APPLYING RISK MANAGEMENT STRATEGIES PRUDENTLY

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Abstract

During the current global financial crisis, the term "Risk Management" is often heard. Just as the causes for the financial problems are elusive, so is a complete definition of what Risk Management means. The answer is highly dependent upon your perceptions of "risk" and your appetite for assuming risks. The proposed paper will explore these issues with some brief case studies as they apply to hydrogen industrial applications, hydrogen refueling stations and fuel cell technologies for distributed generation.

Specifically the paper will identify the various risk exposures from the perspective of the project developers, original equipment suppliers, end users, project funding sources, and traditional insurance providers. What makes this evaluation intriguing is that it is a mixed bag of output capacities, Combine Heat & Power (CHP) potential, and technology maturity. Therefore the application considerations must be part of any overall Risk Management program

Introduction

What is meant by the "Total Cost of Risk"?

The concept of "Total Cost of Risk" concerns the entire spectrum of exposures that potentially threatens a company's financial performance and business relationships. Many factors contribute to the magnitude of the exposures as illustrated in Figure 1.

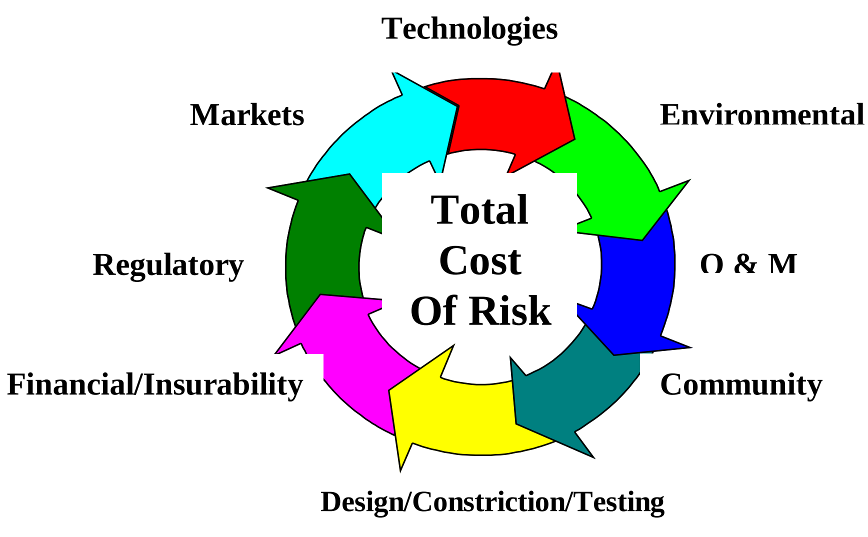

Figure 1. Total Cost of Risk Diagram

Despite attempts at objectively defining risks, there is still a pronounced element of subjectivity. Because of the greater exposure to potential financial loss, we suggest that risk externality is an important consideration for managing in today's highly competitive power marketplace.

Consequences of risk are more extensive than ever with global ramifications. There is a need to examine all of the "special interests" possibilities in order to assemble a comprehensive picture. Once armed with a thorough picture of the risk exposures, the business decision maybe different than when the decision was based on one dimensional input; i.e., only from plant engineering or purchasing.

The challenge of any evaluation of the Total Cost of Risk is to analyze and quantify the potential impacts of the risk externalities. It is also noteworthy that risk resides along a time continuum for a project as shown by the following:

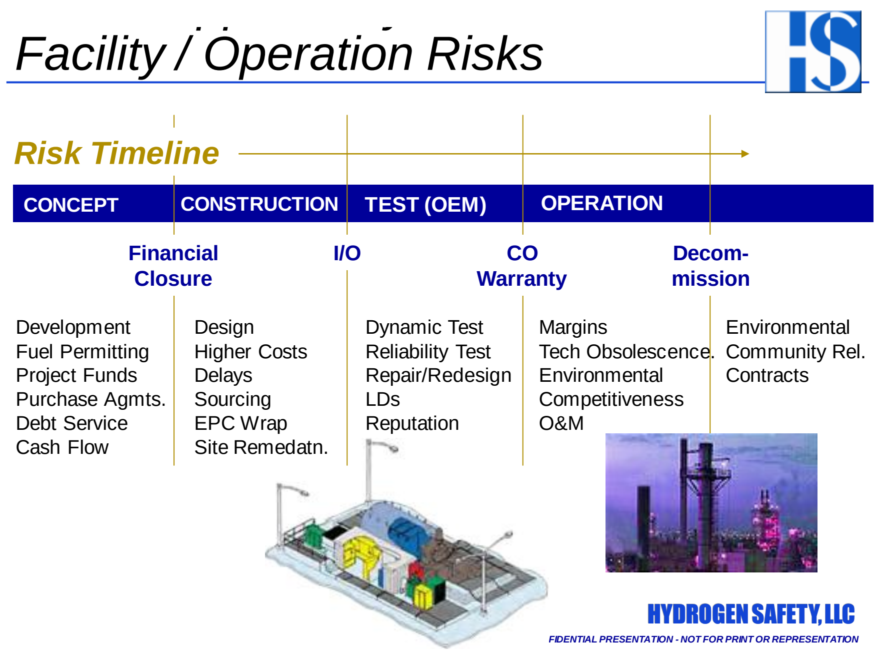

Figure 2. Facility/ Operation Risk Timeline

Figure 2 helps identify the broad scope of issues and potential risk exposures. Note that some of these risks have definable financial consequences. Others are not easily quantifiable because of their interconnected consequences. However, the risk externalities are a business reality.

Risk Perceptions

The perceptions of risk vary considerably among the various interest groups in a project. "New" technology, or innovative applications of technology, force projects to an increased level of scrutiny by banks and insurance companies. The perceived technology risk issues represent yellow caution flags requiring addressing before financial institutions will invest, insurance companies will insure, and developers champion a project.

Figure 3: Risk Perception Illustration

Financial Institutions

Financial institutions or Lenders are primarily concerned about the integrity of their equity participation or debt transaction. Loosely translated, will the borrower be reasonably able to payback their debt? The answer to that question requires an extensive review of many factors that influence the Risk Perceptions.

In most cases, Lenders will hire an "Independent Engineer" (IE), who has a good reputation backed with sufficiently relevant experience. The IE provides an independent and unbiased third party technical perspective on:

- Construction risk
- Operating risk
- Project's fitness for the intended purpose
- All plausible scenarios of cash-flow projections, and
- Ability to reliably serve debt in a conservative basis

It is important to understand that Lenders do not assume any responsibility for the performance of new or conventional technologies. The project sponsor(s) and/or equipment suppliers must be capable of engineering the proper technology and controlling the risk scenarios.

Commercialization Barriers

There are many commercialization barriers that can be categorized in three major groupings.

1. Project Agreements with the Participants:
   - Adequacy of risk sharing between all participants
   - Limits of technical and commercial support by project owners and equipment suppliers
   - Track record for participants for success projects and ones that failed
2. Technology Design:
   - Too many innovations in one project - for example, scale-up of size
   - Combined with integration complexity, unusual equipment designs, untested global sourcing
   - Lack of comfort level or familiarity with respect to process, technology, long-term maintenance costs, and other external costs
3. Operating Risks:
   - Under-estimated up front capital costs and life-cycle costs
   - Margin or Uncertainty Risk (the fear of 'Murphy's Law' – "What will go wrong, will")
   - Country or Political Risk including such risks as inflation, unstable new environmental regulations (Carbon Tax), labor markets
   - Environmental Risks (whether from site pre-conditions or impacts during construction and operation)
   - Change-in-Law Risks, affecting the political or environmental risks

In understanding these potential Commercialization Barriers, it is important to fully investigate these concerns before inception of the project.

Project Agreements and Participants

Typically, each project agreement defines a very detailed scope of work, responsibilities, deliverables, and contractual terms and conditions. Many of the important issues of the project agreements will be discussed further.

Duration

The interests of the financial institutions in a given project must be related to the debt payment schedule. Remember, the bank makes money by making loans and collecting interest. The debt repayment is important. i.e amortization of principal, but both are generally mitigated (i.e. the worry and risk of the loan goes away) by strong cash flow.

Contractual Agreements
A measurement of the borrower's ability to service the debt is the project's ability to consistently and dependably sell its product(s). If fuel is the end product, will there be sufficient demand? Power Purchase Agreements are becoming increasingly rare as the Power Industry evolves into a "merchant plant" mode of operation causing lenders to be concerned about the project's future competitiveness. (PPA contractual obligates parties to delivery of electricity at pre-determined prices.) In either case, financial risks must be controlled to commonly accepted business practices.

Risk Sharing in EPC (Engineered, Procure, Construct) Consortium Bidding
EPC Consortium Bidding should provide proper incentives for performance and cooperation. Lenders look for a "wrap-around" guaranty. For unproven technology, extended Warranties for five years instead of the usual one year could become a contractual requirement.

Liquidated Damages
Project warranties can vary considerably with each project. When the performance falls below certain minimum levels, Liquidated Damages (LDs) are assessed. LDs reflect the impact under-performance has upon the cost of fixing the problem and the lost revenue or business opportunity. The level of LDs for projects employing hydrogen is unknown today but 40% to 50% or higher Liquidated Damages may not be beyond a typical commercial project specification. In comparison, EPC contracts for power plants typically have Liquidated Damages that vary from 5% and 30% on various U.S. projects even with well proven technology.

Project Participants Considerations
Track Record of the project participants is of fundamental importance. The companies must demonstrate that they have the necessary professional experience and a success record in similar type projects. If a project fails, it takes hard work and much time to rebuild a shattered reputation. If top management is perceived as being responsible for a culture conducive to the failure(s) that triggered the loss of trust, a new senior management team is needed.

Company Behind the Technology
Because many Lenders, who are not specific market niche players, do not have a clear understanding of many technologies, they will rely on the company supporting the subject technology, and consider its record in:

(a) Continuously updating its products by introducing meaningful advances without mishap
(b) Prompt fixing of short-term mishaps and solutions to more long-term problems, and
(c) Making their customer "whole" for the resulting losses and even for some of the lost sales opportunities

Creditworthiness
Credit rating is always a bonus for major participants, since it is an identifiable value for the track record in related businesses. It also makes it possible calling for their support under defined "limited recourse" circumstances.

Technology Design Concerns

Fatal Flaws
Fatal flaws with respect to technology include any features that could render the project unfit for the intended purpose and economics. Fatal flaws also represent unquantifiable uncertainties affecting their

economic or environmental impact over the life of the project's financing. This is an easy and short list of horrors facing any project:

1) Technology may be unproved, with upfront engineering risks
2) Excessive construction costs and delays
3) Poor performance
4) Downstream risks (high maintenance or low reliability that worsen with time)
5) Technology obsolescent which allows better technologies to erode its market(s)

Reserve Margins in Plant Performance Guarantees

Reserve Margins in Plant Performance Guarantees are naturally limited by costs. Lenders have also found that too large a design margin may hamper efficiency and/or flexibility, or a control system's precision. Yet, it is a fact of life that performance degrades over time despite periodic overhauls. In addition, there are typically "surprises" during commissioning. The optimal choice, just as for redundancy is in key capital equipment. Choosing the right equipment is both a science and an art, even a matter of sound engineering practices.

Redundancy

Redundancy impacts both capital costs and simplicity, but is justified by considerations of the expense for on-going maintenance or lower production capacity or long periods of process shutdown for repairs.

Component Scale-up

Component Scale-up requires a detailed review of:

(a) What is being scaled-up and how
(b) Design logic, both fundamental and in the light of the operating history of similar processes
(c) Practicality and economics of alternatives, and
(d) Sensitivity of tolerances - can rate variation be plus/minus a factor of ten from a pilot scale factor of 1/5?

The general position is that any substantial change, that is not thoroughly mechanically, chemically and thermodynamically understood or otherwise proven, requires a substantial running period in terms of thousands of hours in representative service to establish confidence level according to several European lenders.

Operating Risks Assessments

Plant Availability and Efficiency Over Operating Period

The technical, economic and environmental performance of the plant is typically monitored on a yearly basis, but lenders can require a quarterly review. Actual performance is compared to specification, environmental permits, and financial models. Cash flow projections are then updated as appropriate. Any important deviations should be immediately understood then addressed by all participants.

O&M Contracts

Once a loan is closed, the lender monitors it through reporting and covenants, typically. As long as those are in good shape, the lender normally doesn't "approve" anything nor do they want to for fear of being at risk of "operating" which the lender never wants to do.

The budgets are based on scheduled and unscheduled overhaul, and the maintenance philosophy (own labor versus subcontract) of the Operator and Owner, as well as all direct and indirect costs of labor and subcontractors, fuel and utilities, before accounting for General & Administrative (G&A) overhead. Budgets should not overlook the obvious costs:

- ✓ Insurance

- ✓ Overtime
- ✓ Holiday compensation
- ✓ Local Taxes
- ✓ Labor Benefits and Pensions
- ✓ Permit maintenance, and
- ✓ Community relations

O&M Contracts with proper incentives are necessary to maintain a balance between:

(a) Long term technical (capacity, efficiency, availability), environmental and economic performance
(b) Short term economics and capacity factor
(c) Exceeding environmental discharge minimums

The design of incentives depends on whether the Operator is totally arms' length or is a meaningful project shareholder. Lenders can and should resolve the problem of excessive operating costs by subordinating to debt service any incentives and a percentage of the profit fee, and even specific costs incurred beyond specific G&A overhead. This approach only works if owner and operator have financial linkage for their stake in the project.

The final test under prolonged financial stress is, "Will the owner and O&M provider continue operations or to walk off and bankrupt the project after assessing the actual overall project economics?"

<u>Insurance Institutions</u>

All insurance companies are risk adverse. Their ability to assess risk and to properly assign a premium for absorbing the risk and to receiving an adequate compensation for their efforts, separates the successful companies from those with adverse results. Those insurance companies with good engineering resources to properly analyze and assess the risks scientifically will provide the better coverages for new technologies. The insurance industry's collective concerns are:

- ? Where has the technology been successfully demonstrated?
- ? How many plants are using this technology and what has been their experience?
- ? What is the normal loss event from this technology?
- ? What is the maximum exposure if the entire plant is destroyed?
- ? What situations are considered maintenance issues and not equipment failure?
- ? What are their associated costs?
- ? What is the exposure due to business interruption losses as defined by the power and/or steam purchase agreement(s)?
- ? What deductible level will prevent an erosion of premium dollars?

Evaluation Process

Insurance companies require the same information as the financial institutions. If the facility is in the development stages, conceptual information including equipment arrangement drawings, performance specifications, supplier proposals, and contractual agreements are needed.

If the facility is being built or in operation, an insurance company will do a risk assessment. A plant visit is made to collect site information. Interviews with operators and maintenance personnel as well as plant management team are done to gain their perspectives. A report is generated for the underwriter. A premium with terms and conditions is developed.

If the insurance company insures similar plants (law of large numbers), their collective experience is drawn upon in the assessment. In fact, their claims experience with a type of technology or vendor is critical to their deliberations to accept this technology.

For plants using hydrogen as a fuel, insurance interests will focus on:

- ✓ Piping and storage ruptures
- ✓ Hydrogen's high volatility and flammability potential
- ✓ Hydrogen leak detection reliability
- ✓ Adherence to specific codes and guidelines for hydrogen
- ✓ Operation controls, and
- ✓ Operator training

These concerns are both pragmatic and quantifiable. Data the DOE's website www.h2incidents.gov,identifies the myriad of potential triggers for accidents to occur.

Table 1 DOE H2 Incidents Report
As of 10/15/10

Contributing Factors	No	Percentage
Human Error	46	12.0%
Situational Awareness	45	11.7%
Equipment Failure	38	9.9%
Changes in Procedures, Equip,Mat'l	34	8.9%
Design Flaw	30	7.8%
Training Issues	27	7.0%
Decision Making	21	5.5%
Inadequate Maintenance	16	4.2%
Inadequate Inspections	16	4.2%
Lack of Protocol/SOP	15	3.9%
Incorrect Protocol/SOP	14	3.6%
Failure to Follow Procedures	10	2.6%
Operation Induced Damages	8	2.1%
Individual Actions	8	2.1%
Communications	8	2.1%
Flammable Mixture in Confined Area	7	1.8%
Inadequate System Monitoring/Oversight	6	1.6%
Incomplete O&M Procedures	6	1.6%
Deficiency in Procedures	4	1.0%
Improper Purging Procedures	4	1.0%
Abnormal Operations	3	0.8%
Inadequate Venting Systems	3	0.8%
Weather	3	0.8%
Other	12	3.1%
Total	384	100%

To conclude, the concerns of both the Financial Institutions and the Insurance Industry must be addressed in order for a facility, using hydrogen, to receive appropriate funding and insurance backing.

Applying Risk Mapping

Integrated frequency versus severity risk plots have been used in the regulation of human health, safety and economic risk from hazardous and nuclear facility operations for some time. We continue to advocate applying these principles for mapping the Total Cost of Risk exposures. Through the use of these risk maps, all the major business risk exposures can be not only compared to each other but also to industry norms. Once quantifying the risk in terms of frequency and financial consequence, prudent business decisions can be made regarding the practicality of mitigating the major risks.

Risk mapping offers the potential for:

- optimization of finite risk management resources,
- assurance that risk management objectives are not compromised by cost containment measures,
- identification and implementation of an optimal risk management strategy that minimizes risk and the cost of risk management simultaneously.

Risk estimates are inherently uncertain. Uncertainty bounds are used to evaluate the modified risk “value” in terms of its cost to mitigate and variability in consequences.

A comprehensive and consistent risk management strategy can be developed utilizing risk maps. The risks can be partitioned into three levels of concern, as shown by the following graph, in terms of loss severity and frequency.

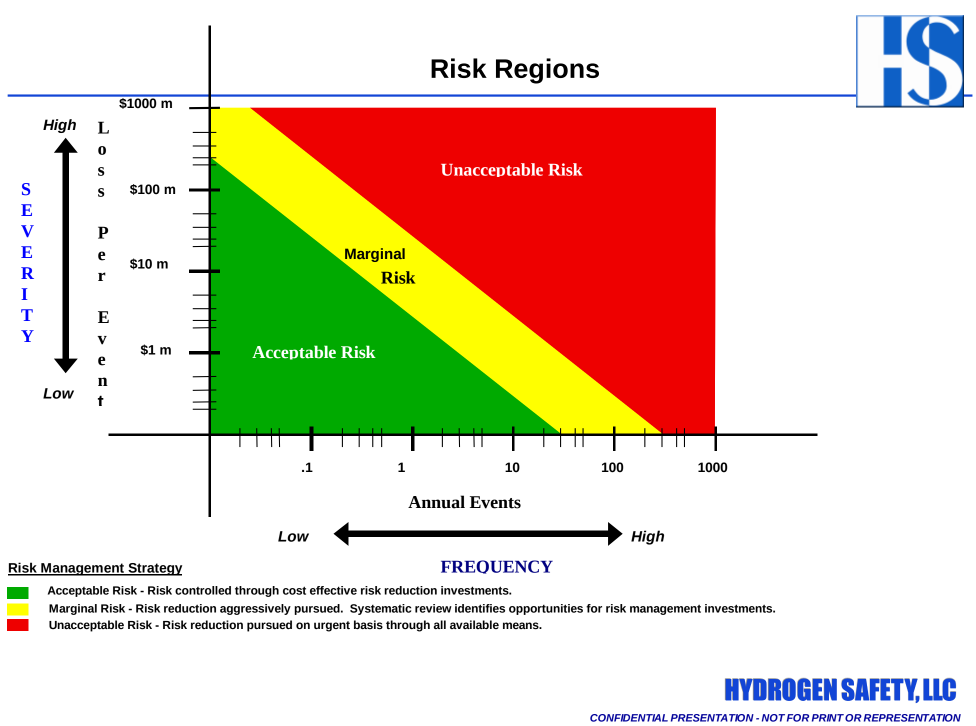

Figure 4. Risk Map

“Acceptable risk” region contains those risks that have manageable frequency of losses and financial consequences that can be reasonable tolerated. In contrast, the “Unacceptable risk” region defines risks that need immediate remedial actions. The area in between represents the “marginal risks” that requires management to explore cost effective risk alternatives such as risk transfer or investments to avoid the risk. It is important to note that these regions have quantifiable estimates for defining the risk exposure.

Risk mapping provides a consistent methodology for identifying and quantifying the Total Cost of Risk exposures.

Risk Mitigation Assessments
Once individual risks are identified the “investment” to either decrease the frequency of losses or their severity can be ascertained. Figure 2 below illustrates how the risks can be “moved” into a more acceptable risk region.

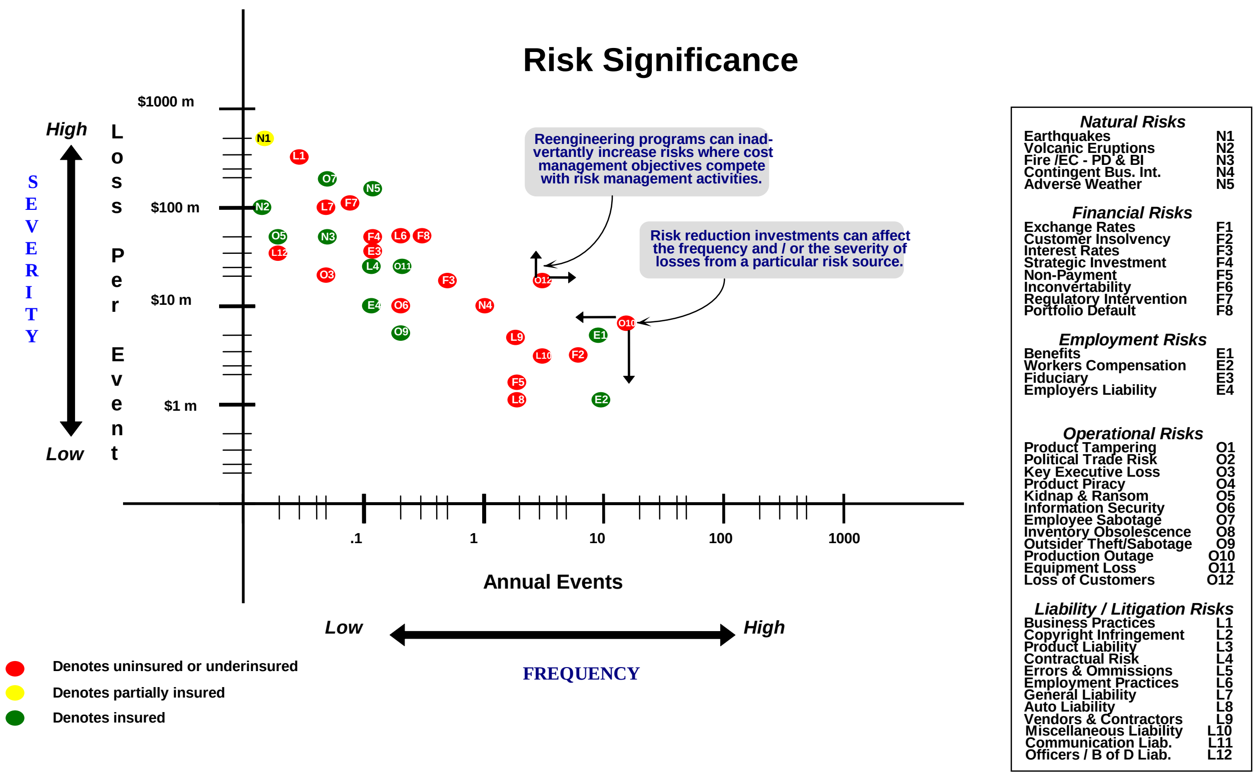

Figure 5. Risk Significance Map

Case Studies

<u>Hospital as a Fuel Cell Site</u>

A power plant developer approached a 300 bed full service hospital in CT about leasing some land in their parking lot to located a 4.6 MW Fuel Cell CHP plant adjacent to Boiler Plant on an area of 140’ x 60’ to generate electricity to local electric utility and 5,600 lbs/hr steam to hospital. The hospital would receive about $1.4 million in lease payments and reduce their fuel bill for steam by approximately $4.80 million. However a contentious issue developed over what is an appropriate compensation for the risks assumed.

To evaluate this deal, we asked some basic questions such as:

- ✓ What is the hospital's current power needs? in 5 years? in 10 years?
- ✓ What is the hospital's current need for waste heat? in 5 years? in 10 years?
- ✓ What are the hospital's current contracts for power & fuel & when do they expire?
- ✓ What fuels are available and pricing thresholds?
- ✓ What is the hospital's "green" position?
- ✓ What is the value of land resources?
- ✓ What Internal Resources are Available For Power Project Development?
- ✓ How does the Energy Actions of the Hospital Impact the Greater Community?
- ✓ What are the Hospital's overall future expansion plans?

Our findings found:

1. The hospital did not have any technology risk exposures,
2. The project risk exposures seemed to be financially mitigated
3. If the hospital wanted a share of the revenue from the sale of power to the local utility, then they would have to participate in the risk sharing currently being borne solely by the developer.

The project was tabled because of the future plans of the hospital to expand or possibly even relocate.

<u>Solar OEM Use of Process Hydrogen</u>

Hydrogen was being utilized for the high temperature processing of glass with two critical machining operations. The principal objective of this project was to provide a Risk Assessment of the proposed Hydrogen infrastructure design and operations, to ensure that the safety design considerations for Hydrogen are being properly incorporated.

A different aspect to this project was the use of equipment and manufacturing practices from Europe. It became apparent that operating and maintenance personnel must be trained for the specific type of equipment that will be used at this facility since the glass fabrication process, Hydrogen storage, distribution, and ventilation system is highly customized. We recommended that the training program address Hydrogen considerations in general as to raise awareness and build competency with four factors:

(1) Design,
(2) Operation,
(3) Maintenance, and
(4) Safety issues.

Annual re-certification should be done for all employees involved with Hydrogen usage.

Emergency Safety Plans needed to be developed to improve the level of awareness of operators to the issues and how they must respond to upset conditions.

Finally there was an array of design and operation risk mitigation recommendations, based upon Codes & Standards, Best Industry Practices and our experiences that included such issues as:

- The ventilation fan should be equipped with a zero speed switch to provide a feedback signal to the systems controls that it is in operation
- Provide adequate grounding and bonding to eliminate static ignition of hydrogen. Static control floor mats at the machines should be provided and proper clothing should be worn by operators
- For hydrogen storage area, security, barriers, and signage should be included as well as lightning protection.

- Audible and visual alarms should be located in the areas of a Hydrogen presence in the event that high levels of Hydrogen are detected.
- All utility piping should be identified as to the contents and labeled at least every 10 feet for the type of gases present to include the direction of flow. All ducts should be identified as to contents and direction of flow shown.
- Vents should terminate at least six (6) feet above the highest point in the roof and should have a straight vertical discharge and equipped with a weather cap to prevent rain, insect and foreign objects entry.

<u>Fuel Cell Cars - Fueling Stations - Permitting Approval for Service Bay Designs</u>
We have many clients who see the tangible benefits from risk management strategies use them on a series of projects.

In this case, we facilitated the identification of potential risk exposures associated with the interface between the hydrogen supplier and the separate dispenser technology. Our efforts were directed towards ensuring the systems were properly integrated and the control systems were harmonized.

This led to another engagement to evaluate the permit application for a hydrogen fueling station on behalf of a town's planning board in terms of codes & standards compliance and inherent design safety considerations. To satisfy the board's and residents' concerned, the risk assessment and risk management efforts were explained to their satisfaction ant the permit was subsequently approved.

A third task was to identify the hydrogen safety design considerations for a service bay devoted to fuel cell powered cars. The architect had limited knowledge of hydrogen codes & standards and did not appreciate the best practices to ensure personnel safety and building integrity.

<u>Hypochlorite Generation Technology</u>
It is important to note the hydrogen is used or created in many industrial processes. Some clients get "religion" after a accident threatens future sales. We originally became involved with this client because they were being sued because a client's maintenance worker tragically died. We successfully argued that the cause of death was not attributable to their equipment but rather human error. However, this triggered a complete assessment of their product lines in terms of code compliance, incorporation of best practices, and training of in-house and end user personnel.

We not only identified potential risk exposures but also quantified them in terms of potential financial consequences. Our risk mitigation recommendations were used to modified their equipment design. We also conducted a training program for their personnel who then used the materials as part of their customer training program.

Another unanticipated outcome of our assessment was their licensing agreements with distributors had to be improved to ensure their technology was properly being applied. This fix was an adjustment to their business flow model that gave the OEM greater control over the sale and installation of their equipment.

<u>National Lab</u>
This wasn't a case where the personnel were unfamiliar with hydrogen and its related issues. Instead the safety review committee for the entire complex required an independent third party to determine the compliance with codes & standards and industry best practices were employed. We conducted a risk

assessment of the design for a new laboratory that is dedicated to researching the effects of Hydrogen on materials as well as provided a customized Hydrogen Safety Seminar to the safety review committee. The local fire marshal participated to become comfortable with the lab design and operations. Once our recommendations were incorporated, approvals to operate were granted. The take away from this case study is that you can't allow compliancy and artificially convincing yourself that you know everything get in your way of optimizing the safety features for your hydrogen operations.

State Government Looking To Use Renewable Energy

We conducted a reliability study and technology due diligence review for the Connecticut Department of Environmental Protection regarding the use of renewable energy technologies, including various fuel cell designs, for State owned facilities within Connecticut. Environmental concerns with the various "green" technologies were assessed in order to quantify or score the benefits from these technologies. The elements of public relations, compatibility with the operations of the host site and costs to build, install and maintained were additional factors as part of a Total Cost of Risk evaluation. One unexpected obstacle was posed by the local utility which raised technology objections concerning the fuel cell project's integration into their grid. This issue was eventually satisfied but at the expense of project delays and increased costs.

Conclusions

Both new and existing uses of hydrogen and hydrogen related technologies can benefit from an effective Risk Management Strategy. The Strategy needs to address all the elements associated with the Total Cost of Risk model. By mitigating risk exposures, the prospects of successful project significantly increase especially if they are identified and incorporated early in the design process.

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