participants is.
- There have been attempts at collaborations, but there appears to be a problem with gaining U.S. consensus and then representing this in outside forums.
- Expect that the review in 2006 will result in a "4" rating, but as this effort is relatively new, opportunities for improved coordination exist and are known by DOE for action. Not an easy challenge by any means, and the work to date has been impressive.
- It was not apparent that NHTSA provides much guidance to LANL for this effort.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.0** for proposed future work.

- Continued support needed and planned, but not directly relevant to hydrogen R&D.
- Identify more details regarding future work including what the goals of that work will be.
- Future plans for research related to this subject are not defined.
- The long-term view of EU regulations and their impact to U.S. commerce are well understood by DOE and are a key future deliverable. This awareness provides DOE with critical insight as to how to manage relationships and know when and how to negotiate and compromise. A key value item of this effort is its "future" objectives.
- Not applicable as there is no research ongoing.

Strengths and weaknesses

Strengths
- Connections and interfaces with international codes and standards body already established.
- This effort is valuable to the overall effort. It is probably fitting that a national lab performs this effort.
- The problems are well identified and addressed.
- Relevant topic.
- Key players involved by DOE understand the international working of codes and standards and know who to engage outside the U.S. to be effective. Communication is a key tool in this effort and DOE is able to keep international stakeholders informed and allows DOE to have their "ear to the rail" should items of interest or concern becomes apparent. Committed personnel are very effective and appear to take personal pride in accomplishing this very challenging effort.
- Presentation provided visibility into the GTR process.

Weaknesses
- Overall coordination of codes and standards goals between the U.S. and Europe.
- It is not clear how the U.S. and EU can come together on regulations despite the efforts of the DOT. Will Pedro's work have any meaningful acceleration on this challenge?
- Most of the barriers are still active.
- Not effective in assisting the GTR process.
- Funding. DOE's requested annual budgets need to be provided in this most critical effort.
- Not sure what the Japanese "systems approach" is composed of. Usually, the Japanese auto industry follows the ISO process and adopts their documents. Up to this point, ISO is using a "component" approach building off the EIHP experience.

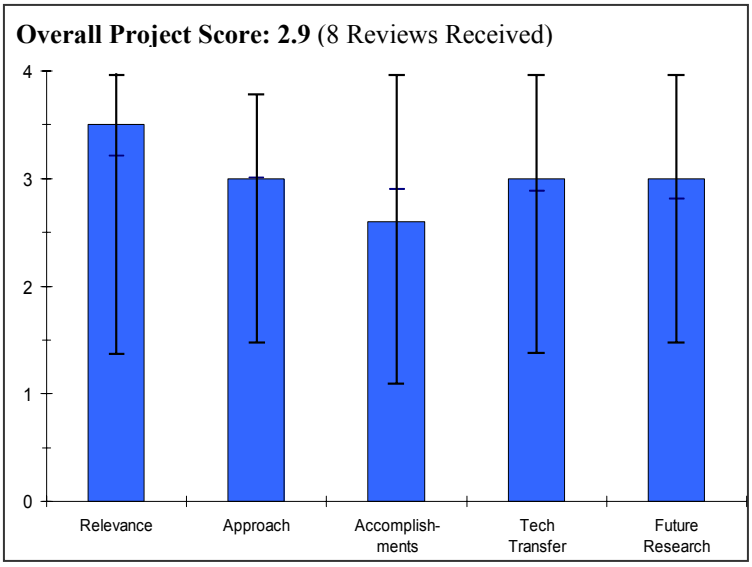
Specific recommendations and additions or deletions to the work scope

- This project would better serve the President's Hydrogen Initiative by assuming more of an input and advisory role to NHTSA. The U.S. effort would be better served by having the UN-recognized representative present at the international meetings, which is currently not happening.
- Develop methodology to more closely align U.S., European and Japanese bodies to refine GTR process.
- Stop activities and have OEMs discuss with North American industry representatives regarding direction of GTRs with NHTSA.
- Full annual funding.
- Consider how to further leverage IPHE to help maximize progress on key issues, such as hydrogen quality, test methods, and vehicle regulations. IPHE is a unique body that could perhaps do more in this area.
- Further LANL participation should be funded through the DOT portion of the Codes and Standards Tech Team budget and not directly through DOE. Allow DOT to decide if this effort is worth continuing.

Project # SA-05: HAMMER Emergency Response Training for the Hydrogen Economy
Kinzey, Bruce; Pacific Northwest National Laboratory

Brief Summary of Project

The DOE HAMMER training center in Richland, Washington is to be the location for a national hydrogen safety training facility. HAMMER will offer classroom and distance (satellite) learning, as well as live-burn and other hands-on props for training emergency responders, code officials, and others on the appropriate safety procedures corresponding to their respective responsibilities in the hydrogen economy.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- Safety training is very important to the Hydrogen Fuel Initiative. The PI did not demonstrate that this is the most appropriate mechanism for developing this curriculum, and that it will result in fulfilling this national need.
- Training first responders to appropriately handle incidents will be important to the successful deployment of new technology and to minimize unnecessary public fear.
- Safety training for first responders and others involved in the codes and standards community is important for the success of the hydrogen economy.
- First responders need to be trained prior to public exposure to hydrogen through fueling and vehicle accidents
- This project addresses a show-stopper for the hydrogen economy.
- One spectacular accident and public opinion would not be favorable.
- This project directly attacks the two barriers identified and is a necessary component of the Hydrogen Fuel Initiative.
- Training of emergency responders is an essential element of the initiative.

Question 2: Approach to performing the research and development

This project was rated **3.0** on its approach.

- A training plan and timeline should be developed that is tied to the commercialization path for the various hydrogen related technologies, starting with those already in practice.
- A lot of work has already been done in predicting potential accident scenarios related to current commercial practices and ongoing codes and standards efforts. These scenarios should be analyzed and built on in order to set priorities for training.
- Funding and time is always a constraint; therefore, it is critical that up-front effort is placed on identifying highest probability scenarios, benchmarking current first-responder protocols, and setting priorities based on gaps that are identified.
- Reasonable approach.
- Addresses a comprehensive list of hazard scenarios.
- Training one million first responders is mind-boggling.
- Concept of HAMMER is great.
- Develop a web-based training module for the masses of first responders and physically "train the trainers" at the HAMMER facility.

- The approach enumerated is good. Involving both OSHA and NFPA is a beneficial strategy.
- Targeted audience will enable a smoother transition to the hydrogen economy.
- Training materials should stress fuel equivalence.
- The approach does not adequately address the need to train all first responders, emergency personnel, etc.

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

This project was rated **2.6** based on accomplishments.

- The PI did not demonstrate that the project team understands the breadth of real-world hydrogen and fuel cell first responder training issues.
- Pilot course planning is good and will be important for setting the tone of future efforts.
- Project has not been well funded so far. Will need greater funding to be fully successful.
- Much accomplished in little time at little cost.
- No additional comments are necessary.
- Just really beginning.
- More relevant next year.
- The only suggestion here would be to have an additional training facility on the east coast to make the training more available to those first responders. Of course, this would entail a larger budget.
- The "training of the trainers" could be followed up with selected scenarios in various locales to give "newly trained" a feel for dealing with issues in their own backyards.
- Ahead of schedule, but the path chosen does not adequately address the real need.

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

This project was rated **3.0** for technology transfer and collaboration.

- Two of the partners listed are not as engaged as the presentation indicated. The project needs more technical input beyond that of the CaFCP to address the full scope of hydrogen infrastructure and potential incident scenarios.
- Good collaboration with multiple organizations.
- Good list of collaborations; all seem reasonable and able to contribute.
- Good coordination with state and federal agencies.
- This is going to be huge task. It will be difficult to come up with the answers.
- Need a plan to engage the 70% who are volunteers.
- Once program fully underway, develop modules for set-up at other sites around the country.
- Appropriate use of coordinating organizations. ICC and NFPA are the two predominant code-setting organizations. As the training progresses, perhaps lower-level officials could be included.
- Good collaboration with many of the organization that will be impacted by safety implications of the initiative.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.0** for proposed future work.

- The PI did not provide adequate detail to determine if the future work will accomplish the outlined objectives.
- Need to tie training schedule to commercialization pathways and current gaps in knowledge. When and where will technologies find their way into the marketplace?
- Although fueling stations are quite visible and are a high probability site for a potential accident, a great deal of up-front orientation of first responders has already occurred. Should these be the first target for training or are there other critical gaps related to commercial hydrogen uses that will have a greater negative impact?
- Good plans for the future. Need to expand training program and make it available to more students.
- Good. Project is fairly new and, to date, funded at a low level. Need to review again as program develops from paper exercise to hands-on training program.

- Presentation indicates clear focus on overcoming existing barriers.
- The harder issues of training the trainer and long distance training are being pushed off, but should be worked on now.

Strengths and weaknesses

Strengths
- The HAMMER facility is a world-class facility with extensive experience in training first responders. The success of this project can increase the probability of correct response to hydrogen accidents, which will be critical for achieving public acceptance of hydrogen technologies.
- Adequate planning.
- One common facility is a good idea.
- Excellent use of previous DOE investment in HazMat facility.

Weaknesses
- More emphasis should be placed on utilizing statistic-based probability scenarios and commercialization timelines for developing training curriculum content and schedules.
- No weaknesses were identified.
- How will you deal with the 70% volunteers?
- Who can pay for their training at PNNL?
- Not enough attention on the front end of the issues that must be addressed to train the million plus personnel.

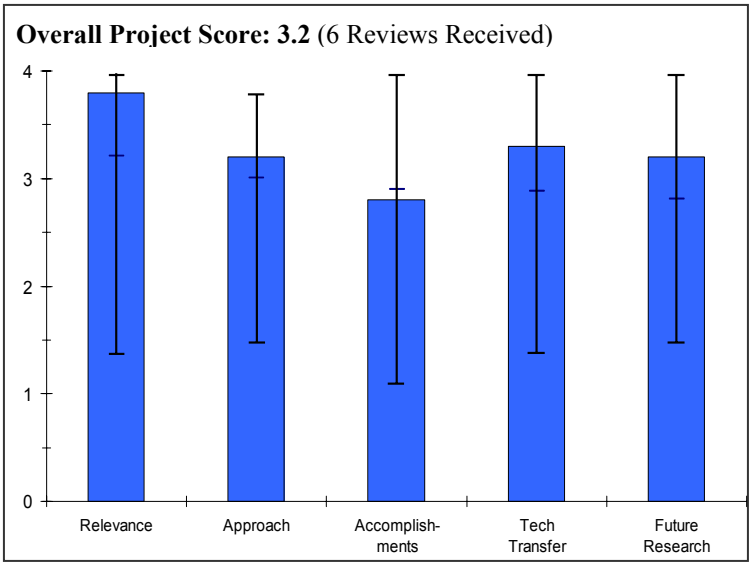
Specific recommendations and additions or deletions to the work scope

- Recommend that the project halt the development of curriculum until the fire safety community completes ongoing projects to adequately define its needs, requirements, and expectations.
- Closer coordination with related international efforts should be emphasized. Lessons learned from experiences in siting and permitting of the many hydrogen demonstrations should be incorporated into the planning.
- Training one million plus first responders requires some innovative planning. As part of this HAMMER effort consider "training the trainer" at the facility (i.e., one or two per jurisdiction) and then develop a web-based training module for the masses with local practice.
- Need to capture the "lessons learned" in a book or on the web.
- Detailed plan on training the trainer, distance learning, development of portable props, etc.

Project # SA-06: Hydrogen Safety Review Panel
Weiner, Steven; Pacific Northwest National Laboratory

Brief Summary of Project

The Hydrogen Safety Review Panel supports the DOE Hydrogen Safety Program, focusing on the development and implementation of practices and procedures that will help ensure safety in the operation, handling and use of hydrogen and hydrogen systems for all DOE projects. Bringing together a broad cross-section of industrial, government and academic expertise, the panel provides guidance and review of safety plans for project teams, conducts safety review site visits and helps capture best practices and lessons learned for the benefit of the program as a whole.



Question 1: Relevance to overall DOE objectives

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

- Project goals and objectives will go a long way to support the President's overall RD&D objectives.
- Will fill the gap of codes and standards needed for refueling hydrogen vehicles.
- Should ensure consistency between auto OEM and fuel providers for hydrogen codes and safety.
- The technical expertise of the panel members is good.
- Getting outside review of safety approaches is important for identifying potential issues and accident scenarios.
- Project strongly supports DOE goals and President's Initiative.
- Safety is an absolute requirement for the R&D plan.

Question 2: Approach to performing the research and development

This project was rated **3.2** on its approach.

- The approach does not seem to take into account the need to modify or develop codes and standards that make this an acceptable fuel of the future.
- More emphasis needs to be placed on information dissemination. 2007 is too late to communicate lessons learned and best practices. Need to seek more opportunities to, at least informally, communicate this information to the program participants.
- How do key issues that are identified get communicated to PI's working on similar projects? Who is responsible for doing this?
- Efforts to utilize as many methods of interacting with projects, rather than just relying on site visits (which will always be limited by schedules and cost) are commendable.
- Project well conceived and organized to meet current objectives
- Can the team handle a large ramp-up in workload in the future?
- Knowledgeable diverse members of Hydrogen Safety Panel insure key safety areas will be addressed.

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

This project was rated **2.8** based on accomplishments.

- The presenter should have included the Checklist of Items they use for review.
- The checklist is the most important part of this presentation.
- The PI demonstrated an understanding of what is needed. Greater detail and information on what the accomplishments are would be beneficial. The information presented did not indicate if the project was successful in achieving safety or identifying safety incident precursors.
- Need to measure impact of Panel. What issues were identified? How did Panel's involvement improve safety? What trends should the program be concerned about? What best practices were identified and how can these be replicated throughout the program?
- Project has made very good progress this year, but as the need for more plan and site reviews increase, can the team keep up with the workload?
- Eleven site visits to date establishes solid base line.
- No additional comments are necessary.

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

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

- This project should have included some discussion on how the critical 'checklist' was developed.
- This project leader should make sure that participants are aware of the measures by which their projects will be reviewed and 'graded'.
- The TV Participants should be the first to have this information shared with them.
- Safety is critical. Greater information into how the efforts and lessons learned ties into the codes and standards development would be beneficial. The PI needs to clarify to whom and how the lessons learned will be conveyed.
- Efforts to communicate activities at national and international conferences are good.
- More emphasis needs to be placed on finding venues/opportunities to communicate lessons learned to all projects in the program.
- Strong collaborative effort with a diverse team.
- Cross section of relevant experience helps insure safety for entire hydrogen demo program.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.2** for proposed future work.

- The checklist should include or suggest alternatives to mitigate risk that may occur to make hydrogen commercially viable.
- The project should focus on taking hydrogen from just an industrial setting to a consumer setting.
- Would have been useful to see more information on how projects will be selected for site visits in the future.
- A communication plan would help identify opportunities to have a greater impact on hydrogen safety practices.
- More detailed plans for future activities, including a timeline should be provided.
- "Guidance for safety aspects of proposed hydrogen project" has been and will continue to be updated.

Strengths and weaknesses

Strengths

- The panel consists of a very strong team of experts in a wide array of technology with practical field experience related to hydrogen safety, as well as safe practices in general. Incorporating safety plans right at the start of projects and reviewing these throughout the lifetime of the project is good.
- High level of expertise among team members.
- Diverse background of team members.

- Knowledgeable diverse members of Hydrogen Safety Panel insure key safety areas will be addressed. Guidance for safety aspects of proposed hydrogen project" has been and will continue to be updated.
- Site visits are essential to the success of the project.

Weaknesses
- The team appears short in the number of AEs and other operational safety officers and experts.
- It is unclear how much impact the panel is actually having. More emphasis should be placed on benchmarking progress towards improving safety and/or replicating best practices.
- Team could get overwhelmed with future workload.
- No weaknesses were identified.

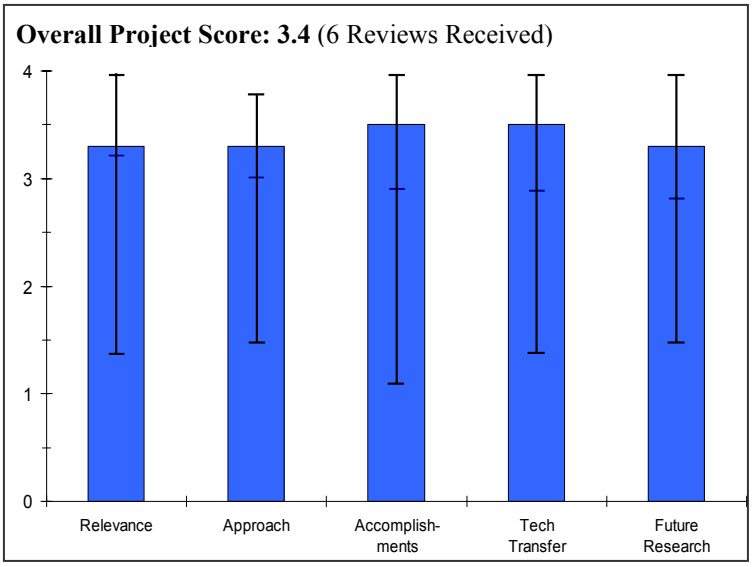
Specific recommendations and additions or deletions to the work scope

- Share the checklist with applicable DOE program participants, particularly the DOE Technology Validation Project participants.
- Focus on making 'hydrogen' a fuel of the future. This means implementing codes and standards that allow it to be a 'consumer friendly' fuel.
- Do not continue with existing 'mindset' of hydrogen as an industrial fuel.
- Consider a new or modified standard that moves it to a commercially viable fuel of choice.
- A requirement for regular reporting on the incident and near-miss checklist should be added.
- The scope is good. Would like to see a more detailed project plan with target dates for when reviews will be completed for major areas of RD&D. Out-year follow-up on projects that have been reviewed should also be addressed.
- Safety needs to be highlighted and tracked during DOE demo program. Energy companies typically open management review meetings with "safety scorecards." Recommend DOE consider ways of focusing/selling safety is an absolute. Safety stats from demo program need to analyzed, summarized, and marketed.
- Many of the safety aspects related to hydrogen can be used for other inert, toxic or flammable gases, e.g., ventilation, cylinder handling, etc. This extension can enlarge the project advantages.

Project # SAP-01: IEA Hydrogen Task 18: Evaluation of Integrated Demonstration Systems
Schoenung, Susan; Longitude 122 West, Inc.

Brief Summary of Project

Under the International Energy Agency Hydrogen Implementing Agreement, DOE is supporting leadership of a task to evaluate hydrogen demonstration systems around the world. Task members represent twelve countries and the European Commission. Detailed modeling and assessment of refueling stations and renewable hydrogen power systems is in progress. A documentation database is also under construction.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.3** for its relevance to DOE objectives.

- This project is a good start in validating models and tools developed to date.
- This project is a good start in developing a database of hydrogen refueling station/system demonstrations on a global basis.
- The poster slides could have more clearly stated the true objectives of this Task 18, i.e.: (1) validating modeling tools already in-use, (2) documenting and comparing codes and standards used in real-world projects.
- This project will serve as an excellent facilitator of international information exchange for the Presidents Hydrogen Fuel Initiative and the International Partnership for a Hydrogen Economy.
- Project has good synergies with Technology Validation and Safety projects.

Question 2: Approach to performing the research and development

This project was rated **3.3** on its approach.

- A key approach for this project appears to be development of this database that allows for easy extraction of select data/information.
- This requires a searchable database.
- Presenter did not present any information on progress made to date in making this database usable for comparisons on key parameters between projects.
- It is not clear what is new about this evaluation.
- This effort will accelerate progress toward overcoming the barriers by making global research results available worldwide.
- Good ideas were presented.

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

This project was rated **3.5** based on accomplishments.

- The goal as stated is to document performance of existing refueling stations.
- The scope appears to be focused more on electrolyzers.
- Value added for this project is to do more than one-of-a-kind station/system to truly understand performance and codes and standards used as it relates to safety.
- Examples of preliminary performance data identified with evaluated systems would have been great.

- Examples of consistency between codes and standards used with the various projects would have added value.
- Not clear if good or fair progress. The work appears to be soft technically for an evaluation project.
- Very good progress in development of the database and making information available on the website.
- Project has displayed good progress since last year.

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

This project was rated **3.5** for technology transfer and collaboration.

- Contributions and sharing of information from the many partners in Task 18 appear to be fairly well coordinated.
- Member participation and support appears to be working fairly well.
- Twelve national collaborations are good, but it would seem that there are many other nations that could contribute.
- Project has displayed good areas of tech transfer.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.3** for proposed future work.

- Not clear that future work will be forthcoming.
- Presenter noted that the project end date is year-end 2006.
- An assessment of achievements to date should be done to determine the need to extend this effort.
- No additional comments are necessary.
- Excellent plan.
- Project is 50% through. It looks promising. PI should stay on track.

Strengths and weaknesses

Strengths
- The project builds on other projects completed and could possibly provide valuable input for future projects or RD&D work.
- The global aspect and support from global entities provides a broader perspective of how the various technologies were implemented.
- Pulling the information together has some merit.
- Good interaction among participants.
- Models for evaluation and design guidance have good approach.
- Maximizing information availability to the world.

Weaknesses
- Refueling stations and stationary plants are too focused on electrolysis.
- Data analysis results appear to be slow and should be proceeding at a faster pace.
- Documentation of the codes and standards used in the various projects are needed now and not 6-months from now.
- It is not clear that the information, once gathered, will be highly useful. One problem is the moving target: Once a report is issued some of the information is already out of date.
- The projects present different sizes (powers) and different level of technology development, which can limit the validity of the results.
- Not apparent that this work is being coordinated with IPHE.

Specific recommendations and additions or deletions to the work scope

- Faster pace of documenting codes and standards used in the various projects in existence to date to identify: (1) best practices; (2) gaps.
- Broaden the scope of technologies to include SMR and other technologies.
- Attempt to include in the database more than one-of-a-kind systems (greater sample sizes) to allow for more conclusive data.
- The project is relevant to evaluate hydrogen demonstration projects under way.
- Safety aspects are not an issue for this project and each participant follows the regulations of its own country.
- Project should be coordinated with the International Partnership for a Hydrogen Economy.