October 26-27, 1999 CONFERENCE OF THE
MARY KAY O'CONNOR PROCESS SAFETY CENTER

BEYOND REGULATORY COMPLIANCE, MAKING SAFETY SECOND NATURE

GEORGE BUSH PRESIDENTIAL CONFERENCE CENTER
COLLEGE STATION, TEXAS.

BENCHMARKING PROCESS SAFETY PROGRAMS

JOHN NORONHA, RESEARCH ENGINEER,
MARY KAY PROCESS SAFETY CENTER

TABLE OF CONTENTS

FIGURES

SUMMARY

The concept of ***informal benchmarking*** is a natural process of sharing and exchanging information on a subject of mutual interest among peers within and even outside one's company. However, only some corporations for significant business functions usually do the ***formal benchmarking*** procedures (Fig.1) described in this paper because of the significant benefits (Figs. 2 and 3). ***In applying benchmarking concepts to process safety, this paper is largely excerpted from and based on the general principles discussed in Robert C. Camp's book on*** "***Benchmarking, The Search For Industry Best Practices That Lead To Superior Performance***" (Ref.1).

For process safety too, benchmarking has been used informally for many years. Edinburgh-based ***Safety, Health, and Environment Intra Industry Benchmarking Association*** (SHEiiBA) (www.sheiiba.org) is the first organization to be almost entirely involved with benchmarking HSE programs.

Benchmarking Process Safety Programs is intended to provide HSE professionals with a mechanism to benchmark their own process safety programs, resources and performance with companies from their own and other industry sectors. The principle is that of ***mutual exchange*** of data, information, and know-how between participants who contribute small amounts of data to a bank of information, and from which they can withdraw significantly greater amounts on demand. The ***real value*** of the exercise is not so much about comparing numbers only, but sharing successful practices and perhaps allowing people to network wit each other- whatever the industry or country.

Different benchmarking programs will have ***different methodologies*** depending on the subject and circumstances. The paper will describe 10 generic benchmarking process steps, which can be used to various extents ***depending*** on the applications.

Without benchmarking, traditional target setting methods within companies is often effective. It is generally based on gut feel, lacking external focus, pursuing pet projects, without recognizing one's strengths and weaknesses.

On the other hand, benchmarking is an ***active commitment from management***. It is a clear and comprehensive understanding of how one's work is conducted as a basis for comparison to industry best practices. It leads to a willingness to change and adapt to industry best practices with new ideas and creativity.

In the discussion of the 10 benchmarking steps, the paper briefly describes how we propose to use a formal benchmarking in the following ***two proposed subjects***:

1) The first case is a proposed benchmarking study on ***risk reduction methods for exothermic reaction processes***, for which there is a need to develop better generally acceptable practices. This project is being coordinated by the Design Institute For Emergency Relief Systems (DIERS) Risk Subcommittee, under the chairmanship of the author (Ref. 3). DIERS is an affiliate of the American Institute of Chemical Engineers. It

has a membership of about 130 member companies worldwide with about 275 members. Note that emergency pressure relief systems are the primary protection system for exothermic reactors.

2) The second case is the proposal to develop a benchmarking study proposal for the ***three consensus goals of the Chemical Safety Program Assessment Project*** being coordinated by the Mary Kay O'Connor Process Safety Center. These three goals were voted for at a Roundtable meeting held on June 2-3,1999 at the Center (Refs. 4-5). The Roundtable consensus goals are:

1. Develop a comprehensive national data system for collection of near-misses and incidents, which can be related to actual causes and establish chemical safety baselines.

2. Establish metrics that relate safety performance and business objectives.

3. Establish targeted reduction goals for chemical safety incidents.

Finally, there is a discussion of the ***SHEiiBA HSE benchmarking program activities***.

1.0 INTRODUCTION

There are several definitions to benchmarking that are relevant and provide varying insights (Ref. 1) to our process safety interests. In this introduction section, we will first describe some ***relevant definitions and concepts*** and then ***address benchmarking process safety programs***. Then, it will reinforce many misconceptions of benchmarking, distinguish the difference between benchmarking and targets; and, finally discuss the benefits of benchmarking, Hopefully, this update at least broadly addresses the questions raised at the June 2-3,1999 Roundtable meeting (Ref. 5).

1.1 Formal Definitions and concepts of Benchmarking

The Xerox definition is "The continuos process of measuring our products, services, and business practices against the toughest competitors or those companies recognized as industry leaders."

Webster's definition is " A standard against something and which can be measured. A survey mark of previously determined position used as a refer processes, resources, and performances with companies from their own view point."

FIGURE 1: BENCHMARKING PROCESSES STEPS
(excerpted from Ref. 1, Pg. 17)

WITHOUT BENCHMARKING	WITH BENCHMARKING
Defining customer requirements	
Based on history or gut feeling Perception Low fit	HSE Practice Objective evaluation High conformance
Establishing effective goals and objectives	
Lacking external focus Reactive Lagging industry	Credible, Defensible Proactive Industry leading
Developing productivity mesures	
Pursuing pet projects Strengths and weaknesses not understood Route of least resistance	Solving real problems Understanding outputs Based on best industry practices
Becoming competitive	
Internally focussed	Concrete understanding of others
Evolutionary change	New ideas of proven practices and technology
Low commitment	High commitment
Industry best practices	
Not invented here Few solutions Frantic catchup activity	Proactive search for change Many options Superior performance

FIGURE 2: KEY REASONS FOR HSE BENCHMARKING AND CONTRASTING RESULTS (primarily excerpted from Ref. 1, Pg. 30)

FIGURE 3: SUCCESS INDICATORS FOR HSE BENCHMARKING
(primarily excerpted from Ref. 1, Pg. 37)

1. An active commitment to benchmarking from management
2. A clear and comprehensive understanding of how one's work is conducted as a basis for comparison to industry best HSE practices
3. A willingness to change and adapt based on benchmarking findings
4. A willingness to share information with benchmarking partners
5. A focus on benchmarking first on best industry practices; and second, on performance metrics.
6. Concentrating on companies with leading HSE practices, or functionally with recognized leaders.
7. Adherence to the 10-step benchmarking process as far as practical
8. An openness to new ideas and creativity and innovativeness in their application to existing processes
9. A continuos benchmarking effort and the institutionalization of benchmarking

A ***generic definition*** is a basis of establishing rational performance gaps through the search of industry best practices that will lead to superior performance.

Another ***working definition*** along the theme of the "The 10-Step Process" (Figure 1) is " a structured way of looking outside to identify, analyze, and adopt the best in industry or function."

Benchmarks may be ***descriptive***, as in the description of a best industry practice, or they may possibly be ***converted to a performance metric***, which allows the effect of incorporating the practice. The challenge is to close the gap between the current practice and benchmark. Any work process is made up of an input, repeatable process based on a method or practice and an output. If the practices are best in the industry, they will most fully satisfy customers.

Benchmark metrics are the conversion of benchmark practices to operational measures. However, unlike many other subjects, quantitative benchmarking is generally ***not as easily usable*** in process safety programs as descriptive benchmarking.

1.2 Benchmarking Process Safety Programs

Benchmarking process safety programs ***provide safety, health, and environmental information*** to SHE professionals around the world. This would provide a mechanism to benchmark their processes, resources and performance with companies from their own and other industry sectors. The idea is based on the view that successful practices are rarely industry-specific and may be easily adopted elsewhere.

Process safety benchmarking, and in general, HSE benchmarking ***has been performed informally for years***. There are hundreds of standards, guidelines and codes, which have developed through committee representatives of many user, insurance and manufacturing companies. These include AIChE, API, ASME, CCPS, NFPA and other professional organizations. Most of them may not have used all the benchmarking procedures described in this paper as formally as they could have. However, they probably met many benchmarking objectives.

However, many process safety subjects ***could be greatly benefited by a more formal benchmarking exercise***. Many standards and guidelines are performance-based and can be accomplished in numerous ways. Some companies have more experience and may have come across more efficient ways of accomplishing the tasks than others in certain applications, and vice a versa. Besides, many companies may be unsure of how to meet a performance standard on a ***cost-benefit basis*** and would like to develop a generally acceptable practice along with other companies. This way they could have a ***credible defense*** (especially for legal reasons in safety procedures) if the procedures were based on a collective experiences and acceptance of all parties involved.

Edinburgh-based SHEiiBA (Reference 2) is the first organization to be almost entirely involved with benchmarking HSE programs. A description of its benchmarking programs is described in Section 3.

1.3 What Benchmarking Is Not

There are ***many misconceptions*** of what benchmarking is; and these should be clearly understood and reinforced (Ref.1). What benchmarking is not should be quickly dispelled. Likewise, since benchmarking involves setting new directions, its relationships to targets should also be understood.

Benchmarking is not a mechanism for ***determining resource reductions***. While this may occur because many operations do not emulate best industry practices, it does not necessarily mean a reduction.

Benchmarking is ***not a panacea or program***. It must be an ongoing management process that requires constant updating. Benchmarking must have a structured methodology to ensure successful completion of thorough and accurate investigations. However, it must be flexible to incorporate new and innovative ways of assembling difficult-to-obtain information, as will be the case of most process safety programs.

Benchmarking is ***not a cookbook process*** that requires only looking up ingredients and suing them for success. Benchmarking is a discovery process and a learning experience. It requires observing what the best practices are and projecting what performance should be in the future.

Benchmarking process safety programs is ***not a fad, but a winning business strategy***. It assists a safety professional to build credible defensible plans and develop new initiatives.

1.4 Benchmarking And Targets

Benchmarking is a ***new way of doing business***.(Ref. 1). It forces an external view to ensure correctness of objective setting. It removes the subjectivity from decision making. It is basically an ***objective-setting process***.

Benchmarks, when best practices are translated into operational units of measure, are a projection of a ***future state or endpoint***. In that regard their achievement may take many years to accomplish. A benchmarking study may indicate that safety goals must be achieved or costs must be reduced. The conversion of benchmarks to operational targets translated the long-term actions into specifics.

Targets are more precise, although their quantification should be based upon achievement of a benchmark. Furthermore, a target incorporates in it what can be realistically can be accomplished within a given time frame, usually one yearly cycle. Considerations of available resources, business priorities, and operational considerations convert benchmarking to a target, yet steadily show progress toward benchmark practices and metrics.

1.5 Why Benchmark?

There are both ***tangible and intangible benefits*** by benchmarking. Benchmarking is ***a goal-setting process***. But, more importantly, it is a means by which the practices, needed to meet new goals, are discovered and understood. These are probably the most basic and fundamental outputs of benchmarking.

Benchmarking legitimizes goals and targets by basing them on external orientation. ***Ownership of and commitment to*** the benchmark is assured through agreement to the practices on which they are based.

A ***comparison of the reasons*** for benchmarking along with a contrast of the results expected with or without this approach is shown in Fig. 2. Some ***success indicators*** for benchmarking are shown in Fig. 3.

2.0 TEN BENCHMARKING STEPS AND APPLICATION TO 2 PROPOSALS

The benchmarking process generically has 10 steps as shown in Figure 1. (Ref.1) We will only discuss some steps briefly. The 10 benchmarking steps are:

1. Identify what is to be benchmarked
2. Identify comparative companies and data sources
3. Determine data collection method and collect data
4. Determine current performance "gap"
5. Project future performance levels
6. Communicate benchmark findings and gain acceptance
7. Establish functional goals
8. Develop action plans
9. Implement specific actions and monitor progress
10 Recalibrate benchmarks.

The paper also briefly describes how we propose to use a formal benchmarking in the following two proposed process safety subjects:

1.Proposed DIERS Benchmarking Study On Risk Management Of Exothermic Reaction Systems

2. Mary Kay O'Connor Chemical Safety Assessment Project

2.0.1 Proposed DIERS Benchmarking Study On Risk Management Of Exothermic Reaction Systems

The first case is a proposed benchmarking study on risk reduction methods for exothermic reaction processes, for which there is a ***need to develop better generally acceptable practices***. The DIERS Risk Subcommittee (Ref. 3) is coordinating this project. Note that DIERS is involved because emergency pressure relief systems are the primary protection system for exothermic reactors.

Ref. 3 describes why the Design Institute For Emergency Relief Systems (DIERS) Users Group of the American Institute of Chemical Engineers would like to benchmark worldwide on risk reduction measures that are used for exothermic reaction systems**.** The authors described the ***dilemmas*** in implementing the DIERS technology and various risk reduction measures on a cost-benefit basis. Not only could there be a ***significant damage potential*** if the DIERS technology were not implemented adequately, but also there would be significant ***benefits*** in scaling the issues up processes. This could save many corporations millions of dollars annually without increasing risks. It also addresses how to tackle of existing versus new projects and meeting the intent of various codes.

2.0.2 Mary Kay O'Connor Chemical Safety Assessment Project

The second case is the proposal to use a formal benchmarking study for the three consensus goals of the June 2-3,199 Roundtable meeting on the Chemical Safety Program Assessment Project. It is being coordinated by the Mary Kay O'Connor Process Safety Center. The Roundtable meeting consensus goals are:

1. **Develop a comprehensive national data system for collection of near-misses and incidents, which can be related to actual causes and establish chemical safety baselines.**

2. **Establish metrics that relate safety performance and business objectives.**

3. **Establish targeted reduction goals for chemical safety incidents.**

These three goals were voted based primarily on information received at the ***June 2-3***, 1999 meeting through 5 briefing papers by 5 experts. The papers did not provide specific conclusions but provided sufficient data and information to stimulate discussion among the Roundtable attendees. The ***44 Roundtable attendees represented academia and researchers, citizen and advocacy groups, consultants, government, industry, and industry associations and insurance groups***.

Each of these goals received about 20 % of the 118 votes cast for 23 subjects selected by the attendees. Thus, this was an overwhelming vote for these 3 goals. It is quite apparent that the 44 Roundtable attendees felt that there was a significant national need to develop some programs to address these 3 goals.

Each of these goals ***are to be developed by stakeholders*** consensus based upon an analysis of the ***history of accident prevention activities***, accident and injury *statistics,* and evaluation of other safety programs. The programs evaluated should include those required by ***regulatory authorities and industry standards***. The goals should be ***achievable and measurable***. Activities necessary to accomplish the goals ***also must be identified and implemented*** within a specified period of time. Finally, the measurement system should be implemented such that the progress towards the national goals can be ***tracked relatively easily.***

In turn, the baseline assessment can be credible only if a ***reliable and comprehensive database*** is available. The ultimate intent of this project is to establish a system that not only helps evaluate the ***effectiveness of current programs*** and activities, but also serves as a ***basis for establishing future goals***. This makes a strong case for benchmarking.

2.1 Step 1 - What Needs To Be Benchmarked

Benchmarking can be tedious and expensive. The key to determining what to benchmark is to identify what process safety program could best benefit from the exercise.

To attack the problem, it is best to start with a ***high level of evaluation***. Usually a subject will have a ***mission statement***. From the mission statement can be derived typical deliverables expected from the customers. This could be a solid starting point to further breakdown more specific deliverables. ***Other key aspects*** in the subject selection are the performance measurement, testing the appropriateness of outputs to be benchmarked, the level of detail, and understanding and documenting the function's current work process.

For the proposed DIERS benchmarking study on risk management of exothermic reaction systems, the proposed questionnaire (Fig. 4) shows the key items that need to be benchmarked.

For the Mary Kay O'Connor Chemical Safety Assessment Project, besides the discussion in Section 2.0.2 on its 3 goals, Figs. 5 and 6 give some suggestions of what needs to be benchmarked and how it can be done.

FIGURE 4: <u>THEME OF PROPOSED DIERS BENCHMARKING QUESTIONNAIRE ON RISK MANAGEMENT OF EXOTHERMIC REACTOR SYSTEMS</u>

1. Does your company have exothermic processes which could runaway or decmpose and cause catastrophic risks due to process deviations, operator error and even fire exposure ?

If so, what is your catastrophic risk assessment based on ? Is it simimar to the DIERS Risk Guidelines?

Also, does your company have a multifaceted approach based on consequence analysis, protection, and prevention of catastrophic risks similar to the DIERS Risk Guidelines?

2. What are the typical sets of conventional, better, and extraordinary preventive and protective methods used for your reactor and storage systems? Please compare it with the DIERS Risk guidelines.

3. Do you use runaway reaction kinetics and two-phase flow venting technmlogies to esti mate the maximum venting pressures and thereby estimate the required vent sizes, the vessel design pressure, and other design factors for a given batch size of a chemical process at a given risk acceptable to your company?

4. If you do use runaway technologies to estimate venting pressures,
   a) Do you have internal resources, or do you use outside consultants?
   b) Do you apply DIERS or other consequence technologies?
   c) If you don't use DIERS, why don't you?
      Complicated ( )?; Lack of confidence in DIERS? ( )?; Other reasons ( )?
   d) Do you accept venting pressures above the 1.2(MAWP) level with correspondingly-increased preventive and protective measures?
   e) What methods of analyses do you use?; and what are their bases (such as process severity, process complexity, and production limitations)?
   f) What is the average time and cost of your vent risk analysis for reactive and non-reactive systems?

5. If you do not use runaway technologies to estimate venting pressures,
   a) Do you use vent and vessel protection designs such as the FIA curves, which have been withdrawn by Factory Insurance Association?
   b) Do you base risk decisions mainly on prevention? And, if so, what prevention techniques do you use? And, if so, is this because of venting environmental concerns? Or, the costs of emergency effluent handling?

6. Do you feel this survey is beneficial to the chemical industry?

Figure 5: DEVELOP INDICATORS, MEASURES, AND METRICS TO MEASURE GOALS OF CHEMICAL SAFETY ASSESSMENT PROJECT

1. **Identify Measures/Indications for National Chemical Safety Goals**

2. **Identify Activities (Of Stakeholder Programs) That Contribute To Indicators And Data Collection From Stakeholders For Measures (Ref. 3, page 5)**

3. **Determine Cause/Effect Relationship Between Stakeholders Goals And Activities**

   - **Is It Possible To Measure The Individual Contribution Of Various Programs (PSM), RMP, CMA's Responsible Care) To Chemical Safety?**

4. **Identify Gaps in Meeting National Chemical Safety Goals**

5. **Identify Ineffective Activities Which Should Be Improved Or Eliminated**

6. **Develop Metrics to Measure Progress Towards National Chemical Safety Goals**

<u>FIGURE 6: : HOW TO IDENTIFY PROGRAMS AND/OR OTHER FACTORS (towards goals of the Chemical Safety Assessment Project)</u>

1. **Delphi Technique on Chemical Companies (Because They are More Likely to Comply)**

2. **Confidential Interviews will be Made with Companies (that are not complying) to Determine if Their Safety Records are Worse (Better) or Statistically Different**

3. **Analyze Whether Only Subjective Conclusions are Possible (Rather Than Objective Conclusions)**

2.2 Step 2 - Identify Comparative Companies And Other Data Sources

This section describes one very important aspect of benchmarking, namely the ***identification and use of information sources***. It is about identifying companies against which to benchmark. At the same time several important information sources need to be identified.

These can be judged, at least initially, in terms of ***relevance*** of the data to the subject, the ease of data collection, and the potential for ***uncovering innovative practices***.

There is a natural tendency, when benchmarking is to be considered, to immediately contact several companies to set up visits. However, experience has shown that this can be a serious mistake and waste valuable resources. ***Sometimes other public information sources (as may the case of the Mary Kay O'Connor project), are extensive and should be tapped first. These are often available in the public domain.***

Automated data bases deserve mention because they are good starting points, relatively inexpensive, and permit a quick focus on desired. ***Professional and trade associations*** are probably the second most productive source of information. They can serve to identify industry leaders as well as provide industry data and information.

The benefit of these information searches will not only ***catalog existing information***, but also further ***help define*** the investigation. The other benefit is tapping information already available may ***develop other sources*** of information.

For safety programs especially, it is not necessary to concentrate on similar industries. Some business functions are the same regardless of dissimilarities of industries. Finally, there is great potential for improving the benefits of benchmarking if we can identify firms with superior logistic functions wherever they may exist.

For the proposed DIERS benchmarking study on risk management of exothermic reaction systems, primary sources of information are the process safety engineers or consultants or the nearest equivalent available in the company such as a capital project engineer or a process engineer.

For the Mary Kay O'Connor Chemical Safety Assessment Project, there is likely to be significant information in the public domain. The primary sources of information will be the various stakeholders of the program, namely industries and industry association representatives; federal, state and local government; response organizations; environmental groups; public advocacy groups and plant personnel.

The following figures give an overview of potential data sources for the chemical safety assessment project: Figure 7 shows the major ***regulatory chemical safety programs*** relating to toxic, reactive, flammable and explosive of accidental releases.

Figure 7: SOME KEY REGULATIONS (Linked with regulators as sources of data for the Chemical Safety Assessment Project)

Year	Regulation
1985	Chemical Emergency Preparedness Program (CEPP)
1986	Emergency Planning and Community Right-to-Know Act (EPCRA)* [also known as Superfund Amendment and Reauthorization Act Title III (SARA)] *Established LEPC's nationwide
1986	Chemical Accident Prevention Program
1986	Chemical Safety Audit Program
1987	Accidental Release Information Program (ARIP)
1990	Clean Air Act Amendments (CAAA) Section 112(R)
1992	OSHA Process Safety Management (PSM) Regulation
1996	EPA Risk Management Program Rule (RMP)

Figure 8: **LOCAL EMERGENCY PLANNING COMMITTEE GUIDEBOOK -Program Requirements Summary (as data source for Chemical Safety Assessment Project)**

	PROGRAM LEVEL		
	1	2	3
Worst Case Release Scenario			
1 One toxic or flammable for each Program 1 process	X		
2 Single toxic for all covered Program 2 or 3 processes		X	X
3 Single flammable for all covered Program 2 or 3 processes		X	X
Alternative Release Scenario			
4 At least one for each toxic in each covered Program 2 or 3 processes		X	X
5 At least one for all flammables for covered Program 2 or 3 processes		X	X
Five-Year Accident History	X	X	X
Management System	X	X	X
Prevention Program		X	X
Emergency Response			
6 Local agencies or facility provide; site must coordinate with response	X		
7 Develop and implement site program		X	X
Submission of RMPlan			
8 Certification statement	X	X	X
9 Worst-case analysis results	X	X	X
10 Alternative case analysis results		X	X
11 Five-year accident history	X	X	X
12 Data on prevention program elements		X	X
***Note*: Must submit additional worst-case scenarios for a hazard class, if different public receptors are potentially affected.**			

Figure 8 relates to Local Emergency Planning Committees (**LEPC**) as potential sources of accident histories. LEPCs have program requirements, which relate to various safety programs used and the 5-year accident history. These documents have details of the 5-year history as they relate to both on-site and off-site deaths, injuries, and property losses (Ref. 6).

The major ***industrial associations*** are ACS, AIChE, API, ASME, CCPS, CMA, and NFPA.

Different stakeholders will likely have ***different goals and objectives***? Some examples of goals are as follows. How many deaths and injuries would be acceptable in a given period of time? How much property damage and business down time is acceptable? How many releases and how large a release is acceptable? How much time and money can be spent on hazard analysis?

Our project goal is to get benchmarking data from a ***representative sample*** of stakeholders to determine their goals and objectives. Then identify commonalties and differences, and then identify what we will consider national chemical safety goals.

Our benchmarking efforts could be based on :

1) A sample representative of the ***66,000 reporting facilities under RMP*** (such as the Alkali and Chlorine, Plastics and Resins, Nitrogen, pesticides and other agricultural chemicals, Petroleum refineries, Petrochemicals, Pulp mills, other inorganic manufacturing, and other basic organic chemicals)

2) Those industries, processes, and chemicals identified as hazard concerns in the ***Accidental Release Information Program*** (ARIP), or

3) ***Narrow industry groups*** such as Chlorine, Ammonia, Phosgene, and Ethylene

Companies are required to report accidents due to government regulations, and often because of internal company policies. Most companies have guidelines describing details such as the purpose, scope, policies, procedures, for both the Safety Department and Line Departments; and the Guidelines for conducting a formal investigation of accidents.

Another potential data source is the recently initiated ***CCPS Incident Data Base*** program . It reviews how data is collected and analyzed for about 25 companies who volunteered and paid dues to be part of the program. *Other sources are* ***two recent articles by Dr. M. S. Mannan, T. M. O'Connor and Dr. H. H. West (Ref. 7), and Ms. E. McCray (Ref. 8) on accident history databases. They all represent the Mary Kay O'Connor Process Safety Center.***

2.3 Step 3 -Data Criteria and Collection Methods

Data collection methods are ***synonymous*** with and integral to sources of data and information. Several were discussed earlier. Their use was covered in sourcing benchmarking partners. Several methods will be reviewed in this section, including their benefits, deficiencies and pointers for effective use. We want to select methods that meet the needs of the study. It may be appropriate to conduct a questionnaire or telephone survey before any site visits. As noted earlier, **all public domain information such as library search and professional and trade associations** should be extracted before any approach is used.

2.3.1 Criteria and Characteristics Of Benchmarking Data Needed

Before starting, several data criteria and characteristics should be considered. Among them are the ***amount and accuracy of the data***, the ***time and the cost*** of the data collection, and whether ***specialists*** are required. If one thing has been learned about benchmarking, it is that it is generally ***laborious*** and does take much time.

Other criteria are the ***basis of information exchange*** and the need to remain in ***continuous contact*** with the sources to be effective. Once best practices are found, documented and communicated through the benchmarking process, the acid test is not so much of benchmarking, but that of the incentive or willingness to implement the best practices by management.

A key element is to ***evaluate whether we can, in fact, use benchmarking*** to assess chemical safety programs including technologies, and subprograms. To do so, we need to develop methods for metrics and measurements. We would need to ***analyze data*** by the identification of general normalized measures, including qualitative and quantitative measures. We need to ***identify factors that are responsible for trends***. We could use Delphi Technique on companies that are likely to ***comply*** with safety programs. We could use confidential interviews for companies (that are ***not complying***) to determine if their safety records are statistically worse, better, or the same. We need to analyze whether only ***subjective conclusions*** are possible (rather than objective conclusions.) from the proposed benchmarking.

2.3.2 Data Collection Methods

Internal Information can come from a wide range of sources within a company, not just the experts. Since benchmarking is expensive, it is wise to consider so for multiple projects internally where feasible. Since many individuals are *keen observers* of peripheral matters, they may be good sources of a variety of information, besides bringing their ***own perspective*** and expertise to the benchmarking project.

Consultants on benchmarking are often beneficial in benchmarking. They are familiar with many other companies' best practices and can share non-confidential information with others. This is often timely and cost-effective. The consultants can also comment more effectively than others on benchmarking findings already documented. Candidate consultants can be obtained from many sources, especially trade associations.

External experts exist in almost all subjects. These individuals may have information on the value of benchmarking for a specific issue. Even if they do not have specific knowledge, they may serve as valuable references to others who do or to where the data can be obtained.

Original research, though expensive, must be conducted where it does not exist in internal and external public sources. The first approach will be questionnaires, then site visits, and then more advanced techniques, such as panels of benchmarking partners.

Questionnaires serve important purposes. First, it ensures that all questions of interest are ***thoroughly documented***. It is ***often debugged*** in a receptive environment to further ensure completeness. It permits ***extensive data*** gathering, which may not be available in a site visit. The chief use of questionnaires is to ensure anonymity when needed. ***When anonymity*** is required, questionnaires are the only method of cooperative data gathering. The difficulty of questionnaires is that the information will be ***filtered*** to a certain extent, especially if a third party is used.

Fig. 12 gives factors to consider in a ***successful questionnaire***. There are 4 types of questions: 1) open ended 2) multiple choice, 3) forced choice, and 4) scaled. Each has its merits. Most important in the structure of questions is how they are worded. There should be no leading questions, which would prejudice the answer or give meaningless results.

If the benchmarking problem has a ***cause-and-effect*** diagrammed, then the casuals for the problem statement are the prime source of the questions.

For the proposed DIERS benchmarking study on risk management of exothermic reaction systems, the cause-and-effect is often diagrammed. So a detailed background of the DIERS technology and its applicability in risk reduction (Ref. 3) will be provided along with the questionnaire.(Fig. 4)

For the Mary Kay O'Connor Chemical Safety Assessment Project, it will be primarily done by a questionnaire using 4 basic types of questions noted above after Reviewing the public domain information.

Some ways to ensure ***mail-administered*** benchmarking success are to preannounce the survey with a mailer or call in advance to obtain a verbal commitment to filling out the form and returning it. This still can be done anonymously.

Telephone-administered surveys can be used for benchmarking. These should be done usually only on a professional-to-professional basis for greatest result. These surveys are usually specific, highly ***information-targeted***, and should take only a short time. The greatest difficulty of this method is locating the right person to answer the questions.

Direct-site visits are the most interesting and credible benchmarking method. Usually this is coupled with a tour of the operation where one can observe the methods, practices, and processes used firsthand. Since, this is ***expensive***, direct visits should only be conducted when these features are required. ***Careful planning*** and preparation are essential to ensure productive use of each party's time.

Making the right contacts and follow-ups are very critical. Usually designated company representatives, professional-to-professional contacts, referrals, and visit itinerary are key factors to success. It is also imperative that a ***pre-visit briefing and a post-visit debriefing*** be conducted. A trip report is appropriate. It should contain the results of the debriefing with all parties agreeing on what was documented.

Prior to making any benchmarking contacts, consideration should be given to the ***basis of information sharing*.** What will be the *motivation, willingness, and restrictions* on the part of others to share information. The key messages should be exchanging, on a professional basis, experiences and judgment of best practices in the industry or functional field. The benefits of information sharing often out-weigh any initial reluctance to participate.

While absolute data is often preferable, ratio-based data is often an acceptable mode of collecting data, as companies may be reluctant to give absolute data. Besides, ratio data can be better used to quantify the effect of that practice or method.

In general ***common sense*** should prevail. If the data and information are judged sensitive to the benchmarker, then it is most likely to be sensitive to the benchmarking partners. ***Judging these sensitivities,*** should forestall any problems; and will allow maximum benefits to be gained from mutual exchanges of information gathered on a positive proactive level.

Benchmarking is ***not static***. They are not often not once created to remain forever. Processes, methods and practices change within an industry. We need to track the relative positions. This is referred to keeping ***benchmarks evergreen.*** Some methods to accomplish this is to ***replicate*** the original approach. This should probably be done about every 3 years but not less than 1 year. The other way is to ***update*** over time, as new information becomes available. This is more gradual and can be done at desired intervals. For process safety, the latter mode of updating is usually generally acceptable.

2.4 Step 4 - Determining The Operational Gap

At this point in the benchmarking process, outputs will have been defined, the best operations of interest found, data gathered, and documented. What will be revealed is the gap or differences between an internal organization's methods and the best in the industry. There are ***3 types of performance gaps: positive, negative and parity.*** What is desired in a gap's analysis is an objective assessment of their magnitude as well as an explanation of why the gap exists.

Differences in practices, especially when external operations are better, are the performance gaps of most interest. Standard comparative analysis can be used.

For the proposed DIERS benchmarking study on risk management of exothermic reaction systems, an evaluation should be made as to whether our internal operations use the DIERS technology adequately on a cost/benefit basis; and that our plant is designed safely. Also, whether we have adequate risk reduction preventive and protective measures to match the risk on a cost-benefit-risk basis.

For the Mary Kay O'Connor Chemical Safety Goals project, an evaluation should be made whether our internal operations are safer than the industry accident statistics; and whether they meet our internal objectives. If not, try to determine an explanation.

2.4.1 Comparative Analysis of the Gap

How are the differences in practices to be analyzed and their impact assessed ? There are two ways: 1) ***Qualitatively*** and 2) ***Quantitatively***.

There is a significant and natural tendency to compare ***them quantitatively before the qualitative***. However, this is often not feasible. Besides, it is often a ***mistake*** to do so. This is because the qualitative answers explain why the metric is what it is. Where possible, the benchmarking investigations should concentrate on a sure understanding of the practices before even conducting the benchmarking, but certainly before attempting to measure the results.

Ultimately, the gap must be quantified and expressed in terms of the effect on the operation. However, it has been the experience that the qualitative should proceed the quantitative since one is the outcome of the other, and not the reverse.

What is to be quantified deserves attention given that the best practices have been incorporated or considered. The number will show ***what the risk would look like*** if the best practices were incorporated. A person could not go to an external firm and find that number. The reason is that no single firm incorporates the best of the best practices. It may be a synthetic number. But if it is a budgetable number, it is generally doable.

2.5 Step 5 -Projecting Future Performance Levels

Once the performance gaps have been fully defined from benchmarking practices, the projection of future performances ***will be necessary***. This is the difference between expected future performance levels and the best in the industry. It is important to project the future gap because industry practices change. Is the gap expected to increase, decrease or stay the same?

In process safety benchmarking, this is important to reflect on the effect of process safety efforts long-range. It gives a quantitative justification of our investments in process safety.

2.6 Step 6 - Commumnicating Benchmarking Findings

This section deals with communicating findings to the ***organization at all levels and gaining its acceptance***. This is important since no matter how well the benchmarking has been conducted, there is obvious skepticism for the introduction of new practices.

It will be wise to give thought to the basis on whether operating personnel, who ultimately have to accept and implement new practices, will be willing to do so.

These are the 3 essential steps to communicate the findings to various affected individuals and organizations:
1) The ***audience*** and its needs should be determined,
2) The ***method*** of communication should be ***selected and tailored to the audience***, and
3) The benchmark findings should be **organized** for the best understanding.

For the proposed DIERS benchmarking study on risk management of exothermic reaction systems, the primary audience are the process safety engineers or consultants or the nearest equivalent available in the company such as a capital project engineer or a process engineer. The communication method would be a revised edition of the DIERS Users Risk Guidelines and several publications in safety engineering journals.

For the Mary Kay O'Connor Chemical Safety Assessment Project, the primary audience are the various stakeholders of the program namely, regulators, industry association representatives; federal, state and local government; response organizations; environmental groups; and public advocacy groups. The methods of communications would depend on the audience. This would range from industrial and engineering safety journals, to newspaper communications.

Benchmarking has shown to be a significant motivation for seeking change within an organization especially among individuals reluctant to accept change. This communications strategy will ***go a long way toward gaining acceptance***. The mission statement and operating principles are very effective in this regard.

2.7 Step 7 - Establishing Functional Goals

This section relates to the ***relationship of benchmarking to goals***; and the effective way the goals, based on the benchmarking findings, can be stated for acceptance by the organization. Goals are a ***statement of planned performance***.

The most effective way found has been to ***convert*** the most important benchmarking findings ***into statements of operating principles***. The principles, directly derived from benchmarking, serve to ***place the organization on notice***. This is about what will be considered when decisions are made for change, how the organization will be expected to change over time, and ultimately how the organization will look when it arrives at a position of maturity derived from benchmarking.

Each company has its own approach to goal setting. So, we will not cover it here. What we will cover is the ***goal setting process and the rationale in relation to benchmarking***.

2.7.1 Process

Benchmarking by its nature ***requires examination of goals*** and goal-setting process. Procedurally, the list of current goals is reexamined as a result of benchmarking efforts. Goals are listed in annual objective statements.

While it is true that the ultimate use of benchmark findings is in ***changing the metric***, it should be done ***with some care***. It is probably best to recognize some range about the mean value of the goal.

In the process of changing goals quantitatively or qualitatively, the ***effect on other upstream and downstream organizations*** need to be clearly understood. The final step is to obtain commitment to change and to determine the new performance gap.

2.7.2 Rationale

Each firm has its own approach to goal setting. For benchmarking purposes, the ***hierarchical cascade*** of mission, operating principles, performance goals, strategies, and tactics is an effective scheme for goal setting.

It is the specific thesis of a major benchmarking expert (Ref. 1) that no worthwhile goals can be established without being based on benchmark findings.

2.8 STEP 8 - Developing Action Plans

The key issue is what changes are necessary to achieve benchmarking findings. One consideration up front of benchmarking is to expect findings to base operating and longer term changes. Another is to examine benchmarking from the viewpoint of their contribution to efficiency and effectiveness.

For the proposed DIERS benchmarking study on risk management of exothermic reaction systems, the benchmarking questionnaire will have a detailed report showing significant benefits in scaling up processes and utilizing less expensive risk analyses and risk reduction measures for a given risk. This could save many corporations millions of dollars annually while still not increasing risks. It also addresses how to tackle of existing versus new projects and meeting the intent of various codes.

For the Mary Kay O'Connor Chemical Safety Assessment Project, we should emphasize the value of the program, viz. to establish a system that not only helps evaluate the effectiveness of current programs and activities, but also serves as the basis of establishing future goals.

During action planning of benchmarking findings, there are 2 things to consider:
1) the activity and task to be accomplished, viz. the who, what, when and how, etc.
2) the people and behavioral aspects of implementing change.

2.9 STEP 9 - Implementing Specific Action Plans And Monitoring Progress

This section addresses the several items important to successfully implement and monitor benchmarking action plans and installing industry best practices. Benchmarking has the ***potential of redirecting resources*** of an organization.

The standard ways are usually through ***line management*** or through the use of a ***dedicated program team***. A non-traditional way is through ***performance teams*** or those closet to the operations. Yet another way is through a senior management level "**process czar**".

There are several monitoring and reporting approaches that can enhance the benchmarking success. Those few, high visibility metrics that indicate progress toward efficiency should be monitored.

For the proposed DIERS benchmarking study on risk management of exothermic reaction systems, one can monitor the extent of scale-up of batch operations without increasing risk. Similar monitoring can be done for ***the Mary Kay O'Connor Chemical Safety Assessment Project.***

To further ensure that the benchmarking findings ***continue to be implemented***, benchmarking should be ***integrated into the vital processes*** through which the organization works. Besides, there should be inspection by management of both the:

1) Implementation of the benchmarking findings, as well as,
2) Whether the 10 steps of benchmarking were followed adequately.

2.10 STEP 10 - Recalibrating

Recalibrating is to ***stay current*** with changing conditions (including people's attitudes to benchmarking), and the process for reaching a mature benchmarking position that yields superior performance.

A major issue is how to make benchmarking ***institutionalized***. In the early stages, it may be helpful to have a professional start benchmarking exercises. Later, this role should be pushed to ***operational managers***.

However, re-calibrating ***may not be necessary***. Before assuming that re-calibrating is required, an internal assessment often is worthwhile.

3.0 SHEiiBA BENCHMARKING ACTIVITIES

SHEiiBA (Reference 2) is the first organization to be almost entirely involved with benchmarking formally for HSE programs. It started in January 1997. SHEiiBA is the Safety, Health, and Environmental Intra Industry Benchmarking Association. It has about 90 large- in some cases global- companies have signed up, attracted by a mix of members, and the ability to ***share information*** with and ***learn from*** their peers. The scheme is operated through Corporate Benchmarking Services, specialists in HSE benchmarking. It's located at 2 Commercial Street, Edinburgh, U.K. EH6 6JA. Tel: 44(0)131 555 4390; Fax: 44 (0) 131 477 7027. More information on SHEiiBA membership can be obtained through their website www.sheiiba.org.

SHEiiBA provides Safety, Health, and Environmental professionals around the world with a ***mechanism to benchmark*** their processes, resources, and performance with companies from their own and other industry sectors.

The idea is ***based on the view*** that successful practices are ***rarely industry-specific*** and may easily be adopted elsewhere. The principle is that of a ***mutual exchange of data***, information, and ***know-how*** between participants who contribute a small amount of data to a bank of information, and from which they can withdraw significantly greater amounts on demand.

SHEiiBA Phase I produced a wealth of ideas, know-how, company profiles, personnel resource tables, performance charts and detailed reports of all aspects of HSE management.

SHEiiBA Phase II covers all the ***conventional accident statistics*** and includes an anonymous league table of 1998 Injury Incident Rates. But its main strength lies in on open questions, which generate a knowledge-base of ideas and methods used in HSE management. This allows participants to make detailed comparisons with their own systems. Contact details allow for ***networking***.

The subject areas covered in Phase II are:
1. Company and Background Information.
2. Locations, processes, size, injury data, and HSE organization.
3. Structure, responsibilities, behavior, and future challenges.
4. Safety, Health, and Environmental Management Policy.
5. Driver training and management of public road risk
6. Environmental Performance and Challenges

The questionnaire was devised by SHEiiBA's Advisory Council, which was made up of HSE experts its member companies. To facilitate the process of gathering, processing, and disseminating the information, the company has written its ***own software program***, which allows participants to answer questions on the screen with either ***numerical or "free text" answers.***

Once a company becomes a member of SHEiiBA, ***they receive the questionnaire*** information building up between each. Once completed the responses are returned on a single floppy disk by mail to SHEiiBA.

Once the participants have submitted their data, they receive by return-a-read-only version of the entire database on a CD. They can ***browse*** through it by single company, by question or by a filtered subset of companies that correspond to specific user-defined criteria, such as industry sector or geography of operations. When a response proves to be of special interest, the user can ***look up the contact*** in that company and be in touch with the individual concerned.

Existing members are sent ***regular updates*** containing new members' responses.

4.0 CONCLUSION

Successful benchmarking is based on ***achieving*** several important factors and management behaviors. It requires ***management commitment*** to make tough decisions to base operational goals on a concerted view of the external environment. Companies should realize that they can ***learn from others*** and constantly measure themselves against the best in the world.

Benchmarking process safety programs can be ***extremely beneficial***. It is an ***efficien***t and necessary way to develop ***generally acceptable and defensible methodologies***. These techniques incorporate the ***best of risk reduction methods on a cost-benefit-risk basis without increasing risk***.

For years, many standards have been developed by committees of experts using ***benchmarking informally***. However, many standards and guidelines could be ***significantly improved if formal benchmarking*** were used as outlined in this paper. These include the incorporation, of the ***10 basic benchmarking steps*** described, to various extents depending on the individual project.

SHEiiBA, the first organization to be almost entirely devoted to benchmarking HSE programs formally**, has done a fine job in initiating some programs**. Careful consideration should be given to *initiating future HSE benchmarking*, such as the proposed DIERS project on evaluating risk reduction methods for exothermic reaction systems, and for the Mary Kay O'Connor program on the 3 goals of the Chemical Safety Program Assessment Project. ***Many HSE process safety programs could be greatly benefited by a more a formal benchmarking process utilizing the 10 steps to varying extents as needed.***

REFERENCES

Ref. 1 "Benchmarking, The SearchFor Industry Best Practices That Lead To Superior Performance", Camp, R.C., ASQC Quality Press, Milwaukee, WI (1989)

Ref. 2 Internet information on SHEiiBA (www.sheiiba.org)

Ref. 3 "Why DIERS Technology Should Be Used In Runaway Risk : Call For a 1999 Worldwide Benchmarking Survey on Various Risk Reduction Measures Used (for Exothermic Reactor Systems) ", Noronha, J.A. and Torres, A.J., Process Safety Progress, Summer 1999

Ref. 4 Preprints of the Roundtable Meeting the Chemical Safety Program Assessment, Mary Kay O'Connor Process Safety Center, Chemical Engr. Dept, Texas A&M University, June 2-3,1999

Ref. 5 Report on June '99 Roundtable Meeting of the Chemical Safety Program Assessment, Mary Kay O'Connor Process Safety Center, Chemical Engr. Dept., Texas A&M University, July 1999

Ref. 6 "Local Emergency Planning Committee Guidebook- Understanding The EPA Risk Management Program Role", Walter, R. J., 1998, CCPS/AIChE, 3 Park Avenue, NY, NY.

Ref. 7 "Accident History Database - An Opportunity", Mannan,M.S., O'Connor T. M., and West, H. H., Environmental Progress, Vol. 18, No. 1., Spring 1999.

Ref. 8 "Accident Databases: What Do They Tell Us?", McCray, E., Ref. 4.